# Hong Kong Diploma of Secondary Education Examination

**Physics – Compulsory part (必修部分)**

**Section A – Heat and Gases (熱和氣體)**
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

**Section B – Force and Motion (力和運動)**
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

**Section C – Wave Motion (波動)**
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

**Section D – Electricity and Magnetism (電和磁)**
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

**Section E – Radioactivity and Nuclear Energy (放射現象和核能)**
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

**Physics – Elective part (選修部分)**

**Elective 1 – Astronomy and Space Science (天文學和航天科學)**
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恆星和宇宙)

**Elective 2 – Atomic World (原子世界)**
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

**Elective 3 – Energy and Use of Energy (能量和能源的使用)**
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

**Elective 4 – Medical Physics (醫學物理學)**
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)



**The following list of formulae may be found useful :**

For uniformly accelerated motion

$v = u + at$

$s = ut + \frac{1}{2}at^2$

$v^2 = u^2 + 2as$

**Use the following data wherever necessary :**

Acceleration due to gravity $g = 9.81\ \text{m s}^{-2}$ (close to the Earth)

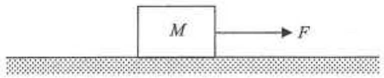
## Part A : HKCE examination questions

**1. < HKCE 1980 Paper II - 10 >**

A spring balance suspended from the ceiling of a lift registers the weight of a 20 kg body as 150 N. The lift is probably

A. ascending with uniform velocity.
B. ascending with uniform acceleration.
C. descending with uniform velocity.
D. descending with uniform acceleration.

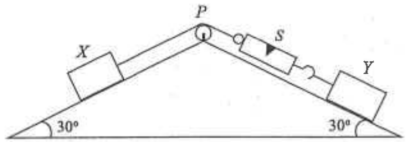
**2. < HKCE 1980 Paper II - 7 >**




A horizontal force $F$ is applied to a block of mass $M$ on a rough horizontal surface. The acceleration of the block is $a$. If the force is changed to $2F$ and the frictional force remains unchanged, then the acceleration of the block will be

A. greater than $2a$.
B. equal to $2a$.
C. between $a$ and $2a$.
D. less than $a$.

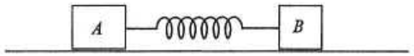
**3. < HKCE 1980 Paper II - 8 >**




In the figure shown, $X$ and $Y$ are blocks of mass 1 kg and 2 kg respectively. $S$ is a spring balance of negligible mass and $P$ is a smooth pulley fixed at the top of two smooth inclined planes. What is the reading of $S$ when $X$ is held stationary by an external force ?

A. 4.9 N
B. 9.8 N
C. 14.7 N
D. 19.6 N

**4.** **< HKCE 1980 Paper II - 3 >**




Two blocks $A$ and $B$ of masses $m_1$ and $m_2$ respectively are connected by a light spring on a horizontal frictionless table. The spring is stretched by moving the blocks apart. What is the ratio of the acceleration of $A$ to that of $B$ at the moment when they are released ?

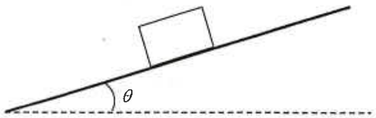
A. $m_1 : m_2$

B. $m_2 : m_1$

C. $m_1^2 : m_2^2$

D. $m_2^2 : m_1^2$

**5.** **< HKCE 1980 Paper II - 4 >**




An object is resting on a rough plane inclined at an angle $\theta$ to the horizontal. As $\theta$ gradually increases, the frictional force acting on the object before sliding occurs is directly proportional to

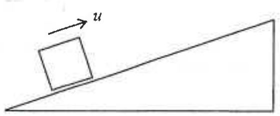
A. 1

B. $\theta$

C. $\sin\theta$

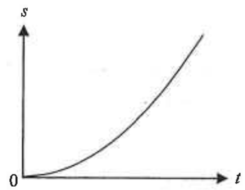
D. $\cos\theta$

**6.** **< HKCE 1981 Paper II - 9 >**

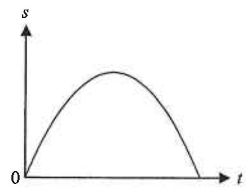



An object is projected up a smooth inclined plane with an initial velocity $u$. Which of the following graphs best represents the variation of the displacement $s$ of the object along the plane with time $t$ ?

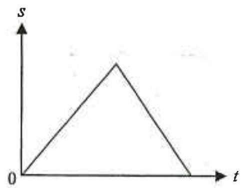
A.



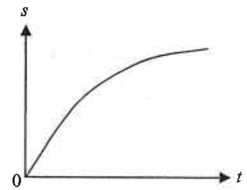

B.




C.

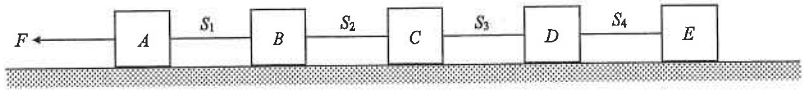



D.






**7.** **< HKCE 1981 Paper II - 6 >**




Five blocks of equal mass $A$, $B$, $C$, $D$ and $E$ are connected by four identical strings, $S_1$, $S_2$, $S_3$ and $S_4$ as shown in the figure above. They are made to slide on a smooth horizontal surface by a steadily increasing force $F$ applied to block $A$. Which of the strings is most likely to break first ?

A. $S_1$

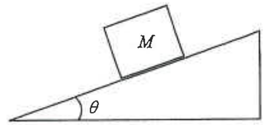
B. $S_2$

C. $S_3$

D. $S_4$

**8.** **< HKCE 1981 Paper II - 3 >**

A body of mass $M$ rests in equilibrium on a plane inclined at an angle $\theta$ to the horizontal. What is the frictional force acting on the body ?




A. zero

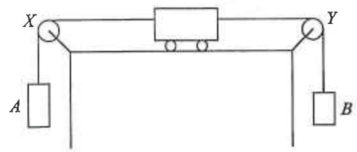
B. $Mg$

C. $Mg \sin\theta$

D. $Mg \cos\theta$

**9.** **< HKCE 1981 Paper II - 4 >**

A trolley of mass 1 kg placed on a smooth horizontal table is connected by two light strings to blocks $A$ and $B$ of masses 0.75 kg and 0.25 kg respectively, as shown in the figure. $X$ and $Y$ are frictionless pulleys. When the system is released, what will be its acceleration ?




A. $0 \text{ m s}^{-2}$

B. $1.0 \text{ m s}^{-2}$

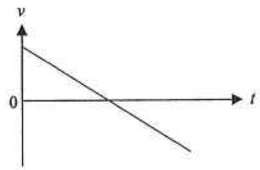
C. $2.5 \text{ m s}^{-2}$

D. $5.0 \text{ m s}^{-2}$

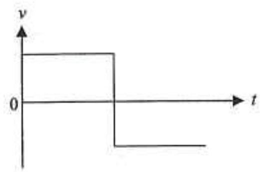
**10.** **< HKCE 1982 Paper II - 5 >**

A constant force directed to the left is acting on a body which is initially travelling to the right. Which of the graphs below best represents the velocity-time graph of the body ?

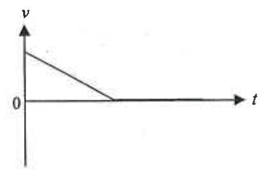
A.



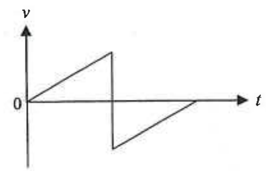

B.




C.

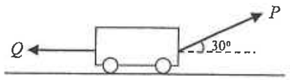



D.



**11.** **< HKCE 1982 Paper II - 7 >**

A trolley on a smooth horizontal surface is pulled by two forces $P$ and $Q$ in the direction as shown in the figure. The magnitude of $P$ and $Q$ are 2 N and 1 N respectively. If the mass of the trolley is 1 kg, the acceleration of the trolley is




A. 0.15 m s$^{-2}$ towards the left
B. 2.24 m s$^{-2}$ towards the left
C. 0.73 m s$^{-2}$ towards the right
D. 0.15 m s$^{-2}$ towards the right

**12.** **< HKCE 1983 Paper II - 8 >**

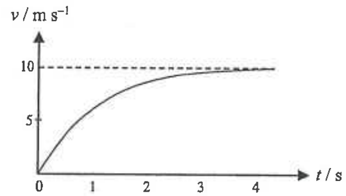
The net force acting on a particle is zero. Which of the statements below concerning the motion of the particle may be true ?
A. The particle is swinging to and fro.
B. The particle is decelerating in a straight line.
C. The particle is moving in a circle with constant speed.
D. The particle is moving with constant velocity.

**13.** **< HKCE 1983 Paper II - 1 >**

A person in a lift, which is ascending at a velocity of 10 m s$^{-1}$, releases a ball. What is the velocity of the ball with respect to the earth at the moment when the ball is released ?
A. 10 m s$^{-1}$ upwards
B. 10 m s$^{-1}$ downwards
C. 20 m s$^{-1}$ upwards
D. 20 m s$^{-1}$ downwards

**14.** **< HKCE 1983 Paper II - 9 >**

The graph shows the variation of velocity $v$ with time $t$ when a metal ball is released from rest and allowed to fall vertically under gravity through oil. Which of the following statements concerning the motion of the ball is/are correct ?



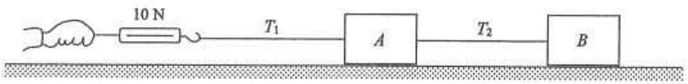

(1) The velocity of the ball decreases with time.
(2) The acceleration of the ball decreases with time.
(3) The ball stops falling after 4 s.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

**15.** **< HKCE 1984 Paper II - 1 >**

If the engine of a rocket travelling in space is turned off, the rocket will
A. stop moving.
B. continue to move with uniform velocity.
C. continue to move with decreasing velocity.
D. continue to move with uniform acceleration.

**16.** **< HKCE 1985 Paper II - 7 >**

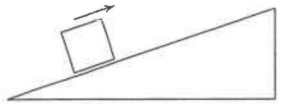



Two blocks $A$ and $B$ of masses 1 kg and 1.5 kg respectively are resting on a smooth horizontal surface and are linked by a string. They are pulled by a force of 10 N as shown in the diagram. What are the tensions $T_1$ and $T_2$ ?

| | Tension $T_1$ | Tension $T_2$ |
|---|---|---|
| A. | 10 N | 10 N |
| B. | 10 N | 6 N |
| C. | 10 N | 4 N |
| D. | 6 N | 4 N |

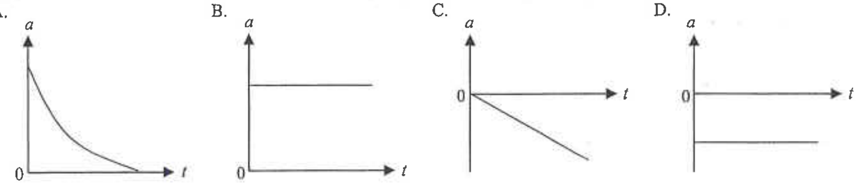


**17.** **< HKCE 1985 Paper II - 10 >**

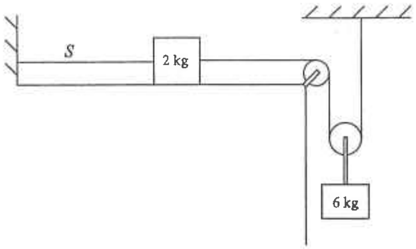


A block is given an initial velocity up a smooth inclined plane. Which graph below shows the acceleration of the block against time ? (The upward direction of motion along the plane is taken as positive.)

A. B. C. D.




**18.** **< HKCE 1986 Paper II - 5 >**

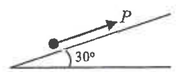



The system of pulleys and blocks is at rest. What is the tension in string $S$ ? (Neglect all friction and the masses of the strings and pulleys.)
A. 9.8 N
B. 19.6 N
C. 29.4 N
D. 39.2 N

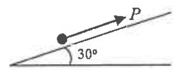
**19.** **< HKCE 1986 Paper II - 3 >**

Which of the following motions of a given mass requires the greatest force $P$ ? (Assume that the surface is smooth.)

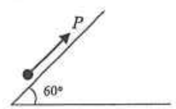
A.
upward acceleration = 0 m s$^{-2}$



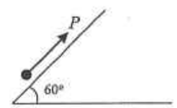

B.
upward acceleration = 1 m s$^{-2}$




C.
upward acceleration = 0 m s$^{-2}$




D.
upward acceleration = 1 m s$^{-2}$



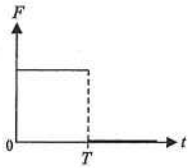
**20.** < HKCE 1987 Paper II - 3 >

Which of the following statements is/are true ? A man in a lift feels heavier when the lift is moving

(1) upwards with acceleration.
(2) upwards with retardation.
(3) downwards with retardation.

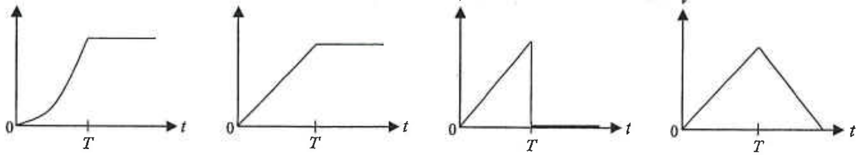
A. (1) only
B. (2) only
C. (1) & (2) only
D. (1) & (3) only

**21.** < HKCE 1987 Paper II - 8 >

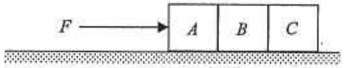



An object is subject to a resultant force ($F$) which varies with time ($t$) as shown in the diagram above. Which of the following graphs correctly shows the variation of its speed ($v$) with time ($t$) ?

A. B. C. D.




**22.** < HKCE 1989 Paper II - 1 >



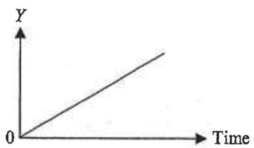

Three blocks of equal mass are placed on a smooth horizontal surface as shown above. A constant force $F$ is applied to block $A$ so that the three blocks move towards the right with the same acceleration. The resultant force acting on block $B$ is

A. 0
B. $\frac{1}{3}F$
C. $\frac{1}{2}F$
D. $\frac{2}{3}F$

**23.** < HKCE 1990 Paper II - 4 >

$Y$ has a linear relationship with time as shown. $Y$ may represent

(1) the speed of a body starting from rest under a constant force.
(2) the distance travelled by a body at constant speed.
(3) the acceleration of a body falling from rest.

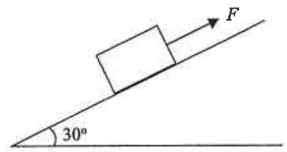



A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only



**24.** < HKCE 1991 Paper II - 9 >

A force $F$ is applied to a block of mass 1 kg as shown below. The **greatest** value of $F$ for the block to remain at rest is 11 N. What would be the motion of the block if $F$ is not applied ?
(Take the acceleration due to gravity to be 10 m s$^{-2}$.)




A. remaining at rest
B. sliding down with constant velocity
C. sliding down with an acceleration of 1 m s$^{-2}$
D. sliding down with an acceleration of 5 m s$^{-2}$

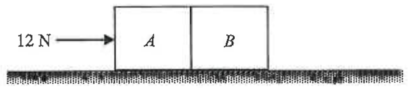
**25.** < HKCE 1991 Paper II - 10 >

A man of weight $W$ stands inside a lift which is moving upwards with a constant speed. If the force exerted by the floor on the man is $R$, which of the below statements is/are correct ?

(1) $R$ is greater than $W$ in magnitude.
(2) $R$ and $W$ are in opposite directions.
(3) $R$ and $W$ form an action and reaction pair according to Newton's third law.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

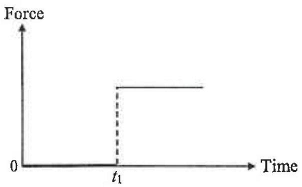
**26.** < HKCE 1991 Paper II - 2 >




Two blocks of equal mass are placed on a smooth horizontal surface as shown above. A constant force of 12 N is applied to block $A$ so that the two blocks move towards the right together. The force acting on $A$ by $B$ is

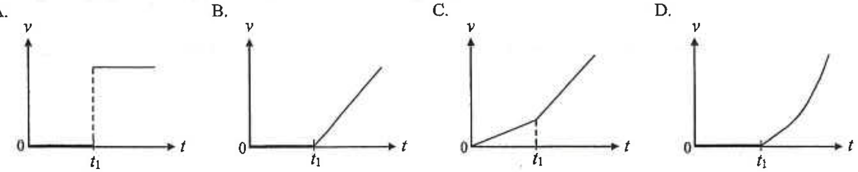
A. 6 N to the left.
B. 6 N to the right.
C. 12 N to the left.
D. 12 N to the right.

**27.** < HKCE 1991 Paper II - 7 >

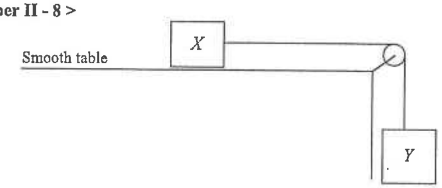



The diagram above shows the variation of the net force acting on an object which is initially at rest. Which of the following velocity-time graphs correctly describes the motion of the object ?

A. B. C. D.



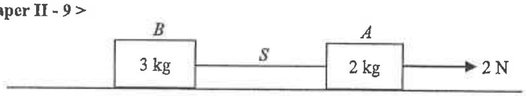
**28.** < HKCE 1992 Paper II - 8 >




Two identical blocks $X$ and $Y$ are connected by a light string passing over a smooth pulley as shown above. The two blocks are released from rest. After a while, the string breaks. Which of the following correctly describes the motion of the blocks immediately after the string breaks ? (Take the acceleration due to gravity to be 10 m s$^{-2}$.)

| | $X$ | $Y$ |
|---|---|---|
| A. | stops moving | accelerates at 5 m s$^{-2}$ |
| B. | moves with constant velocity | accelerates at 5 m s$^{-2}$ |
| C. | moves with constant velocity | accelerates at 10 m s$^{-2}$ |
| D. | decelerates at 5 m s$^{-2}$ | accelerates at 10 m s$^{-2}$ |

**29.** < HKCE 1992 Paper II - 9 >



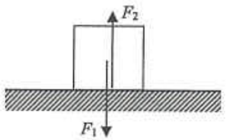

In the diagram above, blocks $A$ and $B$ are connected by a light inextensible string and rest on a smooth horizontal table. The masses of $A$ and $B$ are 2 kg and 3 kg respectively. Block $A$ is pulled by a force of 2 N. Find the tension in the string $S$.

A. 0.4 N
B. 0.8 N
C. 1.0 N
D. 1.2 N

**30.** < HKCE 1992 Paper II - 10 >

Which of the following pairs of forces $F_1$ and $F_2$ is/are action and reaction pair(s) according to the Newton's third law of motion ?

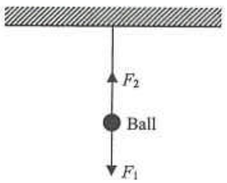
(1)




$F_1$ = Weight of the block

$F_2$ = Reaction from the floor

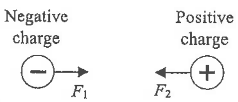
(2)




$F_1$ = Weight of the ball

$F_2$ = Tension of the string

(3)




$F_1$ = Electric force acting on the negative charge

$F_2$ = Electric force acting on the positive charge

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only



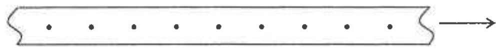
**31.** < HKCE 1994 Paper II - 6 >

A man of mass 50 kg is standing in a lift. If the lift is falling freely, which of the following statements is/are true ?

(1) The weight of the man is 0 N.
(2) The force acting on the floor of the lift by the man is 491 N.
(3) The force acting on the man by the floor of the lift is 0 N.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**32.** < HKCE 1994 Paper II - 2 >

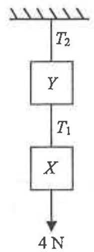


A trolley is given a push and runs down a friction-compensated runway. The motion of the trolley is recorded on the paper tape as shown above. Which of the following changes can enable the trolley to produce a paper tape as shown below :

(1) Giving the trolley a harder initial push.
(2) Increasing the angle of inclination of the runway.
(3) Increasing the frequency of the ticker-tape timer.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**33.** < HKCE 1994 Paper II - 4 >




Two blocks $X$ and $Y$ of weights 2 N and 8 N respectively are suspended by two light strings as shown in the diagram. A downward force of 4 N is applied to $X$. Find the tension $T_1$ and $T_2$ in the two strings.

| | $T_1$ | $T_2$ |
|---|---|---|
| A. | 4 N | 10 N |
| B. | 4 N | 14 N |
| C. | 6 N | 12 N |
| D. | 6 N | 14 N |

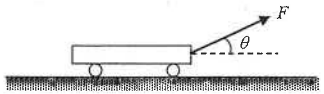
**34.** < HKCE 1995 Paper II - 7 >

A car moves with a speed 30 km h$^{-1}$. The driver applies the brake and the car is stopped in a distance of 12 m. If the car is moving at 60 km h$^{-1}$, what is the stopping distance ? Assume that the same constant braking force is applied in both cases.

A. 12 m
B. 24 m
C. 48 m
D. 72 m

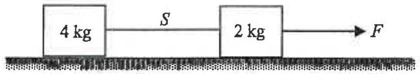
**35.** **< HKCE 1995 Paper II - 6 >**

A trolley is placed on a horizontal ground. A force $F$ inclined at an angle $\theta$ to the horizontal acts on the trolley. What is the horizontal component of $F$ that pulls the trolley towards the right ?




A. $F\theta$
B. $F \sin\theta$
C. $F \cos\theta$
D. $F / \sin\theta$

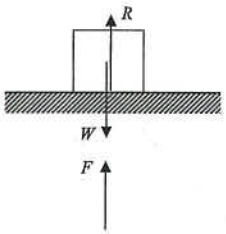
**36.** **< HKCE 1995 Paper II - 2 >**




Two blocks are connected together by a light string $S$ placed on a smooth horizontal surface. They move with uniform acceleration of 2 m s$^{-2}$ under the action of force $F$. What will the accelerations of the blocks become if $S$ suddenly breaks ?

| | 2 kg block | 4 kg block |
|---|---|---|
| A. | 6 m s$^{-2}$ | 0 m s$^{-2}$ |
| B. | 6 m s$^{-2}$ | 2 m s$^{-2}$ |
| C. | 2 m s$^{-2}$ | 0 m s$^{-2}$ |
| D. | 0 m s$^{-2}$ | 3 m s$^{-2}$ |

**37.** **< HKCE 1995 Paper II - 11 >**




$W$ : the weight of the block

$F$ : the gravitational force acting on the earth by the block

$R$ : the force acting on the block by the ground

The above diagram shows a block resting on the ground. Which of the following pairs of forces is/are action and reaction pair(s) according to Newton's third law of motion ?

(1) $R$ and $W$
(2) $W$ and $F$
(3) $F$ and $R$

A. (1) only
B. (2) only
C. (3) only
D. (1) & (2) only

**38.** **< HKCE 1995 Paper II - 5 >**

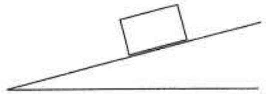
Two objects of difference masses are released from rest at the same height. Assume air resistance is negligible. Which of the following statements is/are correct ?

(1) A greater gravitational force is acting on the object with greater mass.
(2) They take the same time to reach the ground.
(3) They have equal velocities when they reach the ground.

A. (1) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)



**39.** **< HKCE 1996 Paper II - 8 >**

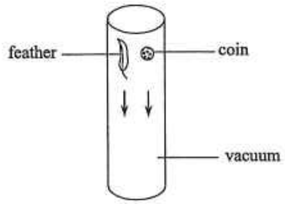


A block remains at rest on an inclined plane as shown above. Which of the following statements is/are true ?

(1) The frictional force acting by the plane on the block is zero.
(2) The normal reaction acting by the plane on the block is zero.
(3) The resultant force acting on the block is zero.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

**40.** **< HKCE 1996 Paper II - 6 >**



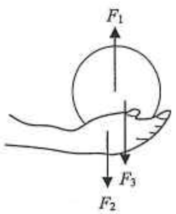

A coin and a feather are released from rest in a cylinder which is vacuum as shown. Which of the following is/are correct deductions from this experiment ?

(1) The masses of the coin and the feather are identical in vacuum.
(2) The coin and the feather fall with the same acceleration in vacuum.
(3) The forces acting on the coin and the feather in vacuum are identical.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

**41.** **< HKCE 1996 Paper II - 10 >**

The below diagram shows a man lifting a ball vertically upwards with uniform acceleration.




Let $F_1$ be the force acting on the ball by the man,
$F_2$ be the force acting on the man by the ball,
$F_3$ be the gravitational force acting on the ball.

Which of the following correctly describes the relation between the magnitudes of the forces ?

A. $F_1 = F_2 > F_3$
B. $F_1 = F_3 > F_2$
C. $F_1 > F_2 = F_3$
D. $F_1 > F_2 > F_3$

**42.** **< HKCE 1996 Paper II - 5 >**

Which of the following statements concerning the motion of an object is/are correct ?

(1) A constant unbalanced force is needed to keep an object moving with uniform velocity.
(2) An increasing unbalanced force is needed to keep an object moving with uniform acceleration.
(3) An object may remain at rest if there is no unbalanced force acting on it.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

**43.** **< HKCE 1996 Paper II - 3 >**

Which of the following statements about mass and weight is **incorrect** ?

A. Mass is measured in kilograms and weight in newtons.
B. Mass is a measure of the inertia of an object and weight is a measure of the gravitational pull on it.
C. The weight of an object at a particular place is proportional to its mass.
D. Both the mass and weight of an object vary slightly at different places on the earth.

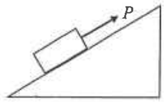
**44.** **< HKCE 1997 Paper II - 9 >**

Which of the following pairs of forces is/are action and reaction pair(s) according to Newton's third law of motion ?

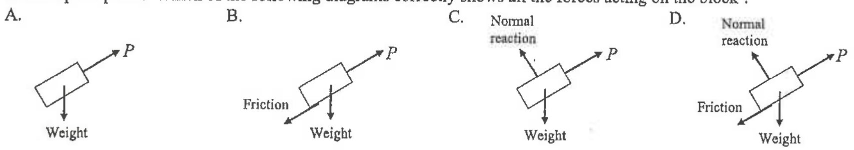
| | | | |
|---|---|---|---|
| (1) | The weight of a man standing on a chair. | and | The force acting on the man by the chair. |
| (2) | The gravitational force acting on the earth by the moon. | and | The gravitational force acting on the moon by the earth. |
| (3) | The force exerted by a swimmer on the water to push the water backward. | and | The force exerted by the water to push the swimmer forward. |

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

**45.** **< HKCE 1997 Paper II - 4 >**

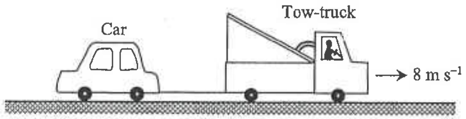



A block is placed on a <u>smooth</u> inclined plane. A force $P$ parallel to the inclined plane is applied to the block so that the block moves up the plane. Which of the following diagrams correctly shows all the forces acting on the block ?




**46.** **< HKCE 1998 Paper II - 6 >**

A broken-down car of mass 1000 kg is pulled by a tow-truck and moves at a constant velocity 8 m s$^{-1}$ along a horizontal road. It is known that the frictional force acting on the car is 500 N. Find the tension in the cable connecting the truck and the car.




A. 0 N
B. 500 N
C. 8000 N
D. 8500 N

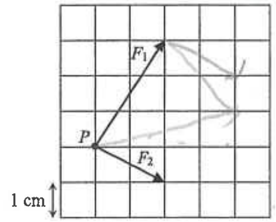


**47.** **< HKCE 1998 Paper II - 8 >**

A girl in a lift uses a spring balance to measure the weight of an object. The reading of the spring balance is 10 N when the lift is at rest. When the lift is moving, the reading of the spring balance becomes 8 N. Which of the following describes the motion of the lift ?

A. moving downwards with a uniform velocity
B. moving upwards with an acceleration
C. moving downwards with an acceleration
D. moving downwards with a deceleration

**48.** **< HKCE 1998 Paper II - 7 >**




Scale : 1 cm represents 1 N

Two forces $F_1$ and $F_2$ act on a particle $P$ as shown. If a third force $F_3$ acts on $P$ to keep it in equilibrium, what should be the magnitude of $F_3$ ?

A. 1.4 N
B. 4.0 N
C. 4.2 N
D. 4.5 N

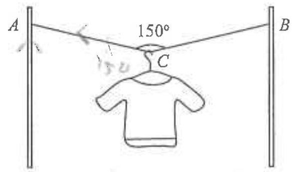
**49.** **< HKCE 1998 Paper II - 9 >**

Which of the following phenomena can be explained by Newton's first law of motion ?

(1) A passenger in a car tends to move forward when the car suddenly stops.
(2) A coin and a feather fall with the same acceleration in a vacuum.
(3) The maximum mass an astronaut can lift on the moon is greater than on earth.

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

**50.** **< HKCE 1999 Paper II - 5 >**



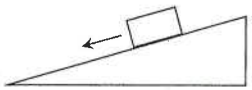

A light rope is fixed at two poles with the ends $A$ and $B$ at the same level. A T-shirt of weight 2 N is hung at the midpoint $C$ of the rope. The rope depresses such that $\angle ACB = 150°$. Find the tension in the rope.

A. 1.0 N
B. 2.0 N
C. 3.9 N
D. 7.7 N

**51.** **< HKCE 1999 Paper II - 4 >**

A block is sliding down a friction compensated runway as shown. Which of the following statements is/are correct ?

(1) The speed of the block is increasing.
(2) The normal reaction acting by the runway on the block is increasing.
(3) The net force acting on the block is zero.



A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**52.** **< HKCE 1999 Paper II - 2 >**

A 2 kg steel sphere and a 1 kg wooden sphere are initially held at the same level above the ground and then released from rest simultaneously. Assume air resistance is negligible. Which of the following statements about the two spheres at any instant before they reach the ground is/are correct ?

(1) The speeds of the two spheres are equal.
(2) The accelerations of the two spheres are equal.
(3) The gravitational forces acting on the two spheres are equal.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

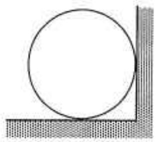
**53.** **< HKCE 2000 Paper II - 2 >**

It is said that Galileo Galilei (1564 - 1642), an Italian scientist, dropped a small iron ball and a large cannon ball from the top of the Leaning Tower of Pisa. He found that the two balls reached the ground at almost the same time.
Which of the following is/are correct deduction(s) from this experiment ?

(1) The two balls fell with the same acceleration.
(2) A body will maintain uniform motion if there is no external force acting on it.
(3) The gravitational forces acting on the two balls were identical.

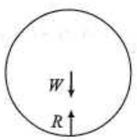
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

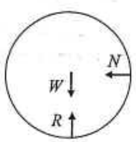
**54.** **< HKCE 2000 Paper II - 8 >**

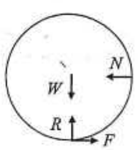


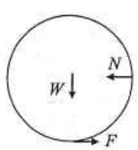
A uniform steel ball lies at rest on a horizontal ground and just touches a vertical wall as shown in the diagram. Which of the following diagrams shows all the forces acting on the ball ?

(Note : $W$ = gravitational force acting on the ball, $R$ = normal reaction from the ground,
$F$ = friction acting by the ground on the ball, $N$ = normal reaction from the wall. )

A.


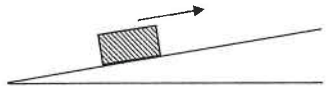

B.



C.


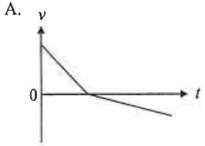

D.


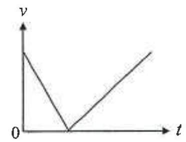


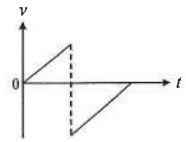

**55.** **< HKCE 2000 Paper II - 7 >**

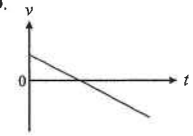


A block is placed on a rough inclined plane and then projected upwards along the plane. After reaching the highest point, the block slides down along the plane. Which of the following graphs shows the time variation of the velocity $v$ of the block ?

A.


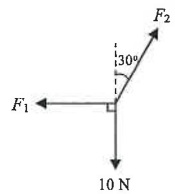

B.



C.



D.


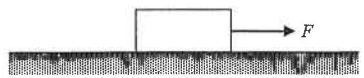

**56.** **< HKCE 2000 Paper II - 6 >**

Three forces of magnitudes $F_1$ , $F_2$ and 10 N act on an object as shown.
If the object is in equilibrium, find the force $F_2$.

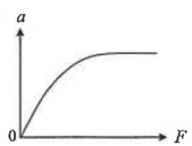


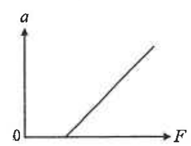

A. 5.0 N
B. 8.7 N
C. 11.5 N
D. 17.3 N

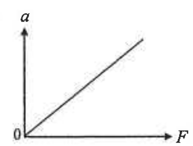
**57.** **< HKCE 2000 Paper II - 9 >**

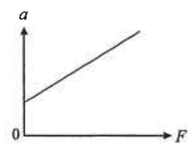



A block is placed on a rough horizontal ground and a horizontal force acts on the block. If the magnitude of the force, $F$, is increased gradually, which of the following graphs shows the relation between $F$ and the acceleration $a$ of the block ?

A.



B.



C.



D.


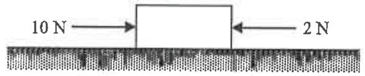

**58.** **< HKCE 2000 Paper II - 5 >**

An astronaut lands on the moon and finds that his weight is about one-sixth of that on the earth. Which of the following deductions is/are correct ?

(1) If he throws an object upwards on the moon, it will reach a higher level than throwing the object with the same speed on earth.
(2) If he releases an object on the moon, it will take a shorter time to reach the ground than releasing the object from the same height on earth.
(3) The maximum weight he can lift on the moon is greater than on earth.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

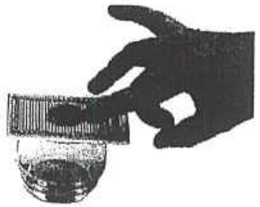
**59.** **< HKCE 2001 Paper II - 5 >**




A block on a rough horizontal table is acted on by two horizontal forces of magnitudes 10 N and 2 N as shown. It remains at rest on the table. If the force of magnitude 10 N is removed, find the resultant force acting on the block.

A. zero
B. 2 N
C. 6 N
D. 8 N

**60.** **< HKCE 2001 Paper II - 4 >**

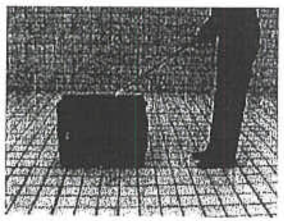


A coin is placed on a piece of cardboard resting on a glass as shown above. If the cardboard is flickered with a finger, the coin will drop into the glass. What does this experiment demonstrate ?

A. The coin will fall with uniform acceleration under the action of gravity.
B. The acceleration of the coin is proportionally to the applied force.
C. Action and reaction always occur in pairs.
D. The coin has a tendency to maintain its state of rest.

**61.** **< HKCE 2001 Paper II - 9 >**

A man is pulling a suitcase along the horizontal ground as shown below.



Which of the following pairs of forces is/are action and reaction pair(s) according to Newton's third law of motion ?

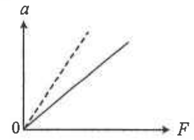
| | | |
|---|---|---|
| (1) The gravitational force exerted by the earth on the man | **and** | The gravitational force exerted by the man on the earth |
| (2) The pulling force exerted by the man on the suitcase | **and** | The friction exerted by the ground on the suitcase |
| (3) The gravitational force exerted by the earth on the suitcase | **and** | The normal reaction exerted by the ground on the suitcase |

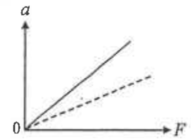
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

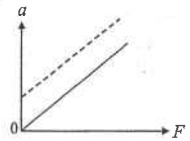


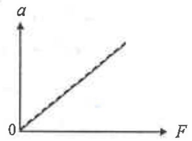
**62.** **< HKCE 2001 Paper II - 7 >**


A student uses a friction-compensated runway to study Newton's second law of motion. The variation of the acceleration $a$ of the trolley with the force $F$ applied parallel to the runway is shown above. If the experiment is repeated with the runway making a larger angle of inclination with the horizontal, which of the graphs (in dotted lines) represents the expected result ?

A.



B.



C.



D.



**63.** **< HKCE 2002 Paper II - 7 >**

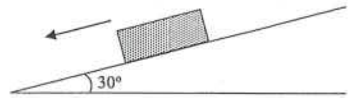
John, of mass 80 kg, is standing on a weighing scale in a lift. At a certain instant, the reading of the weighing scale is 600 N. Which of the following statements about John at this instant is/are correct ?
(Take the acceleration due to gravity to be 10 m $s^{-2}$.)

(1) The gravitational force acting on John is 600 N.
(2) The force exerted by the weighing scale on John is 200 N.
(3) John is accelerating downward at a rate of 2.5 m $s^{-2}$.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

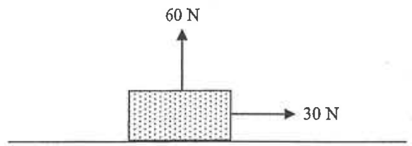
**64.** **< HKCE 2002 Paper II - 6 >**

A block of mass 0.5 kg slides down a rough inclined plane with an acceleration of 3 m $s^{-2}$. If the plane is inclined at 30° to the horizontal, find the friction between the block and the plane.




A. 0.95 N
B. 1.47 N
C. 2.75 N
D. 3.92 N

**65.** **< HKCE 2002 Paper II - 9 >**




A block of weight 100 N is placed on a smooth horizontal table. A vertical force of 60 N and a horizontal force of 30 N are applied to the block as shown. Find the magnitude of the resultant force acting on the block.

A. 30 N
B. 40 N
C. 50 N
D. 67 N

**66.** **< HKCE 2002 Paper II - 4 >**

The following are statements written by three students about Newton's first law of motion.

(1) A stationary object will remain in a state of rest unless acted on by an unbalanced force.
(2) An object undergoing uniform motion will maintain its motion unless acted on by an unbalanced force.
(3) An unbalanced force is required to maintain the motion of an object at uniform velocity.

Which of the above statements is/are correct ?

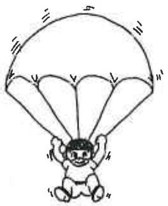
A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

**67.** **< HKCE 2002 Paper II - 5 >**

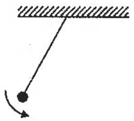
Which of the following objects are under the action of an unbalanced force at the instant shown in the diagrams ?

(1) a **football** being kicked by a player

(2) a **parachutist** falling with uniform velocity

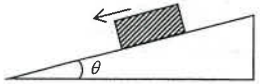


(3) a swinging pendulum **bob**



A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

**68.** **< HKCE 2003 Paper II - 5 >**

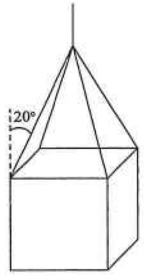



A block of mass $m$ slides down an inclined plane with uniform velocity. What is the net force acting on the block ?

A. $mg$
B. $mg \sin \theta$
C. $mg \cos \theta$
D. zero



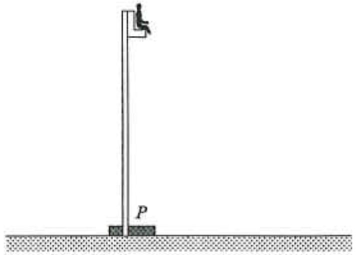
**69.** **< HKCE 2003 Paper II - 7 >**




A uniform cube of weight 600 N is held in equilibrium in the air by four identical cables as shown above. If each cable makes an equal angle of 20° with the vertical, find the tension in each cable.

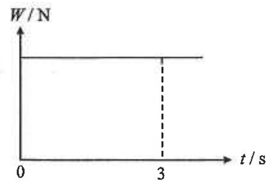
A. 150 N
B. 160 N
C. 412 N
D. 439 N

**70.** **< HKCE 2003 Paper II - 6 >**

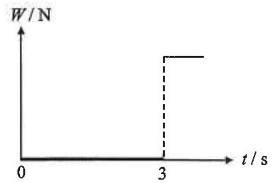



The figure shows a ride in an amusement park. A passenger is fastened to a seat which is then raised to the top of a vertical pole. At time $t = 0$, the seat is released from rest and falls freely. After 3 s, the seat is brought to rest at a point $P$ near the ground. Which of the below graphs best shows the relation between the gravitational force acting on the passenger $W$ and $t$ ?

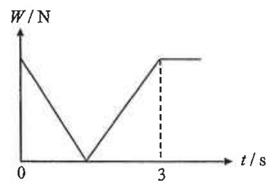
A.



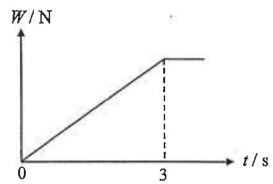

B.




C.




D.



71. < HKCE 2003 Paper II - 8 >

A car accelerates at 3 m s$^{-2}$ along a straight horizontal road. A child of mass 10 kg is sitting on a safety seat inside a car. Find the magnitude of the resultant force exerted by the safety seat on the child.
(Take the acceleration due to gravity to be 10 m s$^{-2}$.)

A. 30 N
B. 100 N
C. 104 N
D. 130 N

72. < HKCE 2003 Paper II - 12 >

A child is sitting on a chair as shown above. Which of the following pairs of forces is/are (an) action and reaction pair(s) ?

| | | |
|---|---|---|
| (1) The gravitational force exerted by the earth on the child. | **and** | The normal reaction exerted by the chair on the child. |
| (2) The force exerted by the child on the chair. | **and** | The normal reaction exerted by the chair on the child. |
| (3) The force exerted by the chair on the ground. | **and** | The gravitational force exerted by the earth on the chair. |

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

73. < HKCE 2004 Paper II - 2 >

An object weighs 60 N on the Earth and 10 N on the moon. Which of the following statements are correct ?
(Take the acceleration due to gravity to be 10 m s$^{-2}$.)

(1) The mass of the object on the Earth is 6 kg.
(2) The mass of the object on the moon is 1 kg.
(3) The acceleration due to gravity on the moon is one-sixth that on the Earth.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)



74. < HKCE 2004 Paper II - 5 >

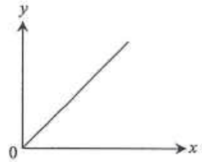

Figure (a) Figure (b)

Two blocks, of masses $m_1$ and $m_2$ ($m_1 > m_2$), are connected by a light inextensible string and placed on a smooth horizontal surface. Let $T_1$ and $T_2$ be the tensions in the string when a horizontal force of magnitude $F$ is applied to the blocks as shown in Figures (a) and (b) respectively. Which of the following relationships are correct ?

(1) $T_1 > T_2$
(2) $\frac{T_1}{m_1} = \frac{T_2}{m_2}$
(3) $T_1 + T_2 = F$

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

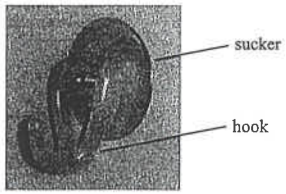
75. < HKCE 2004 Paper II - 7 >




A block is initially at rest on a smooth horizontal table and is pulled by a constant horizontal force. The figure shows the relationship between the physical quantities $y$ and $x$. Which of the following combinations of $y$ and $x$ is **impossible** ?

| | $y$ | $x$ |
|---|---|---|
| A. | displacement of the block | square of time |
| B. | velocity of the block | time |
| C. | square of velocity of the block | displacement of the block |
| D. | acceleration of the block | time |

76. < HKCE 2004 Paper II - 8 >




The photograph shows a sucker sticking a hook to a vertical wall. Which of the following forces balances the gravitational force acting on the sucker and hook by the Earth ?

A. the friction between the sucker and the wall
B. the force exerted by the air molecules on the sucker
C. the normal reaction exerted by the wall on the sucker
D. the gravitational force acting on the Earth by the sucker and hook

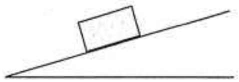
**77.** **< HKCE 2004 Paper II - 4 >**

An object is acted on by three forces $F_1$, $F_2$ and $F_3$ in suitable directions such that it remains at rest. Which of the following combinations of the magnitude of the forces is/are possible ?

| | $F_1$ | $F_2$ | $F_3$ |
|---|---|---|---|
| (1) | 3 N | 4 N | 5 N |
| (2) | 3 N | 4 N | 7 N |
| (3) | 3 N | 5 N | 9 N |

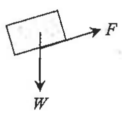
A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

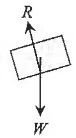
**78.** **< HKCE 2005 Paper II - 3 >**

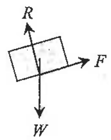


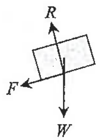
A block remains at rest on a rough inclined plane. Which of the following diagrams shows all the forces acting on the block ?

Note : $W$ = gravitational force acting on the block,
$R$ = normal reaction exerted by the inclined plane on the block, and
$F$ = friction acting on the block.

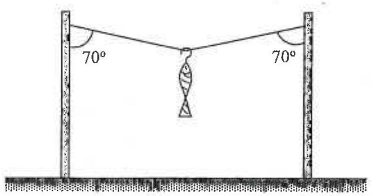
A.



B.



C.



D.



**79.** **< HKCE 2005 Paper II - 32 >**




A fish is hung on a light string as shown above. If the tension in the string is 10 N, find the total weight of the fish and the hook.

A. 10 sin 70° N
B. 10 cos 70° N
C. 20 sin 70° N
D. 20 cos 70° N

**80.** **< HKCE 2005 Paper II - 4 >**

A 1 kg block is pulled by a horizontal force of 5 N and moves with an acceleration of 2 m s$^{-2}$ on a rough horizontal plane. Find the frictional force acting on the block.


A. zero
B. 2 N
C. 3 N
D. 7 N



**81.** **< HKCE 2005 Paper II - 30 >**

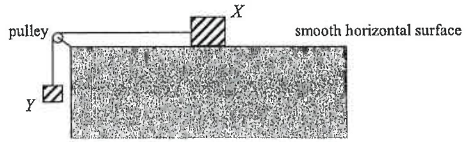
Kelvin is standing on a balance inside a lift. The table shows the readings of the balance in three situations.

| Motion of the lift | Reading of the balance |
|---|---|
| moving upwards with a uniform speed | $R_1$ |
| moving downwards with a uniform speed | $R_2$ |
| moving upwards with an acceleration | $R_3$ |

Which of the following relationships is correct ?

A. $R_1 = R_2 > R_3$
B. $R_3 > R_1 = R_2$
C. $R_1 > R_2 > R_3$
D. $R_3 > R_1 > R_2$

**Questions 82 and 83 :**
Two blocks $X$ and $Y$ are connected by a light string passing over a smooth pulley as shown below. The mass of $X$ is greater than that of $Y$. The blocks are released from rest.




**82.** **< HKCE 2005 Paper II - 28 >**

Which of the following pairs of physical quantities are **not** equal while the blocks are in motion ?

A. the speeds of the blocks
B. the magnitude of the accelerations of the blocks
C. the magnitude of the resultant forces acting on the blocks
D. the magnitude of the forces exerted by the string on the blocks

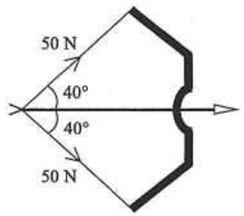
**83.** **< HKCE 2005 Paper II - 29 >**

Which of the following pairs of forces is an action and reaction pair ?

| | | | |
|---|---|---|---|
| A. | The force exerted by the string on $X$ | **and** | The force exerted by the string on $Y$ |
| B. | The force exerted by the string on $Y$ | **and** | The force exerted by $Y$ on the string |
| C. | The gravitational force exerted on $X$ | **and** | The force exerted by $X$ on the horizontal surface |
| D. | The gravitational force exerted on $Y$ | **and** | The force exerted by the string on $Y$ |

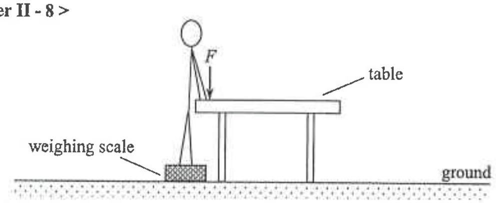
**84.** **< HKCE 2006 Paper II - 30 >**

A bow is pulled horizontally to create a tension of 50 N on its string as shown in the figure. What is the net horizontal force acting on the arrow when it is released ?




A. 32.1 N
B. 38.3 N
C. 64.3 N
D. 76.6 N

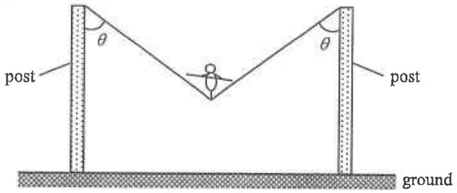
**85.** **< HKCE 2006 Paper II - 8 >**




If Peter stands with his feet on a weighing scale placed on level ground, his weight measured by the scale is $W$. What would be the reading on the scale if he exerts a downward force $F$ on a table top with his hands while he is still standing on the same scale as shown above ?

A. $W$
B. $W + F$
C. $W - F$
D. $F$

**86.** **< HKCE 2006 Paper II - 29 >**




An acrobat is standing in the middle of a cable as shown. The angle $\theta$ is less than 60°. Which of the following relations between the tension $T$ of the cable and the weight $W$ of the acrobat is correct ? (Neglect the weight of the cable.)

A. $T > W$
B. $W > T > \frac{W}{2}$
C. $T = \frac{W}{2}$
D. $T < \frac{W}{2}$

**87.** **< HKCE 2006 Paper II - 31 >**

A student performed an experiment to investigate the factors affecting the acceleration of a trolley carrying different loads. The table below shows the data recorded :

| Trial | Net Force / N | Total mass of the loaded trolley / kg | Acceleration / m s$^{-2}$ |
|---|---|---|---|
| (i) | 2 | 2 | 1 |
| (ii) | 2 | 1 | 2 |
| (iii) | 2 | 0.5 | 4 |
| (iv) | 4 | 2 | 2 |
| (v) | 4 | 4 | 1 |
| (vi) | 8 | 2 | 4 |

Which trials can the student use to deduce the relationship between the acceleration and the net force acting on the trolley ?

A. (i), (ii) and (iii)
B. (i), (iv) and (vi)
C. (ii), (iv) and (v)
D. (iii), (v) and (vi)



**88.** **< HKCE 2006 Paper II - 2 >**

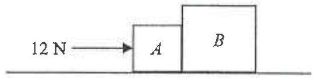
Many traffic accidents on highways are associated with inertia. Which of the following traffic regulations can reduce the risk of traffic accidents due to inertia ?

(1) Passengers should wear seat belts.
(2) Vehicles should not be overloaded.
(3) People should not drive over the speed limit.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

**89.** **< HKCE 2007 Paper II - 3 >**

Two blocks, $A$ and $B$, of masses 1 kg and 3 kg respectively, are placed on a horizontal smooth surface as shown. A horizontal constant force of 12 N is applied to block $A$ so that the two blocks move to the right with uniform acceleration. What is the magnitude of the contact force between $A$ and $B$ ?




A. 3 N
B. 4 N
C. 8 N
D. 9 N

**90.** **< HKCE 2007 Paper II - 5 >**

A horse pulls a block along a rough horizontal road and moves with a uniform velocity. Which of the following correctly describes the directions of the friction from the ground acting on the horse and the block ?

| | Horse | Block |
|---|---|---|
| A. | backward | forward |
| B. | backward | backward |
| C. | forward | forward |
| D. | forward | backward |

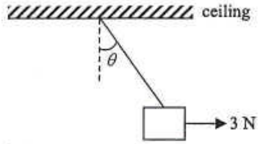
**91.** **< HKCE 2007 Paper II - 6 >**

A child is standing on a weighing scale as shown above. Which of the following pairs of forces is/are (an) action and reaction pair(s) ?

| | | | |
|---|---|---|---|
| (1) | The force exerted by the child on the scale | **and** | The force exerted by the scale on the child |
| (2) | The gravitational force exerted by the Earth on the child | **and** | The force exerted by the scale on the child |
| (3) | The gravitational force exerted by the Earth on the scale | **and** | The gravitational force exerted by Earth on the child |

A. (1) only
B. (2) only
C. (1) & (3) only
D. (2) & (3) only

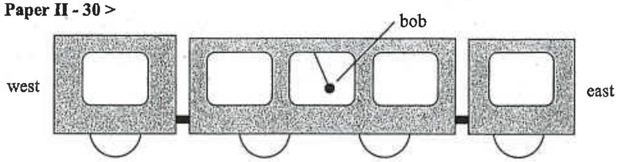
**92.** **< HKCE 2007 Paper II - 30 >**




In the above figure, a 1 kg block is suspended by a string under the ceiling. The block is pulled by a 3 N horizontal force such that it makes angle $\theta$ to the vertical. Which of the following descriptions is correct ? (Note: The tension of the string is denoted as $T$.)

| | $\theta$ | $T$ |
|---|---|---|
| A. | $\theta < 30°$ | $13\text{ N} > T > 10\text{ N}$ |
| B. | $\theta < 30°$ | $T > 13\text{ N}$ |
| C. | $\theta > 30°$ | $13\text{ N} > T > 10\text{ N}$ |
| D. | $\theta > 30°$ | $T > 13\text{ N}$ |

**93.** **< HKCE 2008 Paper II - 30 >**




A bob is hung by a string from the ceiling of a train. At a certain instant, the bob is inclined to the east as shown in the figure. Which of the following descriptions about the motion of the train at this instant is/are possible ?

(1) It is moving to the east and decelerating.
(2) It is moving to the west and accelerating.
(3) It starts to move to the east from rest.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**94.** **< HKCE 2008 Paper II - 7 >**

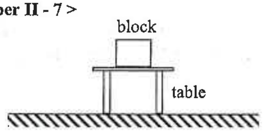



**Figure (a)**

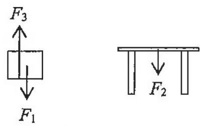



**Figure (b)**

A block is placed on a table resting on the ground as shown in Figure (a) above. Figure (b) shows the forces acting on the block and the table respectively.

Let $F_1$ = weight of the block
$F_2$ = force exerted by the block on the table
$F_3$ = force exerted by the table on the block

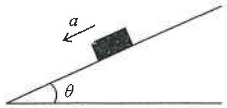
Which of the following statements are correct ?

(1) $F_1$ and $F_2$ represent the same force.
(2) $F_1$ and $F_3$ balance each other.
(3) $F_2$ and $F_3$ form an action-reaction pair.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)



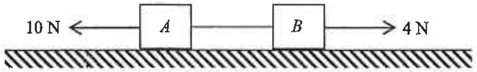
**95.** **< HKCE 2008 Paper II - 33 >**




A block of mass $m$ slides down along a rough inclined plane with constant acceleration $a$ as shown above. What are the friction and the normal reaction acting on the block ?

| | **Friction** | **Normal Reaction** |
|---|---|---|
| A. | $m\,g\sin\theta + m\,a$ | $m\,g\sin\theta$ |
| B. | $m\,g\sin\theta - m\,a$ | $m\,g\cos\theta$ |
| C. | $m\,g\cos\theta + m\,a$ | $m\,g\sin\theta$ |
| D. | $m\,g\cos\theta - m\,a$ | $m\,g\cos\theta$ |

**96.** **< HKCE 2008 Paper II - 5 >**




Two blocks $A$ and $B$ of the same mass on a horizontal surface are connected by a string as shown above. Two horizontal forces of 10 N and 4 N are acting on $A$ and $B$ respectively. Assume all contact surfaces are smooth. What is the magnitude of the tension in the string ?

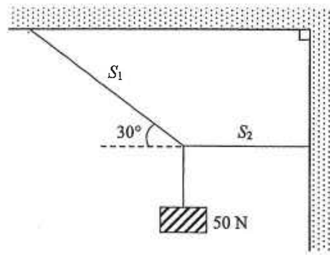
A. 3 N
B. 6 N
C. 7 N
D. 14 N

**97.** **< HKCE 2009 Paper II - 4 >**

A block of mass 1 kg rests on a rough horizontal plane. When it is pulled by a horizontal force of 5 N, it moves with an acceleration of 2 m s$^{-2}$. Now, the block is at rest and is pulled by a horizontal force of 2 N, what is the resultant force acting on the block ?

A. zero
B. 1 N
C. 2 N
D. 3 N

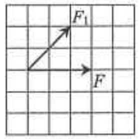
**98.** **< HKCE 2009 Paper II - 29 >**



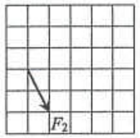

A 50 N block is suspended by two threads as shown in the figure above. Thread $S_1$ makes an angle 30° with the horizontal and thread $S_2$ is horizontal. What is the tension in $S_2$ ?

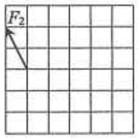
A. 28.9 N
B. 57.7 N
C. 86.6 N
D. 100 N

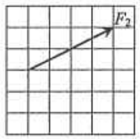
99. < HKCE 2009 Paper II - 7 >

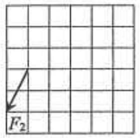



Force $F$ is the resultant of two forces $F_1$ and $F_2$ on a horizontal plane. Which of the following diagrams best represents the missing force $F_2$ ?

A.



B.



C.



D.


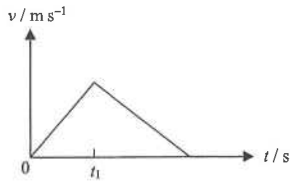

100. < HKCE 2009 Paper II - 8 >

An object of weight 120 N on the Earth's surface is taken to the Moon's surface where the acceleration due to gravity is $\frac{1}{6}$ of that at the Earth's surface. What are the mass and the weight of the object at the Moon's surface ?

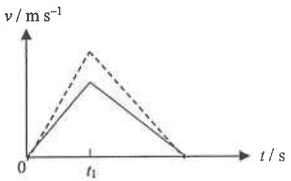
(Take the acceleration due to gravity on the Earth's surface to be 10 m s$^{-2}$.)

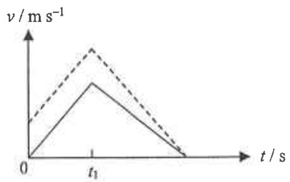
| | mass | weight |
|---|---|---|
| A. | 2 kg | 20 N |
| B. | 2 kg | 120 N |
| C. | 12 kg | 20 N |
| D. | 12 kg | 120 N |

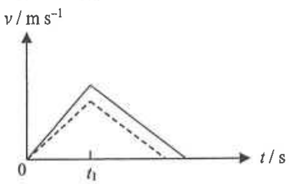
101. < HKCE 2010 Paper II - 2 >

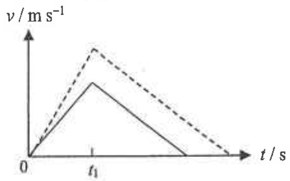



A man pushes a supermarket trolley with a constant horizontal force for $t_1$ seconds, and then releases the trolley. The velocity-time graph of the trolley is shown above. Assume that the friction between the trolley and the ground is constant, which of the following graphs (in dotted lines) best represents the variation of the velocity of the trolley with time if the man repeats the action with a stronger force ?

A.


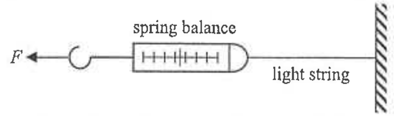

B.



C.



D.




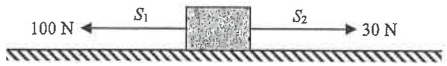

102. < HKCE 2010 Paper II - 3 >




A spring balance is connected to the wall by alight string. A horizontal force $F$ is acting on the spring balance as shown below. The spring balance shows a reading of 5 N. Assume that the mass of the balance can be neglected, what is the magnitude of the tension in the string ?

A. zero
B. 2.5 N
C. 5 N
D. 10 N

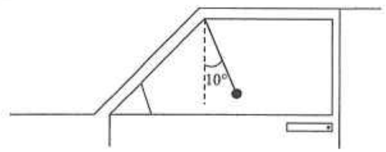
103. < HKCE 2010 Paper II - 28 >




A block of mass 4 kg remains at rest on a horizontal rough surface when strings $S_1$ and $S_2$ of tensions 100 N and 30 N respectively are pulling it. If $S_1$ is broken, what is the magnitude of the net force acting on the block ?

A. zero
B. 30 N
C. 50 N
D. 70 N

104. < HKCE 2010 Paper II - 31 >




In the figure above, a ball is hanging inside a car by a string. When the car accelerates on a horizontal road, the string makes an angle of 10° with the vertical. Find the magnitude of the acceleration of the car. (Take $g$ to be 10 m s$^{-2}$.)

A. 1.74 m s$^{-2}$
B. 1.76 m s$^{-2}$
C. 5.67 m s$^{-2}$
D. 9.85 m s$^{-2}$

105. < HKCE 2010 Paper II - 30 >

An object is projected vertically upwards. $F$ denotes the magnitude of the net force acting on the object and $W$ denotes the magnitude of the weight of the object. If air resistance is **not** negligible, which of the following descriptions are correct ?

(1) When the object is moving up, $F$ is greater than $W$.
(2) When the object is at the highest point, $F$ is equal to $W$.
(3) When the object is moving down, $F$ is smaller than $W$.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

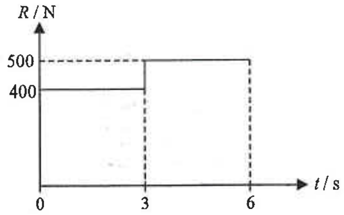
**106. < HKCE 2010 Paper II - 4 >**

A man is standing in a lift. The lift is initially at rest. When the lift starts to move upward, the man feels heavier. Which of the following statements is/are correct ?

(1) The gravitational force acting on the man increases.
(2) The gravitational force acting on the lift increases.
(3) The force acting on the man by the floor of the lift increases.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**Questions 107 and 108 :**
A man of mass 50 kg stands still on a balance in a lift which is initially moving downwards. Between $t = 0$ and 6 s, the reading $R$ of the balance varies with time as shown in the graph below. Take $g$ to be 10 m s$^{-2}$.




**107. < HKCE 2011 Paper II - 3 >**

Which of the following statements is/are correct ?
(1) Between $t = 0$ and 3 s, the net force acting on the man is 400 N.
(2) At $t = 3$ s, the lift starts to move upwards.
(3) Between $t = 3$ s and 6 s, the lift is moving at a constant velocity.

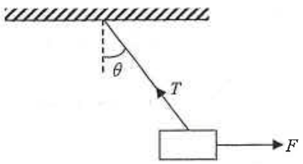
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**108. < HKCE 2011 Paper II - 4 >**

What is the acceleration of the lift between $t = 0$ and 3 s ?
A. 2 m s$^{-2}$
B. 6 m s$^{-2}$
C. 8 m s$^{-2}$
D. 10 m s$^{-2}$

**109. < HKCE 2011 Paper II - 30 >**

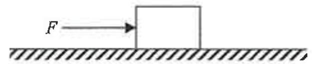
In the figure shown, horizontal force $F$ is applied to a block which is hung by a string under the ceiling. At equilibrium, the string makes an angle $\theta$ with the vertical and the tension in the string is $T$. The weight of the block is




A. $F \sin \theta$
B. $F \cos \theta$
C. $T \sin \theta$
D. $T \cos \theta$

DSE Physics - Section B : M.C. PB - FM2 - M / 31
FM2 : Newton's Laws

**110. < HKCE 2011 Paper II - 5 >**




On a horizontal surface, horizontal force $F$ is exerted on a block as shown in the figure above. When $F = 25$ N, the block remains at rest. Which of the following statements must be correct ?
A. If $F > 25$ N, the block will start to move.
B. If $F = 25$ N, the friction acting on the block will be greater than 25 N.
C. If $F = 20$ N, the friction acting on the block will be 20 N.
D. If $F = 0$, the friction acting on the block will be 25 N.

**111. < HKCE 2011 Paper II - 6 >**

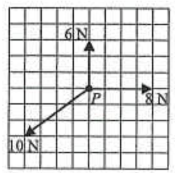
The photo above shows an ant hanging upside down from the ceiling. The ant is holding a 500 mg block using its jaws. The ceiling, the ant and the block are at rest. Which of the following statements is/are correct ?
(1) The force acting on the ant by the ceiling points upwards.
(2) The force acting on the block by the ant and the weight of the block are an action and reaction pair .
(3) The net force acting on the ant is zero.

A. (2) only
B. (3) only
C. (1) & (2) only
D. (1) & (3) only

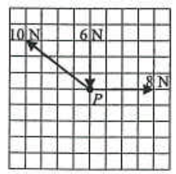
**112. < HKCE 2011 Paper II - 29 >**

Three forces are acting on particle $P$. In which of the following diagrams is the net force on $P$ **not** zero ?

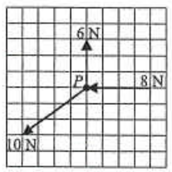
A.



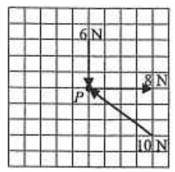

B.




C.




D.

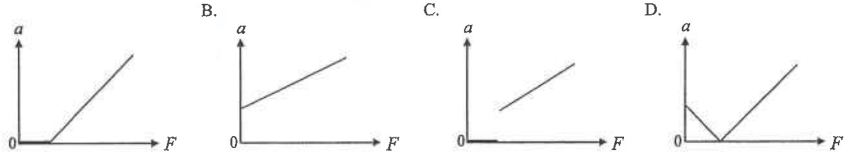


## Part B : HKAL examination questions

**113. < HKAL 1980 Paper I - 1 >**

A block on a rough horizontal plane is subjected to an applied force $F$. Which one of the graphs below best represents the variation of the acceleration $a$ of the block with the applied force $F$ ?

A. B. C. D.

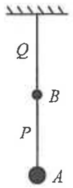



**114. < HKAL 1985 Paper I - 2 >**

A lift of mass $M$ carries a passenger of mass $m$. When the lift rises with a uniform acceleration $a$, the normal reaction between the passenger and the floor of the lift is

A. $m g$.
B. $m (g - a)$.
C. $m (g + a)$.
D. $m (g + a) - M a$.

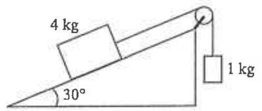
**115. < HKAL 1985 Paper I - 1 >**




Two bodies $A$ and $B$ are connected by a light string $P$ as shown in the figure. The weights of $A$ and $B$ are 10 N and 4 N respectively. $B$ is connected to the roof by another light string $Q$. If string $Q$ is cut and the two bodies allowed to fall, the net force acting on $B$ during free fall is

A. 0 N.
B. 4 N.
C. 6 N.
D. 10 N.

**116. < HKAL 1986 Paper I - 1 >**

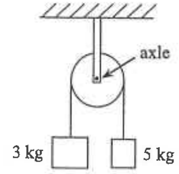



An object of mass 4 kg is placed on a smooth plane inclined at 30° to the horizontal. It is connected by a light string passing over a frictionless pulley to another object of mass 1 kg, as shown above. Take $g$ to be 10 m s$^{-2}$. If the system is released, the tension in the string will be

A. 12 N.
B. 15 N.
C. 18 N.
D. 25 N.



**117. < HKAL 1987 Paper I - 4 >**




A block of mass 3 kg is tied to another block of mass 5 kg with a string passing over a fixed smooth pulley. The weight of the pulley is negligible. Take $g$ to be 10 m s$^{-2}$. When the two blocks are released to move under the action of gravity, the vertical upward force acting on the axle of the pulley is

A. 60 N.
B. 72 N.
C. 75 N.
D. 80 N.

**118. < HKAL 1989 Paper I - 7 >**

David weighs a load with a spring balance inside a lift. Before the lift moves, the scale reads 50 N. The lift goes down and then stops. The reading on the scale is

A. more than 50 N when the lift starts, and remains steady until it comes to rest.
B. less than 50 N when the lift starts, and remains steady until it comes to rest.
C. more than 50 N as the lift starts, and less than 50 N as it comes to rest.
D. less than 50 N as the lift starts, and more than 50 N as it comes to rest.

**119. < HKAL 1991 Paper I - 2 >**

A block of mass $m$ moves with constant acceleration $a$ down an inclined plane making an angle $\theta$ with the horizontal. The friction acting on the block is

A. $mg - ma$.
B. $mg - ma \sin \theta$.
C. $mg \sin \theta - ma$.
D. $(mg - ma) \sin \theta$.

**120. < HKAL 1992 Paper I - 2 >**

Peter has a mass of 40 kg. When he measures his weight with a compression balance inside a lift, he discovers that his weight indicated by the balance is 360 N. Take $g$ to be 10 m s$^{-2}$, the lift is probably

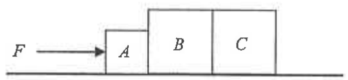
(1) moving upwards and accelerating at 1 m s$^{-2}$.
(2) moving upwards and decelerating at 1 m s$^{-2}$.
(3) moving downwards and accelerating at 1 m s$^{-2}$.
(4) moving downwards and decelerating at 1 m s$^{-2}$.

A. (1) & (3) only
B. (1) & (4) only
C. (2) & (3) only
D. (2) & (4) only

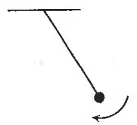
**121. < HKAL 1992 Paper I - 1 >**

Three blocks $A$, $B$ and $C$ of masses $m$, $2m$ and $2m$ respectively are placed on a smooth horizontal ground as shown in the figure. A constant horizontal force $F$ of 20 N is applied to block $A$ so that the three blocks move with the same acceleration towards the right. What is the resultant force acting on block $B$ ?

A. 4 N
B. 6 N
C. 8 N
D. 12 N

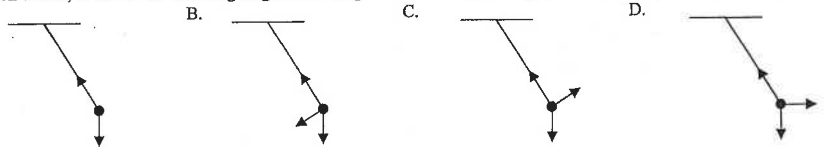


**122.** **< HKAL 1992 Paper I - 3 >**



A bob is connected to a light string attached to the ceiling. The string then swings in a vertical plane. When it is at the position shown, which of the following diagrams best represents the forces acting on the bob ? Neglect air resistance.

A. B. C. D.

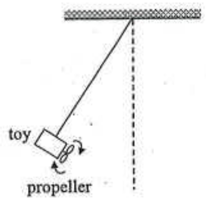


**123.** **< HKAL 1993 Paper I - 1 >**


The resultant of two forces $F_1$ and $F_2$ acting at a point has a minimum value of 7 N and a maximum value of 17 N. When the two forces act at right angles to each other, the magnitude of their resultant is

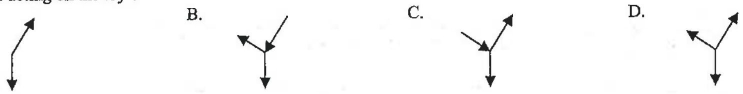
A. 10 N
B. 13 N
C. 18 N
D. 22 N

**124.** **< HKAL 1994 Paper IIA - 1 >**




The above figure shows a toy with a propeller driven by a motor inside the toy connected by a light string to a fixed point on the ceiling. The toy remains stationary when the motor is on. Which of the following diagrams correctly represents the forces acting on the toy ?

A. B. C. D.



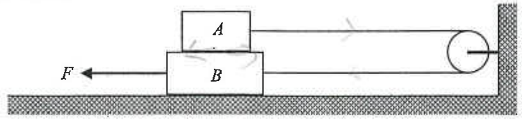
**125.** **< HKAL 1995 Paper IIA - 1 >**

When given a slight push, a block moves freely with constant velocity down a plane inclined at 20° to the horizontal. If the mass of the block is 0.5 kg, find the force parallel to the inclined plane to pull the block up the plane with constant velocity.

A. 1.7 N
B. 3.4 N
C. 4.7 N
D. 6.7 N



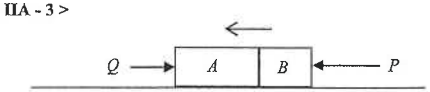
**126.** **< HKAL 1997 Paper IIA - 1 >**




Two blocks $A$ and $B$ are connected by a light string which passes over a smooth, fixed pulley as shown in the above figure. The maximum friction between any two surfaces is 1.5 N. If a horizontal force $F$ is applied to block $B$, find the minimum value of this applied force for moving $B$.

A. 1.5 N
B. 3.0 N
C. 4.5 N
D. 6.0 N

**127.** **< HKAL 1998 Paper IIA - 3 >**




Two blocks $A$ and $B$ of mass ratio 2 : 1 are placed on a horizontal frictionless surface as shown above. $P$ and $Q$ are horizontal forces acting on $A$ and $B$ respectively (with $P > Q$ ) so that the blocks move to the left with constant acceleration. Find the force acting on $B$ by $A$.

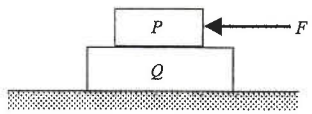
A. $\frac{P-Q}{3}$ B. $\frac{P+Q}{3}$ C. $\frac{2(P-Q)}{3}$ D. $\frac{2P+Q}{3}$

**128.** **< HKAL 2000 Paper IIA - 4 >**

Amy holds one end of a string to which a block of mass 8 kg is tied at the other end. She raises the block with a constant acceleration by pulling the string in an upward direction. If the maximum tension that the string can withstand is 100 N, find the maximum acceleration of the block before the string breaks.

A. 2.7 m s$^{-2}$
B. 3.8 m s$^{-2}$
C. 4.6 m s$^{-2}$
D. 7.2 m s$^{-2}$

**129.** **< HKAL 2000 Paper IIA - 1 >**




Two books $P$ and $Q$ are placed on a horizontal table surface as shown. A horizontal force $F$ is applied to $P$ but the system remains stationary. Which of the following statements is/are correct ?

(1) The frictional force acting on $Q$ by the table surface is greater than $F$.
(2) The frictional force acting on $P$ by $Q$ is towards the right.
(3) The system would remain stationary if $F$ is applied to $Q$ instead.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

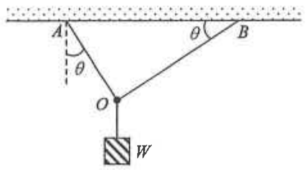
**130.** **< HKAL 2000 Paper IIA - 5 >**

A trolley of mass 0.4 kg moves with a certain acceleration down a runway which is inclined to the horizontal at 12°. If the angle of inclination is increased to 18°, the acceleration of the trolley would be doubled. Find the average frictional force, assuming the same in both cases, acting on the trolley.

A. 0.35 N
B. 0.39 N
C. 0.42 N
D. 0.47 N

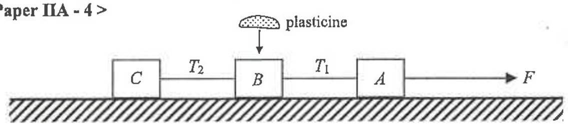
**131.** **< HKAL 2006 Paper IIA - 1 >**

A weight $W$ is suspended from the ceiling by inextensible strings as shown. String $OA$ makes an angle $\theta$ with the vertical while string $OB$ makes the same angle $\theta$ with the ceiling. Find the tension in $OB$.




A. $W \sin \theta$
B. $W / \sin \theta$
C. $W \cos \theta$
D. $W / \cos \theta$

**132.** **< HKAL 2008 Paper IIA - 4 >**

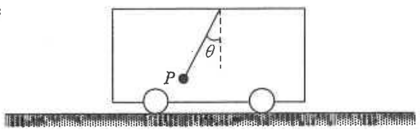



Three blocks $A$, $B$ and $C$, connected by light strings, are placed on a smooth horizontal surface as shown. A constant force $F$ is applied to block $A$ so that the whole system travels to the right with acceleration. If a lump of plasticine is placed on $B$ and it moves together with $B$ while the applied force $F$ remains unchanged, how would the tensions $T_1$ and $T_2$ in the two strings change ?

| | Tension $T_1$ | Tension $T_2$ |
|---|---|---|
| A. | decrease | increase |
| B. | decrease | decrease |
| C. | increase | increase |
| D. | increase | decrease |

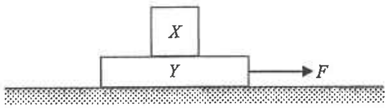
**133.** **< HKAL 2009 Paper IIA - 4 >**

A small bob $P$ is suspended by an inextensible string from the ceiling of a vehicle. The vehicle is moving on a straight horizontal road and the string makes an angle $\theta$ with the vehicle as shown in the figure. Which of the following description of the acceleration of the vehicle is correct ?




A. $g \sin \theta$ to the left
B. $g \sin \theta$ to the right
C. $g \tan \theta$ to the left
D. $g \tan \theta$ to the right

**134.** **< HKAL 2009 Paper IIA - 3 >**



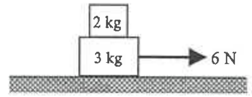

A block $X$ is placed on top of another block $Y$, which rests on a horizontal surface. The blocks have the same mass $m$. The block $Y$ is pulled by a horizontal force $F$ as shown. Assume that all contact surfaces are smooth. What is the acceleration of each block ?

| | acceleration of $X$ | acceleration of $Y$ |
|---|---|---|
| A. | zero | $\frac{F}{m}$ |
| B. | zero | $\frac{F}{2m}$ |
| C. | $\frac{F}{2m}$ | $\frac{F}{m}$ |
| D. | $\frac{F}{2m}$ | $\frac{F}{2m}$ |



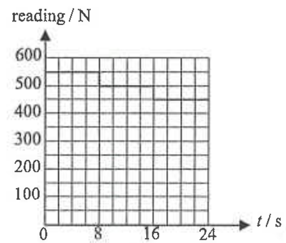
**135.** **< HKAL 2012 Paper IIA - 5 >**

A 2 kg block is placed on top of a 3 kg block on a smooth horizontal surface as shown. A horizontal force of 6 N is applied to the 3 kg block such that the two blocks move together. The friction acting between the two blocks is




A. 0 N.
B. 1.2 N.
C. 2.4 N.
D. 3.6 N.

**136.** **< HKAL 2012 Paper IIA - 6 >**

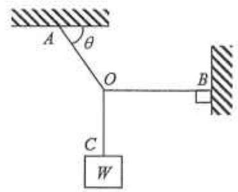



Billy of mass 50 kg stands still on a weighing scale in a lift. The lift starts to ascend at $t = 0$ and comes to rest at $t = 24$ s. The graph shows how the reading of the weighing scale varies within this time interval. What is the corresponding height ascended by the lift ? (Take the acceleration due to gravity to be 10 m s$^{-2}$.)

A. 192 m
B. 144 m
C. 128 m
D. 96 m

**137.** **< HKAL 2013 Paper IIA - 3 >**

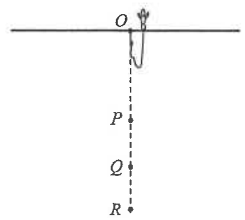
A body of weight $W$ is suspended by three inextensible light strings $OA$, $OB$ and $OC$ as shown in the figure. $OA$ makes an angle $\theta$ with the horizontal while $OB$ is horizontal. The maximum tension that each string can bear is the same. If the weight $W$ gradually increases, which string will break first ?




A. string $OA$
B. string $OB$
C. string $OC$
D. It depends on the value of $\theta$.

**138.** **< HKAL 2013 Paper IIA - 7 >**

A boy performs a 'bungee jump' from the top of a bridge. He is connected with a light elastic cord to the bridge at $O$ as shown in the figure. When he falls down from rest at $O$, the cord starts to stretch at point $P$. He then passes $Q$ where the tension in the cord is just equal to his weight. Finally, the boy reaches point $R$ where he is momentarily at rest. If air resistance is neglected, which of the following descriptions are correct ?

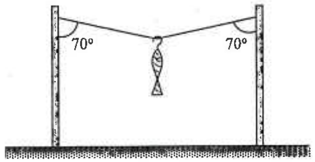



(1) From $P$ to $Q$, the speed of the boy increases throughout.
(2) At $Q$, the speed of the boy is the maximum in the falling motion.
(3) At $R$, the net force acting on the boy is zero.

A. (1) & (2) only
B. (1) & (3) only
C. (2) & (3) only
D. (1), (2) & (3)

## Part C : HKDSE examination questions

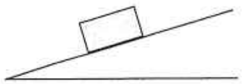
**139. < HKDSE Sample Paper IA - 5 >**




A fish is hung on a light string as shown. If the tension in the string is 10 N, find the total weight of the fish and the hook.

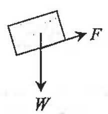
A. 20 sin 70° N
B. 20 cos 70° N
C. 10 sin 70° N
D. 10 cos 70° N

**140. < HKDSE Sample Paper IA - 8 >**



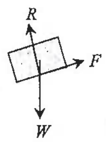
A block remains at rest on a rough inclined plane. Which of the following diagrams shows all the forces acting on the block ?

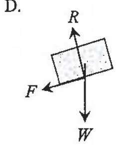
Note : $W$ = gravitational force acting on the block,
$R$ = normal reaction exerted by the inclined plane on the block, and
$F$ = friction acting on the block.

A.


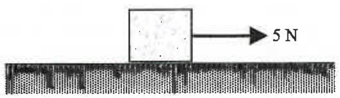

B.



C.



D.



**141. < HKDSE Sample Paper IA - 6 >**




A 1 kg block is pulled by a horizontal force of 5 N and moves with an acceleration of 2 m s$^{-2}$ on a rough horizontal plane. Find the frictional force acting on the block.

A. zero
B. 2 N
C. 3 N
D. 7 N



**142. < HKDSE Sample Paper IA - 9 >**

Kelvin is standing on a balance inside a lift. The table shows the readings of the balance in three situations.

| Motion of the lift | Reading of the balance |
|---|---|
| moving upwards with a uniform speed | $R_1$ |
| moving downwards with a uniform speed | $R_2$ |
| moving upwards with an acceleration | $R_3$ |

Which of the following relationships is correct ?

A. $R_1 = R_2 > R_3$
B. $R_3 > R_1 = R_2$
C. $R_1 > R_2 > R_3$
D. $R_3 > R_1 > R_2$

**143. < HKDSE Practice Paper IA - 10 >**

As shown in Figure (a), a block slides down along a smooth inclined plane from rest. The corresponding speed-time graph of its motion is shown in Figure (b).

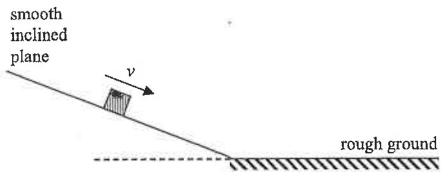



Figure (a)

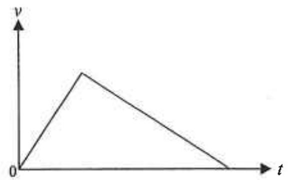
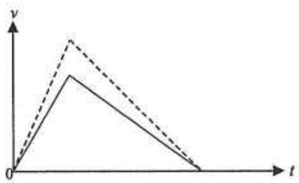
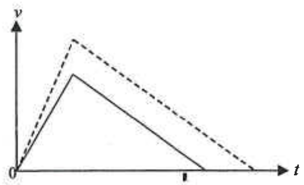
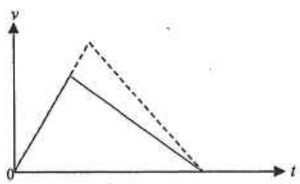


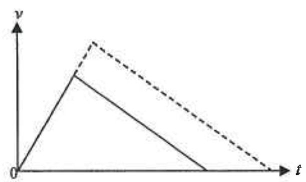

Figure (b)

Which of the following speed-time graphs (in dotted line) best represents the motion of the block if it is released at a higher position on the plane instead ? Assume that the friction between the ground and the block remains unchanged.

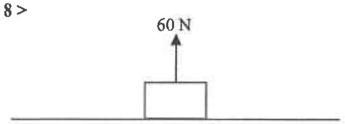
A.



B.



C.



D.


**144.** **< HKDSE Practice Paper IA - 8 >**




A block of weight 100 N is placed on a horizontal table and a vertical force of 60 N is exerted on the block as shown in the figure above. Which of the following statements is/are correct ?

(1) The weight of the block is balanced by the force exerted on the block by the table.

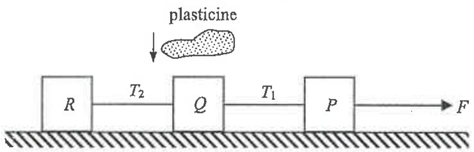
(2) The weight of the block and the force exerted on the table by the block are equal in magnitude.

(3) The force exerted on the table by the block and the force exerted on the block by the table are an action-reaction pair.

A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**145.** **< HKDSE Practice Paper IA - 9 >**

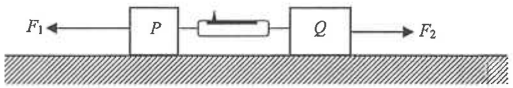
Blocks, $P$, $Q$ and $R$, connected by light inextensible threads, are placed on a smooth horizontal surface as shown. A constant force $F$ is applied to $P$ so that the whole system travels to the right with acceleration.




A lump of plasticine is placed on $Q$ and it moves together with $Q$. If the applied force $F$ remains unchanged, how would the tensions $T_1$ and $T_2$ in the two threads change ?

| | Tension $T_1$ | Tension $T_2$ |
|---|---|---|
| A. | increase | decrease |
| B. | increase | increase |
| C. | decrease | decrease |
| D. | decrease | increase |

**146.** **< HKDSE 2012 Paper IA - 8 >**




Blocks $P$ and $Q$ of mass $m$ and $2m$ respectively are connected by a light spring balance and placed on a smooth horizontal surface as shown. If horizontal forces $F_1$ and $F_2$ (with $F_1 > F_2$) act on $P$ and $Q$ respectively and the whole system moves to the left with constant acceleration, what is the reading of the spring balance ?

A. $\dfrac{2F_1 - F_2}{3}$

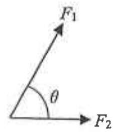
B. $\dfrac{2(F_1 - F_2)}{3}$

C. $\dfrac{2F_1 + F_2}{3}$

D. $\dfrac{F_1 + 2F_2}{3}$



**147.** **< HKDSE 2012 Paper IA - 5 >**

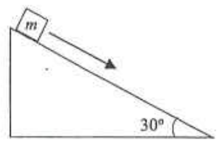



Two forces $F_1$ and $F_2$ of constant magnitude act at the same point as shown. When the angle $\theta$ between $F_1$ and $F_2$ increases from 0° to 180°, the magnitude of the resultant force

A. decreases throughout.
B. increases throughout.
C. decreases and then increases.
D. increases and then decreases.

**148.** **< HKDSE 2012 Paper IA - 10 >**

A block of mass $m$ resting on a 30° incline is given a slight push and slides down the incline with a uniform speed. Which of the following statements about the block's motion on the incline is/are correct ?



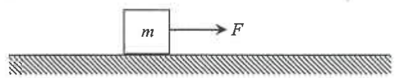

(1) There is no net force acting on the block.

(2) The frictional force acting on the block is 0.5 $mg$.

(3) If the block is given a greater initial speed, it will slide down the incline with acceleration.

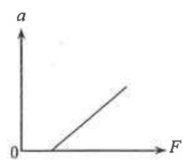
A. (1) only
B. (3) only
C. (1) & (2) only
D. (2) & (3) only

**149.** **< HKDSE 2012 Paper IA - 11 >**

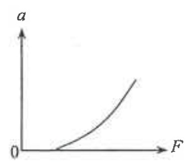



A block of mass $m$ initially resting on a rough horizontal surface is pulled along the surface by a horizontal force $F$ increasing from zero. If the frictional force is constant, which graph shows the relation between the acceleration of the block $a$ and force $F$ ?

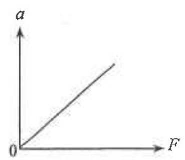
A.



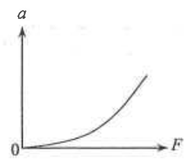

B.



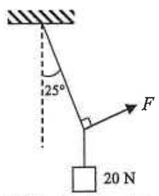

C.




D.



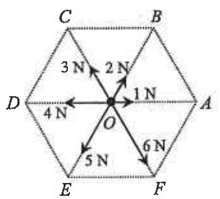
**150. < HKDSE 2013 Paper IA - 5 >**




A block of weight 20 N is suspended by a light string from the ceiling. A force $F$ is applied such that the block is displaced to one side with the string making an angle of 25° with the vertical as shown. Find the magnitude of $F$.

A. 8.5 N
B. 9.3 N
C. 18.1 N
D. 47.3 N

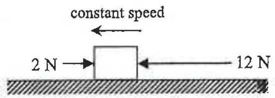
**151. < HKDSE 2013 Paper IA - 6 >**




In the figure, $O$ is the centre of a regular hexagon. A particle at $O$ is subject to six forces with magnitudes indicated as shown. The resultant force acting on the particle is

A. 9 N along direction $OE$.
B. 8 N along direction $OE$.
C. 8 N along direction $OF$.
D. 6 N along direction $OE$.

**152. < HKDSE 2013 Paper IA - 7 >**



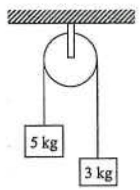

A block on a rough horizontal surface is moving to the left with constant speed under two horizontal forces 2 N and 12 N indicated as shown. If the force of 12 N is suddenly removed, what is the net force acting on the block at that instant ?

A. 12 N
B. 10 N
C. 8 N
D. 2 N

**153. < HKDSE 2014 Paper IA - 8 >**

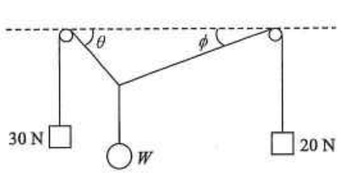
Two blocks of masses 5 kg and 3 kg respectively are connected by a light string passing through a frictionless fixed light pulley. Find the magnitude of the acceleration of the blocks in terms of the acceleration due to gravity $g$ when they are released. Neglect air resistance.

A. $g$
B. $\frac{1}{2}g$
C. $\frac{1}{4}g$
D. $\frac{1}{8}g$






**154. < HKDSE 2014 Paper IA - 4 >**




The figure shows a weight $W$ attached to two light strings which pass over two smooth pegs at the same height and with weights 30 N and 20 N attached to the respective ends of each string. The system is at equilibrium. Which deduction about $W$ is correct ?

A. $W$ is less than 50 N.
B. $W$ is equal to 50 N.
C. $W$ is greater than 50 N.
D. No information about $W$ can be obtained as angles $\theta$ and $\phi$ are not known.

**155. < HKDSE 2015 Paper IA - 5 >**

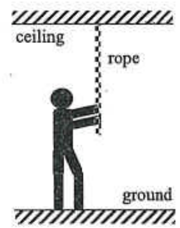
A constant net force acting on an object of mass $m_1$ produces an acceleration $a_1$ while the same force acting on another object of mass $m_2$ produces an acceleration $a_2$. If this net force acts on an object of mass ($m_1 + m_2$), what would be the acceleration produced ?

A. $a_1 + a_2$
B. $\frac{a_1 + a_2}{2}$
C. $\frac{a_1 a_2}{a_1 + a_2}$
D. $\frac{2a_1 a_2}{a_1 + a_2}$

**156. < HKDSE 2016 Paper IA - 6 >**

A boy of weight $W$ exerts a downward pulling force $F$ on a rope of weight $G$ hung vertically from the ceiling. He stands still on the ground as shown. Which of the following gives the magnitude of the force exerted by

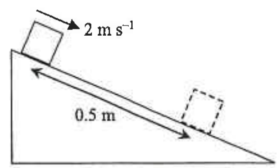
(1) the boy on the ground ;
(2) the rope on the ceiling ?




| | (1) | (2) |
|---|---|---|
| A. | $W$ | $G - F$ |
| B. | $W$ | $G + F$ |
| C. | $W - F$ | $G - F$ |
| D. | $W - F$ | $G + F$ |

**157. < HKDSE 2016 Paper IA - 7 >**

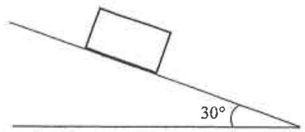
A block with initial speed 2 m s$^{-1}$ slides down a rough inclined plane and stops after travelling a distance of 0.5 m. What is the deceleration of the block ?




A. 1 m s$^{-2}$
B. 2 m s$^{-2}$
C. 4 m s$^{-2}$
D. Answer cannot be found as the angle of inclination of the plane is not given.

**158.** < HKDSE 2017 Paper IA - 6 >

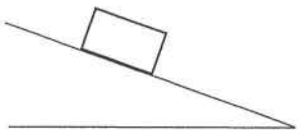
A block is released from rest on an inclined plane as shown. The inclined plane makes an angle of 30° to the horizontal. The block moves with uniform acceleration, and travels a distance of 1 m in the first 3 s. Determine the acceleration of the block.




A. 0.22 m $s^{-2}$
B. 0.33 m $s^{-2}$
C. 4.91 m $s^{-2}$
D. Cannot be determined as the frictional force acting on the block is unknown.

**159.** < HKDSE 2017 Paper IA - 7 >

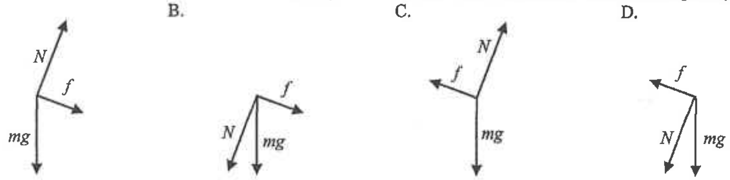
A block of mass *m* stays at rest on a rough inclined plane as shown.



Which of the following diagrams correctly shows the forces acting on the block ?

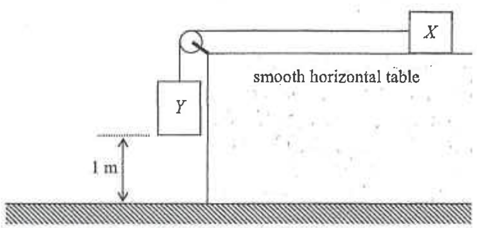
(*N* is the normal reaction from the inclined plane, and *f* is the frictional force between the block and the plane.)

A. B. C. D.




**160.** < HKDSE 2017 Paper IA - 10 >

Blocks *X* and *Y* are connected by a light inextensible string passing over a fixed frictionless light pulley as shown. The mass of *X* and *Y* are 0.5 kg and 1 kg respectively. Initially, *Y* is 1 m above the ground and the string is taut. The system is then released from rest.




What is the speed of *Y* just before it reaches the ground ?

A. 3.62 m $s^{-1}$
B. 4.43 m $s^{-1}$
C. 6.26 m $s^{-1}$
D. 9.81 m $s^{-1}$

There is question in next page



HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.

## M.C. Answers

| | | | | | |
|---|---|---|---|---|---|
| 1. D | 11. C | 21. B | 31. B | 41. A | 51. B |
| 2. A | 12. D | 22. B | 32. A | 42. B | 52. C |
| 3. B | 13. A | 23. C | 33. D | 43. D | 53. A |
| 4. B | 14. B | 24. A | 34. C | 44. D | 54. A |
| 5. C | 15. B | 25. B | 35. C | 45. C | 55. A |
| 6. B | 16. B | 26. A | 36. A | 46. B | 56. C |
| 7. A | 17. D | 27. B | 37. B | 47. C | 57. B |
| 8. C | 18. C | 28. C | 38. D | 48. D | 58. A |
| 9. C | 19. D | 29. D | 39. B | 49. A | 59. A |
| 10. A | 20. D | 30. B | 40. B | 50. C | 60. D |
| 61. A | 71. C | 81. B | 91. A | 101. D | 111. D |
| 62. C | 72. B | 82. C | 92. A | 102. C | 112. C |
| 63. B | 73. B | 83. B | 93. C | 103. A | 113. A |
| 64. A | 74. D | 84. D | 94. C | 104. B | 114. C |
| 65. A | 75. D | 85. C | 95. B | 105. D | 115. B |
| 66. C | 76. A | 86. B | 96. C | 106. B | 116. A |
| 67. B | 77. C | 87. B | 97. A | 107. B | 117. C |
| 68. D | 78. C | 88. D | 98. C | 108. A | 118. D |
| 69. B | 79. D | 89. D | 99. A | 109. D | 119. C |
| 70. A | 80. C | 90. D | 100. C | 110. C | 120. C |
| 121. C | 131. A | 141. C | 151. D | 161. A | |
| 122. A | 132. D | 142. B | 152. A | 162. A | |
| 123. B | 133. D | 143. D | 153. C | 163. C | |
| 124. D | 134. A | 144. B | 154. A | 164. B | |
| 125. B | 135. C | 145. A | 155. C | | |
| 126. C | 136. C | 146. C | 156. D | | |
| 127. D | 137. A | 147. A | 157. C | | |
| 128. A | 138. A | 148. C | 158. A | | |
| 129. D | 139. B | 149. A | 159. C | | |
| 130. C | 140. C | 150. A | 160. A | | |

**161. <HKDSE 2019 Paper IA-5>**

**162. <HKDSE 2019 Paper IA-12>**

163. <HKDSE 2020 Paper IA-5>

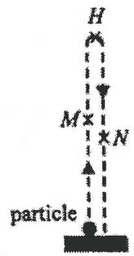

For a car travelling on a highway, which of the following statements about the safety design of the headrest is/are correct ?

(1) As the headrest is soft, it can reduce the force exerted on the passenger's head during impact.
(2) It can minimise injury of the passenger when the car is struck by another one from behind.
(3) It can minimise injury of the passenger when the car brakes suddenly.

A. (1) only
B. (3) only
C. (1) and (2) only
D. (2) and (3) only

164. <HKDSE 2020 Paper IA-6>

A particle is thrown vertically upward and its path is shown below. $H$ is the highest point that the particle reached. Which of the following statements about the particle is/are correct ? Neglect air resistance.




(1) Its acceleration at $M$ is upward.
(2) Its acceleration at $H$ is zero.
(3) Its acceleration at $N$ is downward.

A. (1) only
B. (3) only
C. (2) and (3) only
D. (1), (2) and (3)

## M.C. Solution

1. D

Actual weight = $m g$ = (20) × (9.81) = 196 N

The reading of the balance 150 N is indeed the normal reaction $R$, represents the apparent weight.

$\therefore R < mg$ $\quad\therefore$ direction of acceleration is downwards

$\therefore$ The lift is descending with uniform acceleration.

2. A

① $F - f = Ma$ $\quad\therefore 2F - 2f = 2Ma$ $\quad\therefore 2F = 2f + 2Ma$

② $2F - f = Ma'$

$\therefore 2f + 2Ma - f = Ma'$

$\therefore f = Ma' - 2Ma$ $\quad\therefore a' = 2a + \dfrac{f}{M}$

3. B

As $X$ is held stationary, there is a unknown applied force acting on $X$.

Consider $Y$ that is also stationary : $T = mg\sin\theta$ = (2) (9.81) sin 30° = 9.81 N

Reading of $S$ = tension of the string = 9.81 N ≈ 9.8 N

4. B

After the system is released, $A$ and $B$ move towards each other because of the elastic force of the spring.

The force acting on $A$ and the force acting on $B$ form an action-reaction pair. Thus they are equal and opposite.

$\therefore F = ma$ = constant

$\therefore m \propto \dfrac{1}{a}$ $\quad\therefore \dfrac{a_A}{a_B} = \dfrac{m_2}{m_1}$

5. C

As the object is at rest along a rough inclined plane, forces along the inclined plane are balanced.

$\therefore f = mg\sin\theta$ $\quad\therefore f \propto \sin\theta$.

6. B

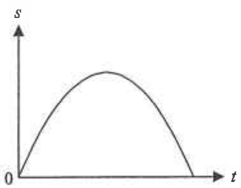
Slope of $s$-$t$ graph = velocity

When the object is moving upwards, it is decelerating,
thus the slope of the graph representing the velocity should be decreasing.

At the highest point, the object is momentarily at rest.

After reaching the highest point, the object moves downwards with acceleration.

The curve should then bend downwards with magnitude of slope increasing.






7. A

Consider block $E$ : $T_4 = (1m)\,a$

Consider block $D, E$ : $T_3 = (2m)\,a$.

Consider block $C, D, E$ : $T_2 = (3m)\,a$

Consider block $B, C, D, E$ : $T_1 = (4m)\,a$

The string $S_1$ with tension $T_1$ has the greatest tension.

As four strings are identical, $S_1$ is likely to be broken first.

8. C

As the object is at rest along a rough inclined plane, forces along the inclined plane must be balanced.

$\therefore f = mg\sin\theta$.

9. C

Consider the whole system of the two blocks and the trolley.

By Newton's second law : $F_{net} = ma$

$(0.75 \times 9.81) - (0.25 \times 9.81) = (0.75 + 1 + 0.25)\,a$ $\quad\therefore a = 2.45\text{ m s}^{-2} \approx 2.5\text{ m s}^{-2}$

10. A

As the force is acting to the left, the acceleration is also towards the left.

As the body is moving to the right, leftward acceleration means that it is under deceleration, thus the velocity should drop.

When the body comes to rest, the force continues to apply to give leftward acceleration,

thus the velocity increases as the body moves leftwards.

Note that as the force is constant, the acceleration is constant, thus the slope of the graph should be constant.

11. C

$P\cos\theta - Q = ma$

$(2)\cos 30° - (1) = (1)\,a$ $\quad\therefore a = 0.73\text{ m s}^{-2}$

12. D

As the resultant force is zero, the acceleration must be zero.

The particle may then be at rest or moving with constant velocity.

13. A

As the ball and the lift move together upwards before the ball is released, due to inertia,

velocity of the ball at the moment of release = velocity of the lift = 10 m s$^{-1}$ upwards

14. B

× (1) Velocity of the ball increases with time up to 10 m s$^{-1}$.

✓ (2) Acceleration = slope of $v \sim t$ graph, which decreases with time.

× (3) After 4 s, the ball should move with a terminal velocity which is not zero.

15. B

Engine turned off

⇒ no net force acting on the rocket

⇒ the rocket has no acceleration

⇒ the rocket continues to move with uniform velocity due to inertia

16. B

The spring balance reads the tension $T_1$ $\therefore T_1 = 10\text{ N}$

Consider $A$ and $B$ as a whole system :

$(10) = (1 + 1.5)\,a$ $\therefore a = 4\text{ m s}^{-2}$

Consider block $B$ : $T_2 = m_B\,a = (1.5)(4) = 6\text{ N}$

17. D

The resultant force acting on the block is $m\,g\sin\theta$, thus the acceleration of the block is $g\sin\theta$

and it is constant and always pointing downwards, no matter whether the block is moving upwards or downwards.

18. C

Consider the pulley connecting to the 6 kg body. There are two strings giving two upwards tensions $T$ to hold the pulley.

$\therefore 2T = mg$ $\therefore 2T = (6)(9.81)$ $\therefore T = 29.4\text{ N}$

As the 2 kg block is at rest, tension of $S$ = tension of the string connecting 2 kg block and 6 kg block = 29.4 N

19. D

$P - mg\sin\theta = ma$

$\therefore P = mg\sin\theta + ma$

The one with maximum $\theta$ and maximum $a$ would give the maximum $P$,

Thus, the case in D has the maximum $P$.

20. D

The man feels heavier if the normal reaction : $R > mg$

i.e., the direction of acceleration is upwards.

Moving upwards with acceleration and moving downwards with retardation both mean an upward acceleration.

21. B

$\because F = ma \propto a$

$\therefore$ The shape of the $F \sim t$ graph is the same as that of $a \sim t$ graph.

As slope of $v \sim t$ graph $= a \propto F$,

Before $t = t_0$, force is positive ⇒ slope of $v \sim t$ graph is positive

After $t = t_0$, force is zero ⇒ slope of $v \sim t$ graph is zero (horizontal line)

Option C is not correct as the velocity cannot be suddenly dropped to zero.



22. B

Since the three blocks are of equal mass, they should experience the same net force.

$\therefore$ Net force on block $B$ : $F_B = \dfrac{F}{3}$

23. C

✓ (1) Constant force ⇒ constant acceleration ⇒ constant slope in $v \sim t$ graph

✓ (2) Slope of $s \sim t$ graph = velocity, which is a constant

× (3) Falling from rest ⇒ constant acceleration ⇒ a horizontal line

24. A

When the force $F$ is applied,

$F = f + mg\sin\theta$ $\therefore (11) = f + (1)(10)\sin 30°$

$\therefore f = 6\text{ N}$ $\therefore$ Maximum friction is 6 N.

If $F$ is not applied,

downward force $= mg\sin\theta = (1)(10)\sin 30° = 5\text{ N}$.

Thus, $f = 5\text{ N}$ $\therefore$ The block remains at rest.

25. B

× (1) If the lift is moving upwards with constant speed, $R = W$.

✓ (2) The normal reaction acting on the man by the floor $R$ is upward while weight $W$ is downward.

× (3) $R$ and $W$ are both acting on the same body, the man, thus they cannot be action-reaction pair.

26. A

Assume the two blocks $A$ and $B$, each block has a mass of $M$.

Consider the whole system : $F = ma$ $\therefore (12) = (2M)\,a$ $\therefore a = \dfrac{6}{M}$

The force between $A$ and $B$ is the normal reaction.

Consider $A$ : $(12) - R = (M)\left(\dfrac{6}{M}\right)$ $\therefore R = 6\text{ N}$

**OR**

Consider $B$ : $R = ma = (M)\left(\dfrac{6}{M}\right) = 6\text{ N}$

27. B

By $F = ma$ $\therefore F \propto a$

$\therefore$ The shape of the $F \sim t$ graph is the same as that of $a \sim t$ graph.

As slope of $v \sim t$ graph $= a$ $\therefore$ slope of $v \sim t$ graph $\propto F$

Before $t = t_1$, force is zero ⇒ slope of $v \sim t$ graph is zero (horizontal line)

After $t = t_1$, force is positive ⇒ slope of $v \sim t$ graph is positive.

28. C

$X$: No net force acting on the $X \Rightarrow X$ moves with constant velocity due to inertia

$Y$: $Y$ is under free fall with the acceleration due to gravity, where $g = 10\ \text{m s}^{-2} \Rightarrow Y$ accelerates at $10\ \text{m s}^{-2}$

29. D

Consider $A$ and $B$ as a whole system :

$F = m a$ $\therefore$ $(2) = (3+2)\,a$ $\therefore$ $a = 0.4\ \text{m s}^{-2}$

Consider block $A$ : $F - T = m_A a$ $\therefore$ $(2) - T = (2)(0.4)$ $\therefore$ $T = 1.2\ \text{N}$

**OR**

Consider block $B$ : $T = m_B a = (3)(0.4) = 1.2\ \text{N}$

30. B

× (1) Both $F_1$ and $F_2$ are acting on the same block. ($F_2$ is the normal reaction acting on the block by the floor.)

× (2) Both $F_1$ and $F_2$ are acting on the ball. ($F_2$ is the tension acting on the ball by the string.)

✓ (3) $F_1$ acts on negative charge while $F_2$ acts on positive charge, they act on two different bodies.

31. B

× (1) $W = m g = 50 \times 9.81 = 490.5\ \text{N}$ which is a constant all the time.

× (2) As the lift falls freely under gravity, the man loses contact with the floor, thus normal reaction $R = 0$

✓ (3) As the man loses contact with the floor, the force acting on the man by the floor $R = 0$.

32. A

✓ (1) A harder initial push would give a greater initial velocity, thus the dots is more separated as shown.

× (2) If the angle of inclination is increased, $mg \sin\theta$ would be greater than the friction $f$,
thus the trolley would move down with acceleration, and the dots would not be equally spaced

× (3) If the frequency is increased, more dots are produced in 1 s, thus the dots should be less separated.

33. D

$T_1 = F + W_X = 4 + 2 = 6\ \text{N}$

$T_2 = T_1 + W_Y = 6 + 8 = 14\ \text{N}$

34. C

Constant braking force means constant deceleration.

By $v^2 = u^2 + 2as$ $\therefore$ $(0) = u^2 + 2(-a)s$ $\therefore$ $s = \dfrac{u^2}{2a}$ $\therefore$ $s \propto u^2$

$\therefore$ $\dfrac{s_1}{s_2} = (\dfrac{u_1}{u_2})^2$ $\therefore$ $\dfrac{(12)}{s_2} = (\dfrac{30}{60})^2$ $\therefore$ $s_2 = 48\ \text{m}$



35. C

Horizontal component the applied force $= F\cos\theta$

as $\theta$ is the angle between the direction of motion and applied force.

36. A

Before the string $S$ breaks, $F = m a = (4+2)(2) = 12\ \text{N}$

After the string $S$ breaks,

consider the 4-kg block : no horizontal force acts on it $\therefore$ $a = 0\ \text{m s}^{-2}$

consider the 2-kg block : the net force acting on the 2-kg block is $F$, i.e. 12 N.

$\therefore$ $F = m a$ $\therefore$ $(12) = (2)\,a$ $\therefore$ $a = 6\ \text{m s}^{-2}$

37. B

× (1) $R$ and $W$ are both acting on the same block, they cannot be action-reaction pair.

✓ (2) $W$ and $F$ are equal and opposite, and they act on 2 different bodies.

× (3) $F$ and $R$ are in same direction.

38. D

✓ (1) As $W = m g$, thus greater mass experiences a greater gravitational attraction force.

✓ (2) Both of them have the same acceleration due to gravity $g$, as $g$ is independent of mass,
thus they reach the ground at the same time.

✓ (3) Both of them have the same acceleration due to gravity $g$,
thus they reach the ground with the same velocity.

39. B

× (1) As the block is at rest, there must be frictional force acting on it to prevent the tendency of sliding.

× (2) As the block is in contact with the inclined plane, there must be normal reaction acting on the block.

✓ (3) As the block is at rest, there must be no net force (no resultant force) acting on it.

40. B

× (1) The mass of the coin should be much greater than that of the feather.

✓ (2) In vacuum, there is no air resistance,
thus both of them fall down with the same acceleration due to gravity $g$.

× (3) As the coin and the feather have different mass, by $W = m g$,
they should have different weight, i.e., different gravitational attraction force acting on each other them.

41. A

Since both $F_1$ and $F_3$ are acting on the ball, and the ball has upward acceleration,

thus the net force acting on the ball must be upwards $\therefore$ $F_1 > F_3$

Since $F_1$ and $F_2$ are action-reaction pair, $\therefore$ $F_1 = F_2$

Thus, $F_1 = F_2 > F_3$

42. B

× (1) To keep an object moving with uniform velocity, i.e. zero acceleration, the net force should be zero. Thus no unbalanced force is needed.

× (2) To keep an object moving with uniform acceleration, i.e. constant acceleration, the net force (unbalance force) should be constant, not increasing.

✓ (3) If there is no unbalanced force, the acceleration is zero. The object may remain at rest OR may move with uniform velocity.

43. D

✓ A. Mass : in kg ; Weight : in N.

✓ B. Mass indicates how large is its inertia ; weight represents how large the gravitational force acting on it.

✓ C. $W = m\,g$, for a particular place, $g$ is constant, thus $W \propto m$.

× D. Mass is always a constant but weight would vary at different places.

44. D

× (1) Both these two forces are acting on the man, but action-reaction pair must act on 2 different bodies

✓ (2) If the action force is on $A$ by $B$, then the reaction force is on $B$ by $A$, thus forces between the earth and the moon are action and reaction pair.

✓ (3) The force exerted by a swimmer on the water is the action force, and the force exerted by the water to push the swimmer forward is the reaction force.

45. C

The block must have weight pointing vertically downwards.

Since the object is in contact with the inclined plane, normal reaction must act on the block.

Since the inclined plane is smooth, there is no friction.

46. B

As the car moves with constant velocity, it has zero acceleration, thus the horizontal forces acting on it are balanced.

$\therefore\ T = f = 500$ N

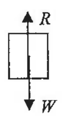
47. C

As $W = 10$ N, $R = 8$ N, $\therefore\ R < W$

since the downward force $W$ is greater, the net force is downwards

thus, the acceleration is downwards

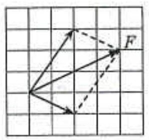
$\therefore$ the lift should have a downward acceleration OR upward deceleration.




48. D

To keep $P$ in equilibrium,

$F_3 = F = \sqrt{2^2 + 4^2} = 4.5$ N






49. A

✓ (1) The passenger in a moving car should move together with the car with the same velocity. As the car suddenly stops, due to the inertial of the passenger, he would keep on moving forwards. This is explained by the First law of motion, which is also called the Law of Inertia.

× (2) By Newton's second law, $m\,g = m\,a \quad \therefore\ a = g$

× (3) The maximum mass an astronaut can lift is greater on the moon is due to the smaller gravity of the moon.

50. C

At equilibrium, both ropes $AC$ and $CB$ exert an upward component $T\cos\theta$ on the shirt.

$2\,T\cos\left(\frac{150^\circ}{2}\right) = 2$

$\therefore\ T = 3.9$ N

51. B

× (1) On a friction-compensated runway, a block should move with constant velocity.

× (2) The normal reaction force : $R = mg\cos\theta$, which is a constant throughout the motion.

✓ (3) As friction is compensated by the component of weight along the inclined plane, i.e. $f = m\,g\sin\theta$, there is no net force acting the block.

52. C

✓ (1) As the two balls are falling under the same acceleration due to gravity, they must reach the ground at the same time with the same speed.

✓ (2) They have the same acceleration as the acceleration due to gravity is independent of the mass of a body.

× (3) By $W = mg$, different masses should have different gravitational forces $W$.

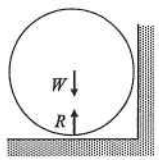
53. A

✓ (1) As the two balls reach the ground at the same time, they must have the same acceleration due to gravity.

× (2) This is Newton's first law, but it cannot be deduced from the result of the two falling balls.

× (3) Two balls of different mass should have different gravitational forces.

54. A




$W$ : gravitational force by the earth must exist for a body placed on the earth's surface

$R$ : normal reaction must exist and this force is used to support or balance the weight $W$

$F$ : friction does not exist as the ball has to tendency to slide

$N$ : normal reaction from the wall does not exist as the ball just touches the wall, it does not really press the wall

55. A

When the block is moving upward, the friction is pointing downwards.

$\therefore\ m g \sin\theta + f = m a_1$ and $a_1$ causes the deceleration of the block.

When the block is moving downward, the friction is pointing upwards.

$\therefore\ m g \sin\theta - f = m a_2$ and $a_2$ causes the acceleration of the block.

Comparing the two equations : $a_1 > a_2$

As absolute value of the slope of $v \sim t$ graph = magnitude of acceleration

$\therefore$ slope of the line representing the upward motion should be steeper.

56. C

Balance of forces in vertical direction : $F_2 \cos 30° = 10$ $\quad\therefore\ F_2 = 11.5$ N

57. B

On a rough surface, there must be friction.

$\therefore\ F - f = m a$

$\therefore\ a = \frac{1}{m}F - \frac{f}{m}$

This is a linear equation with a positive $x$-intercept, thus option B is correct.

58. A

By $W = mg$, as the weight $W$ is one-sixth on the moon, the acceleration due to gravity $g$ is also one-sixth on the moon.

✓ (1) By $v^2 = u^2 + 2as$ $\quad\therefore\ (0) = u^2 + 2(-g)s$ $\quad\therefore\ g\downarrow \Rightarrow s\uparrow$ for the same $u$

× (2) By $s = ut + \frac{1}{2}gt^2$ $\quad\therefore\ s = \frac{1}{2}gt^2$ $\quad\therefore\ g\downarrow \Rightarrow t\uparrow$ for the same $s$

× (3) To lift an object, the maximum force that can be applied by the astronaut = weight of the object
Since the maximum force of the astronaut is the same on the moon, he can only lift the same weight.
However, he can lift a greater mass on the moon.

59. A

Since the block is at rest, the friction acting on the block = 10 – 2 = 8 N

When the force 10 N is removed, the only applied force is 2 N, thus the friction would also reduce to 2 N.

$\therefore$ The resultant force is zero.

60. D

This experiment is used to demonstrate the Newton's 1st law.

When the cardboard is flickered away, the coin has the tendency to remain at rest, and the tendency is the inertia.

61. A

✓ (1) This is the action and reaction pair between the earth and the moon.

× (2) These two forces both act on the same body : the suitcase.

× (3) These two forces both act on the same body : the suitcase.



62. C

Slope of the $a$ - $F$ graph represents $\frac{1}{\text{mass}}$ $\quad\therefore$ slopes of the two graphs are the same since the mass is unchanged.

If the angle is increased, the runway would not be friction compensated

and the trolley would have an acceleration even when the applied force $F$ is zero.

$\therefore$ The new graph should have a positive $y$-intercept.

63. B

× (1) The gravitational force (weight) acting on John by the earth = $m g$ = (80)(10) = 800 N

× (2) The force exerted by the weighing scale on John is the normal reaction,
and this is equal to the normal reaction acting on the weighing scale, which is 600 N.

✓ (3) As reading of the weighing scale is smaller than the weight of John, direction of $a$ is downwards,
the lift must either be accelerating downward or decelerating upward.
By Newton's second law,
$mg - R = ma$ $\quad\therefore\ (800) - (600) = (80)\,a$ $\quad\therefore\ a = 2.5\ \text{m s}^{-2}$

64. A

Net force acting on the block = $m g \sin\theta - f = m a$

$\therefore\ (0.5)(9.81) \sin 30° - f = (0.5) \times (3)$

$\therefore\ f = 0.9525\ \text{N} \approx 0.95\ \text{N}$

65. A

Since the vertical force 60 N would be balanced by the normal reaction acting on the block and its weight,

i.e. downward force of weight 100 N = upward vertical force 60 N + upward normal reaction 40 N

Thus, the only force unbalanced is the horizontal force of 30 N, and this is the resultant force.

66. C

✓ (1) The object has the inertia to remain its initial state (at rest) when there is no unbalanced force.

✓ (2) The object has the inertia to remain its initial state (uniform motion) when there is no unbalanced force.

× (3) If there is unbalanced force, the object would have acceleration, and cannot be at uniform velocity.

67. B

✓ (1) The football first is at rest and then moves after being kicked by the player.
The football is under acceleration, so an unbalanced force exists.

× (2) For uniform velocity, the acceleration is zero, there is no unbalanced force acting in the parachutist.

✓ (3) The velocity of the bob is continuously changing as the direction of velocity is changing.
As velocity changes, acceleration must occur, an unbalanced force is required for the acceleration.

68. D

Since the block moves with uniform velocity, $a = 0$

Thus net force = 0

69. B

Balance of forces in vertical direction :

$4\,T\cos 20^\circ = 600$

$\therefore\ T = 160$ N

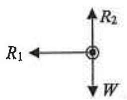
70. A

The gravitational force $W$ is the weight of a body which is acting on the body by the Earth.

Thus the weight is always a constant value, thus the graph should be a horizontal line.

71. C

Consider the forces acting on the child :




The force $R_1$ is the normal reaction acting on the child from the back of the seat.

$R_1$ causes the acceleration of the child, thus $R_1 = m\,a = (10) \times (3) = 30$ N

The force $R_2$ is the normal reaction acting on the child from the bottom of the seat.

$R_2$ is balanced by the weight, thus $R_2 = m\,g = (10) \times (10) = 100$ N

Both $R_1$ and $R_2$ are the forces exerted by the safety seat on the child, thus, their resultant is $\sqrt{(30)^2 + (100)^2} = 104$ N

72. B

× (1) These two forces act on the same body, the child, thus they must not be an action and reaction pair.

✓ (2) The force exerted on the chair by the child and the force exerted on the child by the chair are action and reaction pair since they act on two different bodies.

× (3) The force exerted by the chair on the ground is pointing downwards.
The gravitational force exerted by the earth on the chair is also pointing downwards.
Both of these two forces have the same direction, they must not be action and reaction pair.

73. B

✓ (1) By $W = m\,g$, since $g$ on the Earth is 10 m s$^{-2}$, mass of the object on the Earth is 6 kg.

× (2) Mass is independent of the gravity, thus mass of the object on the moon should also be 6 kg.

✓ (3) By $W = m\,g$, since the same mass gives one-sixth of the weight on the moon, $g$ on the moon must then be one-sixth that on the Earth.

74. D

✓ (1) In Figure (a), $F = (m_1 + m_2)\,a$ . In Figure (b), $F = (m_1 + m_2)\,a$ .
Thus, the acceleration must be the same in both figures.
In Figure (a), $T_1 = m_1\,a$ . In Figure (b), $T_2 = m_2\,a$ .
As $m_1 > m_2$ , therefore, $T_1 > T_2$

✓ (2) In Figure (a), $T_1 = m_1\,a \quad \therefore\ a = \dfrac{T_1}{m_1}$ . In Figure (b), $T_2 = m_2\,a \quad \therefore\ a = \dfrac{T_2}{m_2}$ .
Since the acceleration $a$ are the same, thus $\dfrac{T_1}{m_1} = \dfrac{T_2}{m_2}$

✓ (3) $F = (m_1 + m_2)\,a = m_1\,a + m_2\,a = T_1 + T_2$



75. D

✓ A. By $s = \frac{1}{2}\,a\,t^2$ , a graph of $s$ against $t^2$ gives a straight line through the origin.

✓ B. By $v = a\,t$ , a graph of $v$ against $t$ gives a straight line through the origin.

✓ C. By $v^2 = 2\,a\,s$ , a graph of $v^2$ against $s$ gives a straight line through the origin.

× D. Since the acceleration is constant due to the constant horizontal force, a graph of $a$ against $t$ should give a horizontal line.

76. A

To balance the weight of the sucker, there must be an upwards force acting on the sucker.

The only force that can act along the wall is the friction.

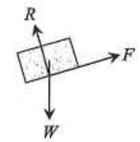
77. C

✓ (1) If $F_1$ and $F_2$ are in perpendicular direction, then their resultant force is $\sqrt{3^2 + 4^2} = 5$ N.
If $F_3$ is in the opposite direction to the resultant of $F_1$ and $F_2$, then the object is in equilibrium.

✓ (2) If $F_1$ and $F_2$ are in the same direction, then their resultant force is $3 + 4 = 7$ N.
If $F_3$ is in the opposite direction to the resultant of $F_1$ and $F_2$, then the object is in equilibrium.

× (3) If $F_1$ and $F_2$ are in the same direction, then their resultant force is $3 + 5 = 8$ N.
However, $F_3$ has a magnitude of 9 N which is too great for the object to be in equilibrium.

78. C




Since the inclined plane is rough, there must be friction acting on the block.

As friction tends to prevent the block from sliding down, the direction of the friction is upwards along the plane.

Normal reaction exists when two surfaces are in contact.

79. D

Resolve the tension in each side into vertical and horizontal components.

The two vertical components $T\cos 70^\circ$ are balanced by the weight of the fish and hook.

$\therefore\ W = 2\,T\cos 70^\circ = 20\cos 70^\circ$ N

80. C

By $F - f = m\,a$

$\therefore\ (5) - f = (1)\,(2) \qquad \therefore\ f = 3$ N

81. B

① When the lift is moving upwards with a uniform speed, there is no acceleration, thus $R_1 = mg$.

② When the lift is moving downwards with a uniform speed, there is no acceleration, thus $R_2 = mg$.

③ When the lift is moving upwards with an acceleration, there is an upward net force, thus $R_3 > mg$.

$\therefore\ R_3 > R_1 = R_2$

82. C

× A. Since the two blocks are connected together, they must move together with the same speed.

× B. Since the two blocks are connected together, they must move together with the same magnitude of acceleration.

✓ C. As the two blocks have the same magnitude of acceleration, but their masses are different, they have different magnitude of resultant force.

× D. Since the two blocks are connected together by the same string, the tension exerted by the same string must be the same.

83. B

To be an action and reaction pair, the two forces must be equal in magnitude and opposite in direction,

and act on two different bodies such that : force exerted by *A* on *B* and force exerted by *B* on *A*.

Option B is correct as these are the action-reaction pair between the string and *Y*.

84. D

Net horizontal force = 2 × 50 cos 40°

= 76.6 N

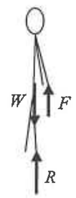
85. C

Consider the forces acting on Peter :

① weight of Peter $W$

② reaction force by the table $F$

③ normal reaction force $R$ by the weighing scale, i.e. the reading of the scale




Since Peter is in equilibrium,

$\therefore\ F + R = W$

$\therefore\ R = W - F$

86. B

Resolve the tension in each side into vertical and horizontal components.

The two vertical components $T\cos\theta$ are balanced by the weight of the acrobat.

$\therefore\ W = 2T\cos\theta \qquad \therefore\ \cos\theta = \dfrac{W}{2T}$

As $0° < \theta < 60°$

$\therefore\ \cos 0° > \cos\theta > \cos 60°$ ( $\cos\theta$ is a decreasing function, that is, greater θ gives smaller cos θ )

$\therefore\ 1 > \dfrac{W}{2T} > 0.5 \qquad \therefore\ T > \dfrac{W}{2}$ and $W > T$

87. B

In order to deduce the relationship between the acceleration and the net force, the mass should be kept constant.

Since trials (i), (iv) and (vi) have the same mass of 2 kg, these 3 trials should be chosen.



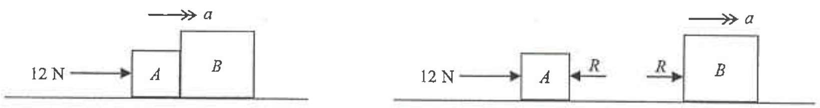
88. D

✓ (1) Seat belts can prevent passengers from throwing forwards due to inertia when accident occurs.

✓ (2) When a vehicle is overloaded, its mass increases, thus its tendency to keep on motion is increased, therefore, it is harder to brake the vehicle within a safety distance.

✓ (3) If a vehicle exceeds the speed limit, it is harder to brake the vehicle to rest due to its inertia.

89. D




Consider the two blocks together,

$F_{net}$ = total mass × acceleration $\quad \therefore\ (12) = (1+3)\,a \quad \therefore\ a = 3\ \text{m s}^{-2}$

Consider the block $B$, contact force = mass of $B$ × acceleration = (3) × (3) = 9 N

90. D

Since the horse gives a pulling force in forward direction to the block, the friction acts on the block is in backward direction.

Since the block gives a pulling force in backward direction to the horse, the friction acts on the horse should be in forward direction.

91. A

For an action and reaction pair, one should be acting on *A* by *B* and the other should be acting on *B* by *A*.

✓ (1) These are action and reaction pair between the child and the scale.

× (2) The reaction of the force by the Earth on the child should be the force by the child on the Earth.

× (3) The reaction of the force by the Earth on the scale should be the force by the scale on the Earth.

92. A

Resolve the tension $T$ into a horizontal component $T\sin\theta$ and a vertical component $T\cos\theta$.

Since the block is in equilibrium under 3 forces : the tension $T$, the weight of 10 N, the force of 3 N,

balance the force horizontally, $T\sin\theta = 3$

balance the force vertically, $T\cos\theta = 10$

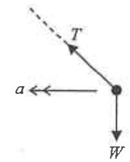
$\therefore\ \tan\theta = 0.3 \quad \therefore\ \theta = 16.7° \quad \therefore\ \theta < 30°$

$\therefore\ T\sin 16.7° = 3 \quad \therefore\ T = 10.4\ \text{N} \quad \therefore\ 13\ \text{N} > T > 10\ \text{N}$

93. C

Since the vertical component of the tension $T$ balances the weight $W$,

the horizontal component of the tension $T$ is the net force, thus, the acceleration is towards the west.




✓ (1) Moving to the east and decelerating means that the acceleration is towards the west.

✓ (2) Moving to the west and accelerating means that the acceleration is towards the west.

× (3) Starting to move to east means that the acceleration is towards the east.

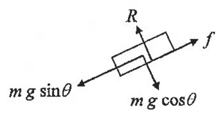
94. C

× (1) $F_1$ is the weight of the block acting by the Earth,
$F_2$ is the normal reaction acting on the table by the block.
They are two different types of forces.

✓ (2) Since $F_1$ and $F_3$ are the only two forces acting on the block, and the block is at rest, thus these two forces balance each other.

✓ (3) $F_2$ is the normal action acting on the table by the block,
$F_3$ is the normal action acting on the block by the table.
These two forces act on two different bodies and they are action and reaction pair.

95. B




Along the inclined plane, there are two forces acting on the block.

The $m\,g \sin\theta$ is downwards and the friction $f$ is upwards.

By net force = $m\,a$ ∴ $m\,g \sin\theta - f = m\,a$

∴ $f = m\,g \sin\theta - m\,a$

In the direction perpendicular to the inclined plane, there are two forces acting on the block.

The $m\,g \cos\theta$ is downwards and the normal reaction $R$ is upwards.

Since there is no net force in this direction, these two forces are balanced.

∴ $R = m\,g \cos\theta$

96. C

By Newton's second law, net force = mass × acceleration

Consider $A$ : $10 - T = m\,a$

Consider $B$ : $T - 4 = m\,a$

∴ $10 - T = T - 4$ ∴ $T = 7$ N

97. A

Under the pulling force of 5 N :

$F_{net} = m\,a$ ∴ $(5) - f = (1)(2)$ ∴ maximum friction $f = 3$ N

Under the pulling force of 2 N :

friction = 2 N to oppose the tendency of motion, thus the resultant force is zero.

98. C

Resolve the tension $T_1$ in $S_1$ into two components :

vertical component = $T_1 \sin 30°$ horizontal component = $T_1 \cos 30°$

Balance the forces in vertical direction :

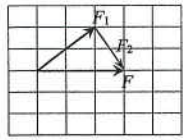
$T_1 \sin 30° = 50$ ∴ $T_1 = 100$ N

Balance the forces in horizontal direction :

$T_1 \cos 30° = T_2$ ∴ $T_2 = (100) \cos 30° = 86.6$ N



99. A




The two forces $F_1$ and $F_2$ should give a vector sum of $F$.

100. C

On the Earth's surface : weight = 120 N mass = 12 kg

On the Moon's surface : weight = $120 \times \frac{1}{6}$ = 20 N mass = 12 kg

101. D

From $t = 0$ to $t = t_1$, since the applied force is stronger, the acceleration is greater, thus the slope of the graph is greater.

Beyond $t_1$, the only force acting on the trolley is friction.
Since the friction remains the same, the deceleration is the same, thus the slope should be the same.

102. C

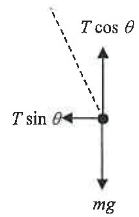
Spring balance reads the tension in the string,

thus tension = reading = 5 N

103. A


Initially, in order to prevent sliding of the block, friction of 70 N acts on the block towards the right to keep it at rest.
After $S_1$ is broken, friction would change direction and reduce to 30 N towards the left to prevent sliding of the block.
Thus, the net force acting on the block is zero.

104. B




The tension should be resolved into two components.

The horizontal component of tension is the net force.

∴ $T \sin\theta = m\,a$

The vertical forces are balanced.

∴ $T \cos\theta = m\,g$

Combining the two equations :

∴ $\tan\theta = \dfrac{a}{g}$

∴ $a = g \tan\theta = (10) \tan 10° = 1.76$ m s$^{-2}$

105. D

✓ (1) When the object is moving up, air resistance $R$ is downwards, thus the net force : $F = W + R$
$\therefore F > W$

✓ (2) When the object is at the highest point, it is momentarily at rest, thus air resistance is zero.
$\therefore F = W$

✓ (3) When the object is moving down, air resistance $R$ is upwards, thus the net force : $F = W - R$
$\therefore F < W$

106. B

× (1) The gravitational force acting on the man is the weight of the man, which is unchanged.

× (2) The gravitational force acting on the lift is the weight of the lift, which is unchanged.

✓ (3) The force acting on the man by the floor is the normal reaction force $R$.
When the lift accelerates upwards, $R - m\,g = m\,a$, thus $R$ increases.
As $R$ becomes greater than $m\,g$, the man feels heavier.

107. B

× (1) At $t = 0$ to 3 s, $R = 400$ N, and $W = m\,g = 500$ N $\therefore$ Net force $= W - R = 100$ N.

× (2) At $t = 3$ s, $R = 500$ N, thus there is no net force, and the lift should move down with constant velocity.

✓ (3) At $t = 3$ to 6 s, since there is no net force, thus no acceleration, the lift is moving at constant velocity.

108. A

By Newton's second law, net force = $m\,a$

$\therefore m\,g - R = m\,a$

$\therefore (50 \times 10) - (400) = (50)\,a$

$\therefore a = 2\text{ m s}^{-2}$

109. D

Resolve the tension $T$ into vertical component $T\cos\theta$ and horizontal component $T\sin\theta$

Since the forces are balanced, thus

$T\sin\theta = F$

$T\cos\theta = W$

Thus the weight is equal to $T\cos\theta$.

110. C

× A. The maximum friction may not be equal to 25 N.
If the maximum friction is greater than 25 N, then the block can still be at rest even when $F > 25$ N.

× B. When $F = 25$ N, the block is at rest, thus the friction $f = 25$ N, so that the net force is zero.

✓ C. If $F = 20$ N, $f = 20$ N to oppose the start of motion.

× D. If $F = 0$ N, $f = 0$ N.



111. D

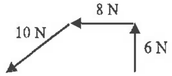
✓ (1) The force acting on the ant by the ceiling must be upwards to balance the weight of the ant and the block.

× (2) These two forces are both acting on the block, they cannot be an action and reaction pair.

✓ (3) As the ant is at rest, the net force acting on it must be zero.

112. C

If the net force is zero, the three forces adding head-to-tail should form a closed triangle.




The three forces in diagram C cannot form a closed triangle, thus they cannot give zero net force.

113. A

By Newton's 2nd law, $F - f = m\,a$ $\therefore$ $a = \dfrac{1}{m}F - \dfrac{f}{m}$

It is a straight line with positive slope ( $1/m$ ) and negative $y$-intercept ( $-f/m$ )

114. C

$R - mg = ma$ $\therefore R = mg + ma = m(g + a)$

115. B

When the system is in free fall, the strings become slack and no tension acts on every body.

The only force acting on each body is its own weight. Thus, net force on $B$ is 4 N.

116. A

Consider the 4 kg body : $(4 \times 10 \times \sin 30°) - T = (4)\,a$

Consider the 1 kg body : $T - (1 \times 10) = (1)\,a$

$\therefore a = 2\text{ m s}^{-2}$ and $T = 12$ N

117. C

Consider the 5 kg body : $(50) - T = (5)\,a$

Consider the 3 kg body : $T - (30) = (3)\,a$

$\therefore a = 2.5\text{ m s}^{-2}$ and $T = 37.5$ N

$\therefore$ Vertical upward force on the axle $= 2\,T = 2 \times 37.5 = 75$ N

118. D

Reading on the spring balance scale is the tension $T$.

When the lift starts to go down, it undergoes downward acceleration.

$\therefore m\,g - T = m\,a$ $\therefore T < m\,g$ $\therefore$ reading is less than 50 N

When the lift is going to stop, it undergoes downward deceleration (i.e. acceleration in upward direction)

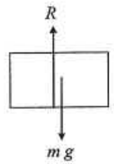
$\therefore T - m\,g = m\,a$ $\therefore T > m\,g$ $\therefore$ reading is more than 50 N

119. C

$m g \sin\theta - f = m a \qquad \therefore\ f = m g \sin\theta - m a$

120. C

The weight indicated by the balance is in fact the normal reaction $R$.




When $R < mg$, the direction of the acceleration is downwards,

that is, moving downward with acceleration **OR** moving upward with deceleration.

By $m g - R = m a$

$\therefore\ (400) - (360) = (40)\, a \qquad \therefore\ a = 1\ \text{m s}^{-2}$

121. C

$F = (m + 2m + 2m)\, a \qquad \therefore\ a = \dfrac{F}{m+2m+2m} = \dfrac{20}{5m}$

Net force on $B$ $= m_B \times a = (2m)\left(\dfrac{20}{5m}\right) = 8$ N

122. A

Tension exists along the string and weight exists to act on the bob.

Only two forces act on the bob when it is swinging in air.

123. B

Minimum resultant ⇒ two forces are in opposite direction $\qquad \therefore\ F_1 - F_2 = 7 \ \ldots (1)$

Maximum resultant ⇒ two forces are in same direction $\qquad \therefore\ F_1 + F_2 = 17 \ \ldots (2)$

Solving (1) and (2),

$F_1 = 12$ N and $F_2 = 5$ N

When 2 forces are at right angle,

$F = \sqrt{F_1^2 + F_2^2} = \sqrt{12^2 + 5^2} = 13$ N

124. D

Weight of the body is vertically downwards.

Tension of the string acting on the toy is upward along the string.

The propeller gives a propelling force in upward left direction to make the toy in equilibrium.

125. B

For the block moves downward with constant velocity without acceleration, friction is balanced by $mg \sin\theta$.

$\therefore\ f = m g \sin\theta = (0.5)(9.81) \sin 20° = 1.68$ N

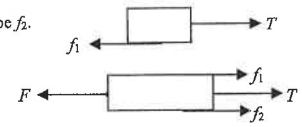
To move the block upward with constant velocity, applied force $F$ must overcome $mg \sin\theta$ and the downward friction.

$\therefore\ F = m g \sin\theta + f = (0.5)(9.81) \sin 20° + 1.68 = 3.4$ N



126. C

Let the friction between $A$ and $B$ be $f_1$ and the friction between $B$ and the ground be $f_2$.




Consider block $A$ : $T = f_1 \qquad \therefore\ T = 1.5$ N

Consider block $B$ : $F = f_1 + T + f_2$

$= (1.5) + (1.5) + (1.5) = 4.5$ N

127. D

$P - Q = (2m + m)\, a \qquad \therefore\ a = \dfrac{P-Q}{3m}$

The force acting on $B$ by $A$ is the normal reaction $R$.

Consider body $B$,

$P - R = m_B\, a$

$\therefore\ R = P - (m)\cdot\left(\dfrac{P-Q}{3m}\right) = \dfrac{2P+Q}{3}$

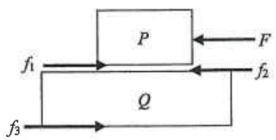
128. A

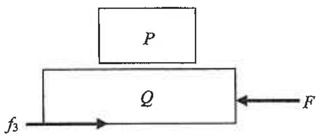
$T_{max} - m g = m a$

$(100) - (8)(9.81) = (8)\, a$

$\therefore\ a = 2.69\ \text{m s}^{-2} \approx 2.7\ \text{m s}^{-2}$

129. D




× (1) At rest ⇒ no net force ⇒ $f_1 = F$ and $f_1 = f_2$ (action-reaction) and $f_2 = f_3$ (balance of forces)
$\therefore\ F = f_3$

✓ (2) Direction of $f_1$ is opposite to $F$ ⇒ $f_1$ is towards the right

✓ (3) If $F$ is applied to $Q$, then the friction acting on $Q$ by the floor is still $f_3$ and $f_3 = F$, thus $Q$ is still at rest.
As $Q$ is at rest, $P$ is also at rest and there is no friction between $P$ and $Q$.

130. C

When inclined angle is 15° :

$(0.4 \times 9.81) \sin 12° - f = (0.4)\, a \qquad \ldots$ ①

When inclined angle is 20° :

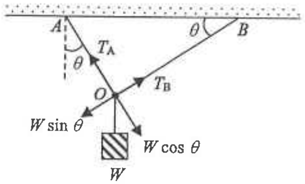
$(0.4 \times 9.81) \sin 18° - f = (0.4)(2a) \qquad \ldots$ ②

① × 2 − ② :

$\therefore\ 2 \times (0.4 \times 9.81) \sin 12° - (0.4 \times 9.81) \sin 18° = f$

$\therefore\ f = 0.42$ N

131. A




Since $\angle AOB = 90°$, the weight $W$ should be resolved into two perpendicular components along $OA$ and $OB$.

Balance of forces along $OB$ : $T_B = W \sin\theta$

132. D

After the plasticine is placed, the total mass $M$ of the system increases.

By $F = Ma$, the acceleration of the system decreases.

Consider the block $A$ : $F - T_1 = m_A a$ As acceleration $a$ decreases, tension $T_1$ increases.

Consider the block $C$ : $T_2 = m_C a$ As acceleration $a$ decreases, tension $T_2$ decreases.

133. D

The tension is resolved into a vertical component $T\cos\theta$ and a horizontal component $T\sin\theta$ towards the right.

① $T\sin\theta = ma$

② $T\cos\theta = mg$

$\therefore \tan\theta = \frac{a}{g}$

$\therefore a = g\tan\theta$

As the net force $T\sin\theta$ is towards the right, the acceleration of the vehicle is towards the right.

134. A

Consider the block $X$, there is no friction acting on it, thus there is no horizontal force acting on it.

The acceleration of $X$ is zero.

Consider the block $Y$, as there is no friction, the only horizontal force acting on it is $F$.

By $F = ma$, the acceleration of $Y$ is $F/m$.

135. C

Since the two blocks move together, they have the same acceleration.

Consider the two blocks as a whole system :

$F = (m_1 + m_2)a \quad \therefore (6) = (2+3)a \quad \therefore a = 1.2 \text{ m s}^{-2}$

Consider the 2 kg block :

$f = m_1 a = (2)(1.2) = 2.4 \text{ N}$

**OR**

Consider the 3 kg block :

$F - f = m_2 a \quad \therefore (6) - f = (3)(1.2) \quad \therefore f = 2.4 \text{ N}$



136. C

Reading of the scale is equal to the normal reaction $R$ acting on the man.

At $t$ = 0 to 8 s, $R$ = 550 N.

By $R - mg = ma \quad \therefore (550) - (500) = (50)a \quad \therefore a = 1 \text{ m s}^{-2}$. The lift is accelerating upwards.

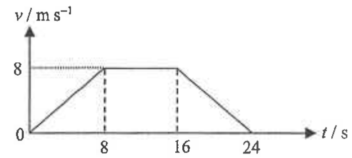
At $t$ = 8 to 16 s, $R$ = 500 N.

As $R = W$, the net force is zero, thus the lift is moving upwards with uniform velocity.

At $t$ = 16 to 24 s, $R$ = 450 N.

By $mg - R = ma \quad \therefore (500) - (450) = (50)a \quad \therefore a = 1 \text{ m s}^{-2}$. The lift is decelerating upwards.

Draw a velocity - time graph.




Maximum velocity : $v = u + at = (0) + (1)(8) = 8 \text{ m s}^{-1}$

Height = total distance travelled = area under the graph

$= \frac{1}{2}(8 + 24)(8) = 128 \text{ m}$

137. A

$T_A \sin\theta = T_C \quad \therefore T_A > T_C$

$T_A \cos\theta = T_B \quad \therefore T_A > T_B$

String $OA$ would break first as its tension is the greatest among the three strings.

138. A

✓ (1) Tension of the elastic cord depends on the extension.
From $P$ to $Q$, the extension of the cord is smaller than that at $Q$,
thus the weight of the boy is greater than the tension of the cord ($mg > T$).
As the net force is downwards, the acceleration is downwards,
therefore, the boy is under acceleration and his speed increases throughout.

✓ (2) From $O$ to $Q$, the boy's speed increases throughout as $mg > T$.
At $Q$, the forces are balanced as $mg = T$.
From $Q$ to $R$, the boy's speed decreases as $T > mg$.
Thus, the speed is the maximum at $Q$.

× (3) At $R$, the boy is momentarily at rest but the acceleration is upwards as $T > mg$.
Thus, net force is not zero.

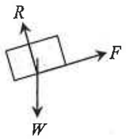
139. B

Resolve the tension in each side into vertical and horizontal components.

The two vertical components $T\cos 70°$ are balanced by the weight of the fish and hook.

$\therefore W = 2T\cos 70° = 20\cos 70° \text{ N}$

140. C




Since the inclined plane is rough, there must be friction acting on the block.

As friction tends to prevent the block from sliding down,
the direction of the friction is upwards along the plane.

Normal reaction exists when two surfaces are in contact.

141. C

By $F - f = m a$ $\quad \therefore$ $(5) - f = (1)(2)$ $\quad \therefore$ $f = 3$ N

142. B

① When the lift is moving upwards with a uniform speed, there is no acceleration, thus $R_1 = mg$.

② When the lift is moving downwards with a uniform speed, there is no acceleration, thus $R_2 = mg$.

③ When the lift is moving upwards with an acceleration, there is an upward net force, thus $R_3 > mg$.

$\therefore$ $R_3 > R_1 = R_2$

143. D

**Motion of the block on the smooth inclined plane :**

$m g \sin \theta = m a$

$\therefore$ $a = g \sin \theta$

The acceleration depends on the angle of the incline. Slope of the $v$-$t$ graph represents the acceleration $a$.

Release at higher position with the same angle results in the same slope with greater velocity at the bottom.

**Motion of the block on the rough ground :**

$f = m a$

The deceleration depends on the friction $f$. Slope of the second portion of the line represents the deceleration.

Same friction indicates the same deceleration and the same slope.

144. B

× (1) The weight of the block should be balanced by the force exerted by the table and the 60 N, that is, $W = R + 60$ and $R = 40$ N.

× (2) The force exerted on the table by the block is the normal reaction $R$ which is equal to 40 N.

✓ (3) These two forces are equal and opposite, and act on each other.

145. A

After the loading of the plasticine, the total mass increases, thus the acceleration $a$ decreases.

Consider block $R$, $T_2 = m_R\, a$, as $a$ decreases, $T_2$ decreases.

Consider block $P$, $F - T_1 = m_P\, a$, as $a$ decreases, $T_1$ increases.



146. C

Consider the whole system : $F_1 - F_2 = (m + 2m)\, a$ $\quad \therefore$ $a = \dfrac{F_1 - F_2}{3m}$

Consider $P$ : $F_1 - T = (m)\left(\dfrac{F_1 - F_2}{3m}\right)$

$\therefore$ $T = \dfrac{2F_1 + F_2}{3}$

147. A

At 0°, the resultant force is $F_1 + F_2$, and this resultant force is the greatest.

At 180°, the resultant force is $F_1 - F_2$, and this resultant force is the smallest.

Thus, the resultant force decreases throughout.

148. C

✓ (1) Since the slides down with uniform speed, the acceleration is zero, thus the net force is also zero.

✓ (2) Since net force is zero $\therefore$ $f = m g \sin 30° = 0.5\, m g$

× (3) The acceleration depends on the friction and the angle of the incline, but not affected by the initial speed.

149. A

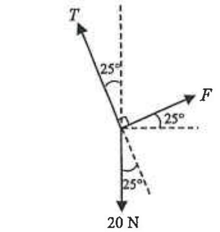
By Newton's second law, net force = mass × acceleration

$\therefore$ $F - f = m a$

$\therefore$ $a = \dfrac{1}{m} F - \dfrac{f}{m}$

The graph is a straight line with a negative $y$-intercept.

150. A




Balance of forces in $x$-direction : $T \sin 25° = F \cos 25°$ $\quad \therefore$ $T = F \dfrac{\cos 25°}{\sin 25°}$

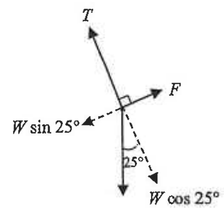
Balance of forces in $y$-direction : $T \cos 25° + F \sin 25° = 20$

$\therefore$ $F \dfrac{\cos 25°}{\sin 25°} \times \cos 25° + F \sin 25° = 20$

$\therefore$ $F \dfrac{\cos^2 25° + \sin^2 25°}{\sin 25°} = 20$

$\therefore$ $F = 20 \sin 25° = 8.5$ N

**OR**




Resolve the weight $W$ into 2 components : $W \sin \theta$ and $W \cos \theta$

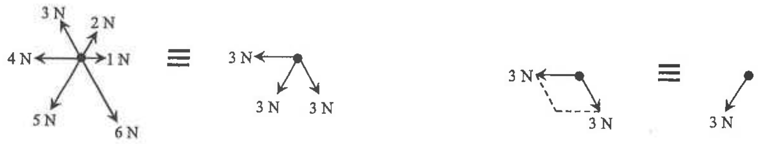
Balances of forces :

① $F = W \sin \theta$

② $T = W \cos \theta$

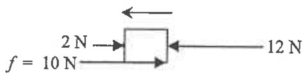
$\therefore$ $F = 20 \sin 25° = 8.5$ N

151. D

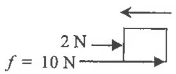



The resultant force is 3 N + 3 N = 6 N along *OE* direction.

152. A




Friction along sliding surface must always be opposite to the motion and keep constant.




When the 12 N is removed, as the block still keeps moving, the direction and magnitude of the friction $f$ is unchanged, thus, the net force acting on the block = 2 + 10 = 12 N

153. C

Let the tension be $T$ and the acceleration be $a$.

As block of 3 kg has smaller mass, acceleration of 3 kg block is upwards and acceleration of 5 kg block is downwards.

Consider the 3 kg block : $T - (3\,g) = (3)\,a$

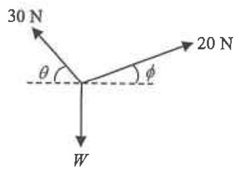
Consider the 5 kg block : $(5\,g) - T = (5)\,a$

Combine the two equations :

$(5\,g) - (3\,g) = (3+5)\,a$

$\therefore\ a = \frac{1}{4}g$

154. A




As the system is in equilibrium, forces in the vertical direction are balanced.

$\therefore\ 30\sin\theta + 20\sin\phi = W$

As $\sin\theta$ and $\sin\phi$ must be less than 1,

$\therefore\ 30\sin\theta < 30$ and $20\sin\phi < 20$

$\therefore\ W < 50$ N

$\therefore$ $W$ must be less than 50 N



155. C

$F = m_1 a_1$ and $F = m_2 a_2$

$F = (m_1 + m_2)\,a$

$\therefore\ F = (\frac{F}{a_1} + \frac{F}{a_2})\,a \qquad \therefore\ \frac{1}{a} = \frac{1}{a_1} + \frac{1}{a_2}$

$\therefore\ a = \frac{a_1 a_2}{a_1 + a_2}$

156. D

The boy experiences 3 forces :

① weight $W$ acting on the boy by the Earth (downwards)

② normal reaction $R$ acting on the boy by the ground (upwards)

③ pulling force $F$ by the rope on the boy (upwards)


$\therefore\ F + R = W \qquad \therefore\ R = W - F$

By Newton's third law, force acting on the ground by the boy is also $R$, which is $W - F$.

Force acting on the ceiling by the rope = weight of the rope + pulling force by the boy
= $G + F$

157. C

By $v^2 = u^2 + 2as$

$\therefore\ (0) = (2)^2 + 2\,a\,(0.5) \qquad \therefore\ a = -4$ m s$^{-2}$

Deceleration of the block is 4 m s$^{-2}$.

158. A

By $s = ut + \frac{1}{2}at^2$

$\therefore\ (1) = (0) + \frac{1}{2}a\,(3)^2 \qquad \therefore\ a = 0.22$ m s$^{-2}$

159. C

Weight $mg$ is pointing vertically downwards.

Normal reaction $N$ is pointing upwards and perpendicular to the inclined plane.

Friction $f$ is pointing upwards along the inclined plane to oppose the sliding of the block.

160. A

Since $X$ and $Y$ move together, they have the same magnitude of acceleration $a$.

The net force pushing them to move together is the weight of $Y$.

$\therefore\ (1)(9.81) = (0.5 + 1)\,a \qquad \therefore\ a = 6.54$ m s$^{-2}$

Consider the falling motion of $Y$.

By $v^2 = u^2 + 2as$

$\therefore\ v^2 = (0) + 2\,(6.54)\,(1) \qquad \therefore\ v = 3.62$ m s$^{-1}$

**The following list of formulae may be found useful :**

For uniformly accelerated motion $v = u + at$

$s = ut + \frac{1}{2}at^2$

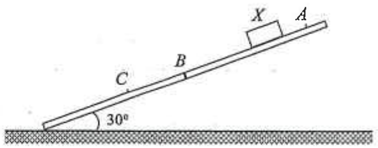
$v^2 = u^2 + 2as$

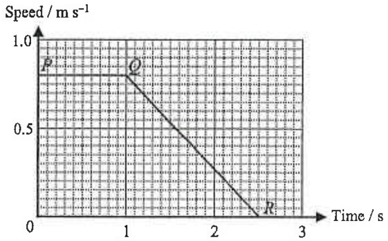
**Use the following data wherever necessary :**

Acceleration due to gravity $g = 9.81 \text{ m s}^{-2}$ (close to the Earth)

## Part A : HKCE examination questions

1. **< HKCE 1985 Paper I - 1 >**




The figure above shows a block $X$ of mass 0.5 kg sliding down a plane inclined at an angle of 30° with the horizontal. The plane is composed of two portions made of different materials. They join at $B$. The speed-time graph of the block is shown . $PQ$ denotes the motion of the block in portion $AB$ while $QR$ denotes the motion in portion $BC$.

(a) Find

(i) the resultant force, and

(ii) the frictional force

acting on the block $X$ in the portion $AB$ of the inclined plane. (4 marks)

(b) From the graphs shown above, find

(i) the acceleration of, and

(ii) the distance travelled by

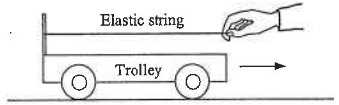
the block $X$ in the portion $BC$ of the inclined plane. (4 marks)



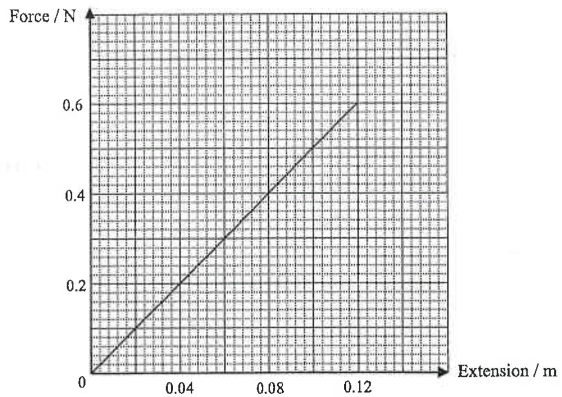
1. (c) If the block $X$ is projected upwards from point $C$ along the inclined plane with a certain initial speed, sketch the speed-time graph of the upward motion. (Assume the block passes through point $B$.) (4 marks)

2. **< HKCE 1990 Paper I - 1 >**

The figure below shows a trolley of length 0.25 m resting on a horizontal runway. An elastic string of unstretched length 0.15 m is tied to the trolley. The trolley is pulled along the runway by stretching the elastic string. By keeping the length of the stretched string equal to the length of the trolley, a constant force $F_1$ N is applied to pull the trolley.




(a) The force-extension characteristic of the elastic string is shown below.



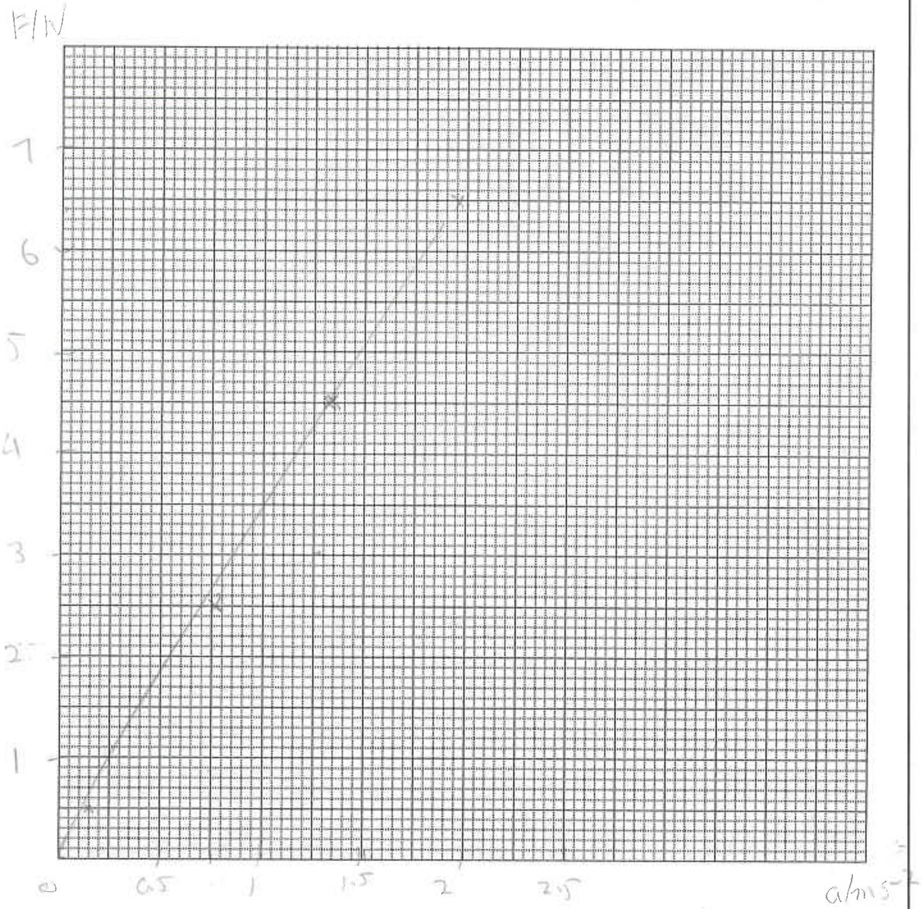

What is the value of $F_1$ ? (1 mark)

(b) The experiment is repeated with two, three and four identical strings in parallel. The following results are obtained :

| Number of elastic strings | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Force on trolley by strings $F$ / N | $F_1$ | $F_2$ | $F_3$ | $F_4$ |
| Acceleration $a$ / m s$^{-2}$ | 0.15 | 0.75 | 1.35 | 1.95 |

(i) Find the values of $F_2$ , $F_3$ and $F_4$ . (1 mark)

2. (b) (ii) Using a scale that 4 cm represents 0.5 N and 4 cm represents 0.5 m s$^{-2}$, plot a graph of $F$ against $a$. (4 marks)

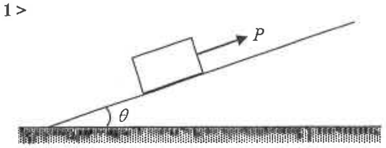



(iii) Find the equation relating $F$ and $a$ from the graph in (ii). (3 marks)

(iv) Comment on the physical meaning of $F_o$, the intercept on the $F$ axis, when $a$ equals zero. (2 marks)



3. **< HKCE 1994 Paper I - 1 >**

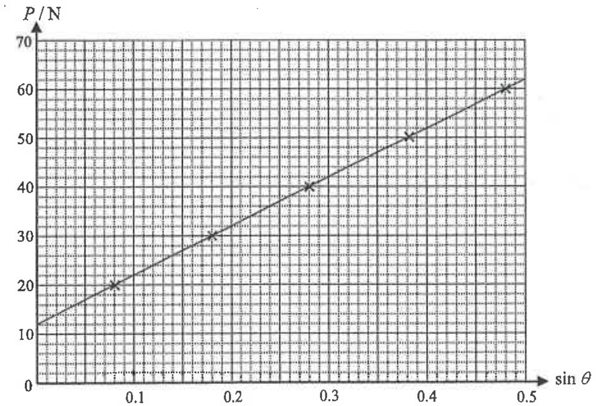



A block is placed on a rough plane inclined at an angle $\theta$ to the horizontal. A force $P$ parallel to the inclined plane is applied to the block so that it moves up the plane at a constant speed. See the figure above.

(a) Draw a diagram to show all the forces acting on the block. Name the forces. (3 marks)

(b) Describe briefly a method to check whether the speed of the block remains constant. (2 marks)

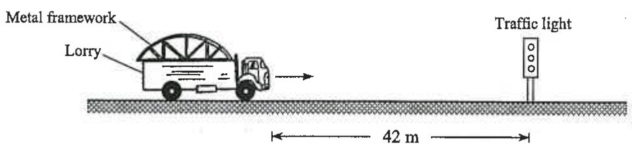
(c) A student performs an experiment to find the relationship between $P$ and $\theta$. Different values of $\theta$ are used and the corresponding values of $P$ are measured. The results are plotted in a graph of $P$ against sin $\theta$ as shown below.




(i) Find the intercept of the graph on the $P$-axis and the slope of the graph. Hence write down the equation relating $P$ and sin $\theta$. (4 marks)

(ii) State the physical meanings of the intercept and the slope found in (i). (2 marks)

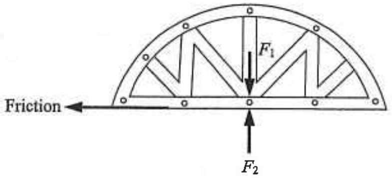
4. **< HKCE 1999 Paper I - 7 >**




A lorry, with a heavy metal framework placed on top, is travelling at a uniform speed of 16 m s$^{-1}$ along a straight road. (See the above figure.) At time $t = 0$, the driver observes that a traffic light, which is at a distance of 42 m from the lorry, is turning red. The driver applies the brake at $t = 0.5$ s. The lorry then decelerates uniformly and comes to a rest at $t = 4.5$ s.

(a) Find the deceleration of the lorry from $t = 0.5$ to 4.5 s. (1 mark)

(b)




The above figure shows the forces acting on the framework when the lorry is decelerating. The mass of the framework is 1000 kg.

(i) Name the forces $F_1$ and $F_2$. (2 marks)

(ii) Explain whether $F_1$ and $F_2$ are a pair of action and reaction according to Newton's third law of motion. (2 marks)

(iii) Find the magnitude of the friction if the framework decelerates at the same rate as the lorry. (2 marks)

(iv) The driver is charged by a policeman for not fastening the framework on the lorry. State **two** daily situations in which the framework will slip from the moving lorry. (2 marks)



5. **< HKCE 2001 Paper I - 8 >**

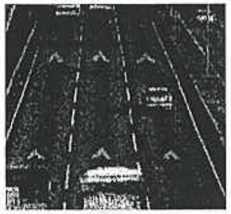


**Figure 1**

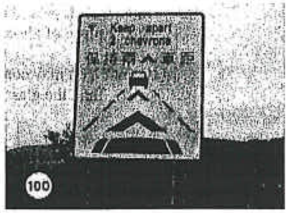


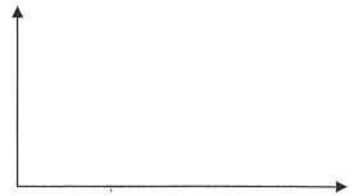
**Figure 2**

Figure 1 shows a horizontal straight highway with a speed limit of 100 km h$^{-1}$ (i.e. 27.8 m s$^{-1}$). For safety reasons, drivers are advised to maintain a safety distance of 80 m from the cars ahead. Large arrows (chevrons) are painted on the highway (each at 80 m apart) and road signs are set up to remind drivers of this safety distance (see Figure 1 and 2).

(a) Find the time taken by a car to drive from one arrow to another when it is travelling at 100 km h$^{-1}$. (1 mark)

(b) A car is travelling at 100 km h$^{-1}$ on the highway. At time $t = 0$, the driver observes that an accident has happened and a lorry stops 80 m ahead. He applies the brakes to stop the car with uniform deceleration. The reaction time of the driver is 0.8 s and the decelerating time of the car is 4 s.

(i) Sketch the speed-time graph of the car. (3 marks)

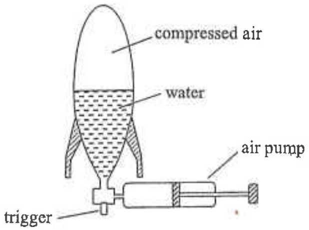


(ii) Explain whether the car will hit the lorry. (3 marks)

(iii) The total mass of the car and the driver is 1200 kg. Find the average braking force on the car. (3 marks)

(c) Suppose the highway in Figure 1 is on a slope with traffic running downhill. Do you think that the distance between two arrows should be greater than, equal to or less than 80 m ? Explain your answer by considering the forces acting on a car. Assume that the speed limit of the highway and the braking force acting on the car remain unchanged. (4 marks)

**6.** **< HKCE 2004 Paper I - 2 >**




The Figure above shows a water rocket. The rocket is filled with water and compressed air. Explain why the rocket rises when the trigger is pulled and name the law or principle involved. (3 marks)

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**7.** **< HKCE 2005 Paper I - 13 >**

Read the following descriptions about ejection seats and answer the questions that follow.

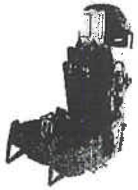


**Figure 1**

**Figure 2**

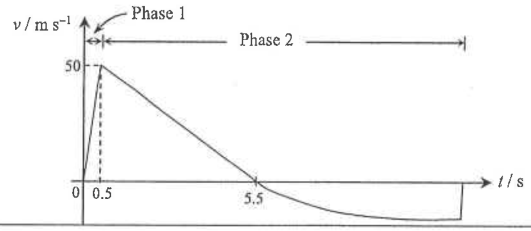
Ejection seats (see Figure 1) are important safety devices in military planes. The pilot, together with the seat, are ejected out of the plane in an emergency. Figure 2 shows a test of the ejection process. A dummy pilot sitting on the ejection seat is initially placed on the ground. The ejection process can be divided into two phases.

Phase 1 : At time $t = 0$, a rocket installed under the seat is ignited. From $t = 0$ to 0.5 s, the seat accelerates upwards.

Phase 2 : At $t = 0.5$ s, the rocket exhausts its fuel. After a while, the seat reaches its maximum height. The seat is then detached from the dummy and a parachute carried by the dummy is opened. The dummy eventually reaches the ground.

Figure 3 shows the velocity-time graph of the dummy during the ejection process. Assume that the motion of the dummy is vertical throughout the process, and the effect of air resistance is negligible before the parachute is opened. (The acceleration due to gravity is taken to be 10 m s$^{-2}$.)

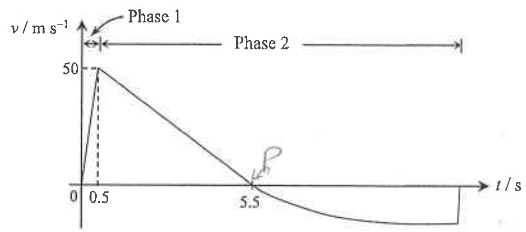
**Figure 3**




Source for Figures 1 and 2 : http://www.science.howstuffworks.com/ejection-seat2.htm



**7.** (a) In the Figure below, label the point which corresponds to the instant when the dummy reaches the maximum height.
(Note : Use $P$ to denote the point.) (1 mark)




(b) Find the maximum height above the ground reached by the dummy. (2 marks)

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(c) The mass of the dummy is 80 kg. Find the force exerted by the ejection seat on the dummy in Phase I. (3 marks)

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(d) By considering the forces acting on the dummy, explain the following motion of the dummy in Phase 2 :

After the parachute has been opened, the dummy accelerates downwards at first and then falls with a uniform velocity (see Figure 3).

It is known that the force exerted by the parachute on the dummy increases with its speed. (3 marks)

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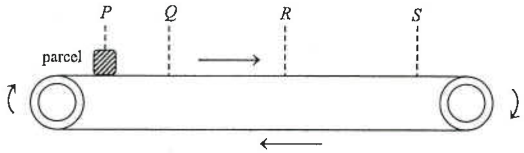
**8.** **< HKCE 2006 Paper I - 4 >**




The above Figure shows a conveyor belt in a factory. A parcel of mass 10 kg is placed at position $P$ when the belt remains at rest. The workman controls the belt such that the parcel undergoes a motion described in the below Table. The parcel and the conveyor belt move together without slipping during the entire motion.

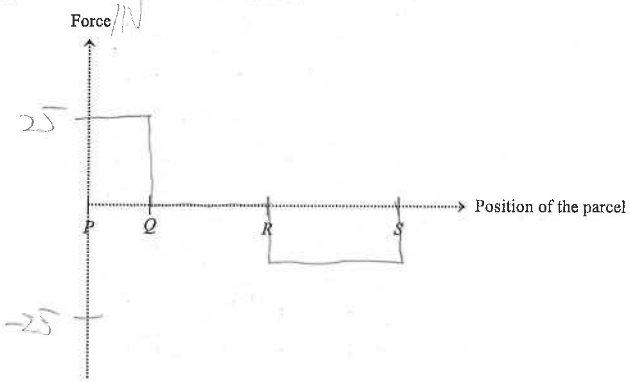
| Position of the parcel | Motion | Data given |
|---|---|---|
| $P \to Q$ | Uniform acceleration | $PQ$ = 5 m and time required = 2 s |
| $Q \to R$ | Uniform velocity | ----- |
| $R \to S$ | Uniform deceleration to rest | ----- |

(a) Consider the motion when the parcel travels from $P$ to $Q$.

(i) Draw a free-body diagram to show all forces acting on the parcel in the space provided below. Name the forces. (2 marks)

(ii) Find the net force acting on the parcel. (3 marks)

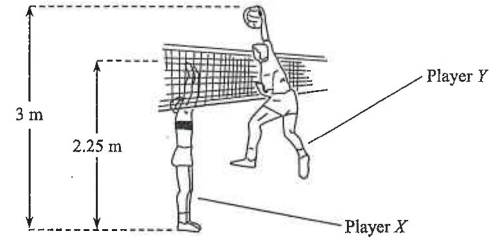
(b) In the Figure below, sketch a graph to show the variation of the frictional force exerted by the conveyor belt on the parcel. (3 marks)






**9.** **< HKCE 2007 Paper I - 2 >**

The Figure below shows Player $X$ trying to block the ball from Player $Y$ in a volleyball game. Standing on the ground with his arms fully stretched upwards, Player $X$'s hands are 2.25 m above the ground. In order to block the ball, Player $X$ has to jump up such that his hands reach a height of 3 m.

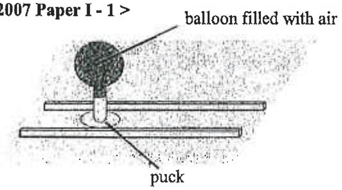


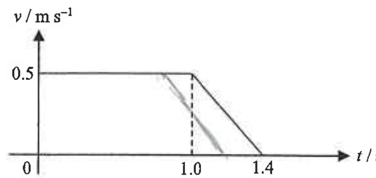

(a) Using Newton's laws of motion, explain why Player $X$ can gain an initial speed to leave the ground vertically. (3 marks)

(b) Player $X$ jumps up vertically and his hands can just reach a height of 3 m. Estimate the initial speed of Player $X$ at the instant he leaves the ground. Assume that air resistance is negligible. (2 marks)

(c) Player $Z$ is a teammate of Player $X$. His hands can also reach a height of 2.25 m when his arms are fully stretched upwards, but he is heavier than Player $X$. If he jumps up such that his hands just reach a height of 3 m, explain whether the initial vertical speed of Player $Z$ will be the same as Player $X$. (2 marks)

**10.** **< HKCE 2007 Paper I - 1 >**




A balloon is filled with air and is attached to a puck. It releases air through a hole at the bottom of the puck. The balloon puck then moves on a horizontal straight track as shown in the above figure and its velocity-time graph is also shown.

(a) (i) Describe the motion of the balloon puck from time $t$ = 0 to 1.4 s. (2 marks)

(ii) Explain why the motion of the balloon puck changes at $t$ = 1.0 s. (2 marks)

(b) If the balloon is filled with less air and its initial velocity is still 0.5 m s$^{-1}$, sketch the corresponding velocity-time graph of the balloon puck in the above velocity-time graph. (2 marks)

**11.** **< HKCE 2008 Paper I - 3 >**

Read the following passage about Mega Drop and answer the questions that follow.

Figure 1 shows a "Mega Drop" in an amusement park. The vehicle carrying the passengers is lifted by an electric motor-winch and steel ropes. Once it reaches the top of the tower, the vehicle remains at rest for a while. It is then released and falls under gravity. When the vehicle gets very close to the ground, it decelerates downward and finally stops.

**Figure 1**

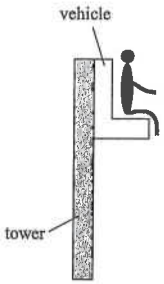



**Figure 2**

Let's consider why the passengers experience weights when the vehicle is at rest at the top of the tower (Figure 2). The earth attracts our bodies while the seat also gives a supporting force on us. These two forces are equal in magnitude but opposite in direction. Our bodies experience the supporting force and thus we can experience our weight.

When we are falling in a "Mage Drop", we are nearly free falling and experience weightlessness. This feeling gives an excitement to the passengers.

(a) Consider when the passenger is at rest at the top of the tower :

(i) Explain in terms of force acting on the passenger why the passenger is at rest. (2 marks)

(ii) Explain whether the forces acting on the passenger mentioned in the passage are action-reaction pair. (2 marks)

(b) Consider when the "Mega Drop" falls with acceleration :

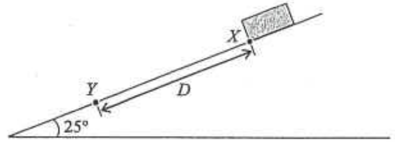
(i) Compare the magnitude of the vertical forces action on the passenger with those mentioned in (a)(ii). (2 marks)

(ii) Hence, explain why the passenger experiences "weightlessness". (1 mark)



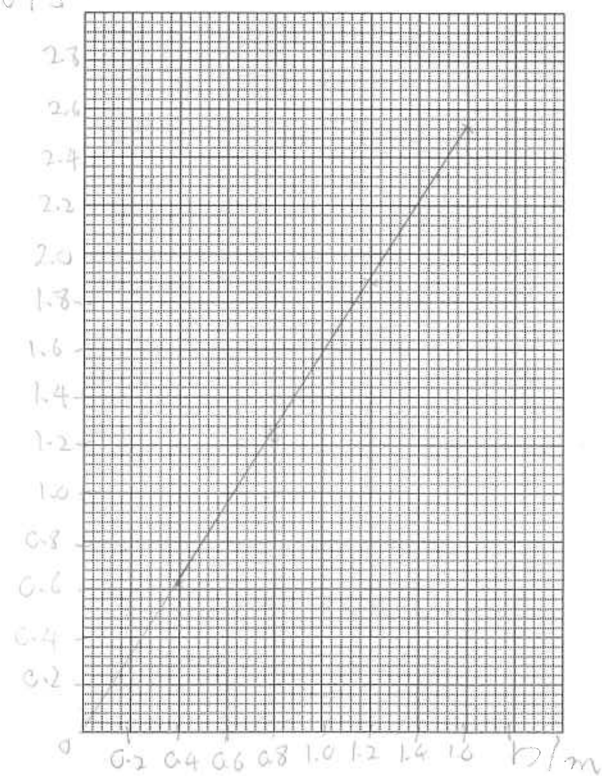
**12.** **< HKCE 2009 Paper I - 9 >**

An experiment is set up to measure the average friction acting on a plastic block sliding on a wooden plane with an inclination 25°C to the horizontal as shown in the figure below. When the block is released from rest at *X*, the timer starts. When the block reaches *Y*, the timer stops. The experiment is repeated by varying the positions of *Y* along the plane. The results obtained are shown in the Table.




| Distance between $X$ and $Y$ ($D$ / m) | Time taken ($t$ / s) |
|---|---|
| 0.4 | 0.79 |
| 0.8 | 1.12 |
| 1.2 | 1.37 |
| 1.6 | 1.59 |

(a) (i) Plot a graph of $t^2$ against $D$ in the below Figure. A scale of 1 cm representing 0.2 s² and 0.2 m is used. (4 marks)



12. (a) (ii) Find the slope of the graph plotted in (a)(i). (1 mark)

(iii) Hence, find the average acceleration of the block. (2 marks)

(b) Draw a free-body diagram to show all the forces acting on the sliding block in the space provided below. Name the forces. (2 marks)

(c) The mass of the block is 0.178 kg. Find the average friction acting on the sliding block. (2 marks)

**13. < HKCE 2010 Paper I - 1 >**

Figure 1 shows a 15 kg parcel resting on the floor of a train which travels along a straight horizontal path. The parcel and the train move together without slipping during the entire motion. Take the direction of the motion of the train as positive.

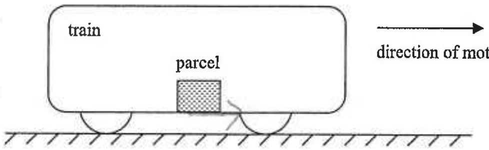



**Figure 1**

The velocity-time graph of the train is shown in Figure 2.

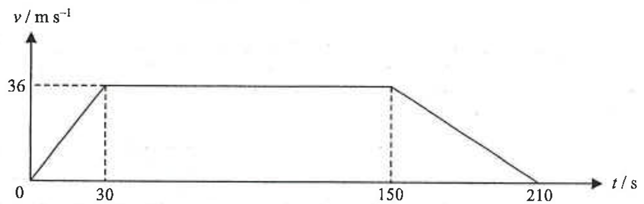



**Figure 2**

(a) In Figure 1, use an arrow to show the direction of the frictional force acting on the parcel by the train floor between $t = 0$ and 30 s. (1 mark)



13. (b) In Figure 3, sketch the force-time graph showing the net force acting on the parcel between $t = 30$ s and 210 s. (The part between $t = 0$ and 30 s has been shown in the graph.) (2 marks)

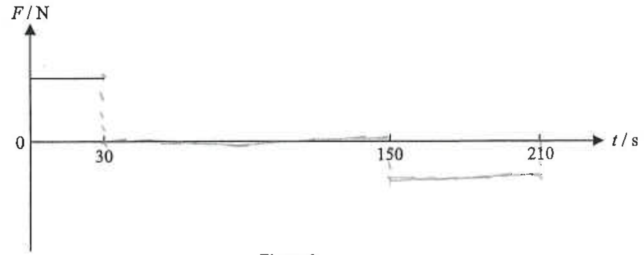



**Figure 3**

(c) Find the magnitude of the net force acting on the parcel between $t = 0$ and 30 s. (2 marks)

(d) Find the distance travelled by the train from $t = 0$ to 210 s. (2 marks)

## Part B : Supplemental exercise

14. Susan takes part in a 100 m race at an athletic meet. She starts at time $t = 0$ s and accelerate at a uniform rate of 1.6 m s$^{-2}$ for 5 s. She then maintains a uniform speed afterwards and reaches the finishing line at $t = 15$ s. Susan's mass is 45 kg.

(a) Find the resultant force acting on Susan in the race during the first 5 s. (2 marks)

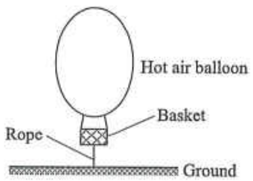
(b) Find the resultant force acting on Susan in the race after $t = 5$ s. (1 mark)

15. A helicopter of mass 1500 kg is initially at rest at a certain level above the ground. It accelerates uniformly and vertically upwards for 75 m and reaches a speed of 15 m s$^{-1}$. Assume the air resistance is negligible.

(a) Calculate the acceleration of the helicopter. (2 marks)

(b) Calculate the uplifting force acting on the helicopter. (3 marks)

**16.**




A hot-air balloon is tied to the ground by a rope to stop it from rising as shown in the above figure. The total mass of the balloon and the basket is 750 kg. There also exists an upward force of 8000 N acting on the balloon.

(a) What is the tension of the rope ? (3 marks)

(b) The rope is then cut and the balloon starts to rise up.

(i) What is the acceleration of the balloon after the rope is cut ? (3 marks)

(ii) What is the height that the balloon has risen after 1 minute ? (2 marks)

(iii) If the balloonist throws some sandbags out of the basket during the rise, what is the effect on the acceleration of the balloon ? Explain briefly. (3 marks)

**17.** John is riding a bicycle along a straight road with uniform speed 10 m $s^{-1}$. At time $t = 0$, he sees a warning signal. John applies the brake for 2.0 s to bring the bicycle to rest with uniform deceleration. Assume John's reaction time (i.e. the time lapse between seeing the signal and starting to apply the brake) is 0.2 s.

(a) Find the distance travelled by the bicycle from $t = 0$ to $t = 0.2$ s. (2 marks)

(b) Find the distance travelled by the bicycle when it is decelerating. (2 marks)

(c) By using Newton's laws of motion, explain why it is dangerous for John to carry an excessive amount of goods on the bicycle when he is riding in the street. (3 marks)

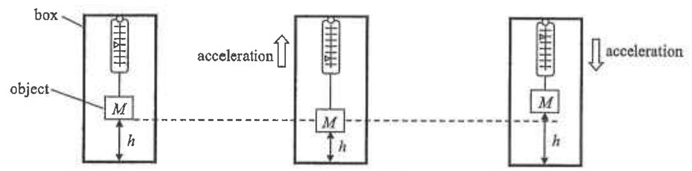


## Part C : HKDSE examination questions

**18.** **< HKDSE 2014 Paper IB - 4 >**

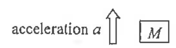
Read the following description about **accelerometers** and answer the questions that follow.

An accelerometer is a device for measuring acceleration. The following example illustrates the principle of a simple accelerometer. An object of mass $M$ is suspended by a spring balance inside a box. If the box is at rest without acceleration, the object is $h$ above the bottom of the box (Figure 1). When the box accelerates upward, $h$ decreases (Figure 2). Likewise, when the box accelerates downwards, $h$ increases (Figure 3). Since it is known that the tension of the spring balance is directly proportional to its extension, we can therefore determine the magnitude and direction of the box's acceleration by measuring $h$.




at rest without acceleration — **Figure 1**; accelerating upward — **Figure 2**; accelerating downward — **Figure 3**

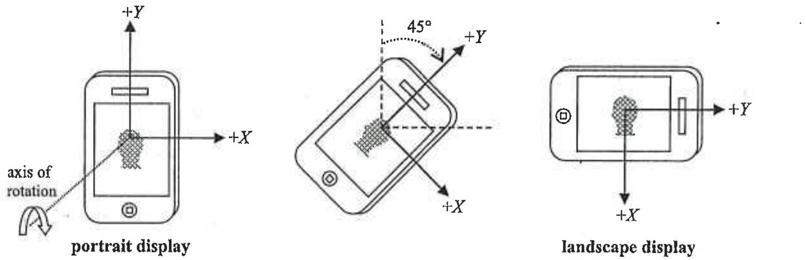
(a) Draw a labelled free-body diagram in the space provided below showing the forces acting on the object when the box accelerates upward with acceleration $a$. Explain why $h$ decreases in this case. (4 marks)




(b) The scale of the spring balance is calibrated such that the pointer moves 1 cm for a change of 2 N of force. The weight of the object is 5 N. If $h$ decreases by 0.5 cm compared to the situation in Figure 1, what is the reading of the balance ? Hence find the magnitude of the corresponding acceleration of the box. (Acceleration due to gravity $g = 9.81$ m $s^{-2}$) (3 marks)

**18.** Electronic accelerometers employing similar principles are widely used in smart phones. The phone's orientation is detected by a set of built-in accelerometers each detecting the acceleration due to gravity along mutually perpendicular axes of the phone. A phone in vertical orientation is shown on the left of Figure 4, its accelerometer along the $Y$ axis would be sensing the acceleration due to gravity, denoted by $a_Y = -g$. When the phone is rotated about a horizontal axis perpendicular to both $X$ and $Y$ axes by more than 45°, 'portrait display' would change to 'landscape display' as shown on the right of Figure 4.

**Figure 4**




(c) What would the kind of display be if the phone is rotated clockwise until the acceleration $a_Y$ sensed by the accelerometer along the $Y$ axis is $-0.5\ g$ ? Explain. (2 marks)

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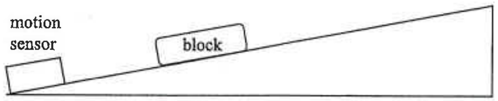
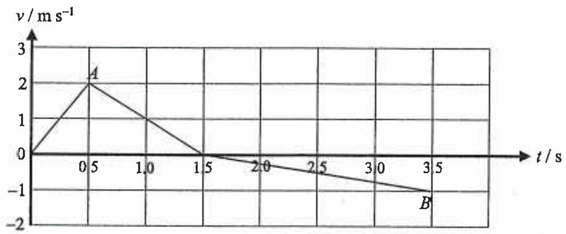
**19.** **< HKDSE 2015 Paper IB - 4 >**

The motion of a block on an inclined plane can be investigated using a motion sensor connected to a computer (not shown in the figure.)




A block is given a push up a rough inclined plane and then released. The velocity-time ($v$-$t$) graph recorded by the sensor is shown below. Assume that the frictional force acting on the block is constant in magnitude throughout the motion. Neglect air resistance. ( $g = 9.81\ \text{m s}^{-2}$ )




Point $A$ on the graph corresponds to the instant at which the push is removed.

(a) Describe the block's motion from $A$ to $B$. (2 marks)

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**19.** (b) (i) Find the magnitude of the block's acceleration from $t = 1.5$ s to $t = 3.5$ s. (2 marks)

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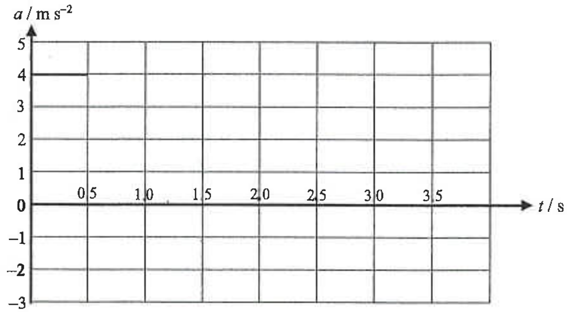
(ii) Draw the corresponding acceleration-time ($a$-$t$) graph of the block. With the direction up the inclined plane taken to be positive, the part during which the block is being pushed has been drawn for you. (2 marks)




(c) Draw a free-body diagram to show the force(s) (with labels) acting on the block as it moves up the inclined plane after the push is removed. (2 marks)

(d) If the mass of the block is 1.0 kg, find the magnitude of the frictional force. (3 marks)

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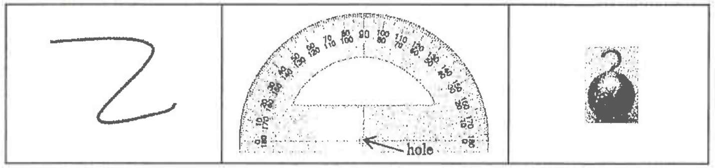
**20.** **< HKDSE 2015 Paper IB - 5 >**

You are given a long light string, a protractor and a metal ball with a hook.

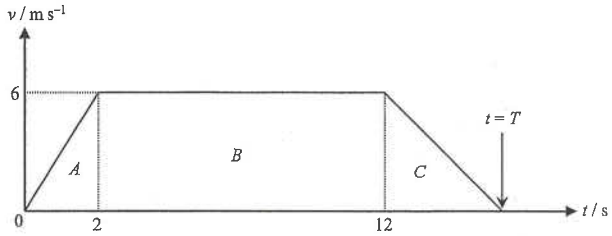



Suppose you are inside a train which is at rest initially and later it travels along a straight horizontal track with constant acceleration. With the aid of a diagram, describe how to measure the acceleration of the train. Show your working including mathematical derivation. (6 marks)



**21.** **< HKDSE 2016 Paper IB - 3 >**

A person of mass $m$ stands on a balance inside a lift. The lift goes down from the top of a building at time $t = 0$ and it reaches the ground at $t = T$. The velocity-time ($v$ - $t$) graph of the lift is shown in the Figure below. ($g = 9.81$ m s$^{-2}$)




(a) Calculate the acceleration of the lift from $t = 0$ to $t = 2$ s. (2 marks)

The reading of the balance changes during the person's ride on the lift and the readings registered are 685 N, 569 N and 395 N.

(b) Match these readings with the three stages, $A$, $B$ and $C$, of the ride shown in the above Figure. Hence deduce the mass of the person. (3 marks)

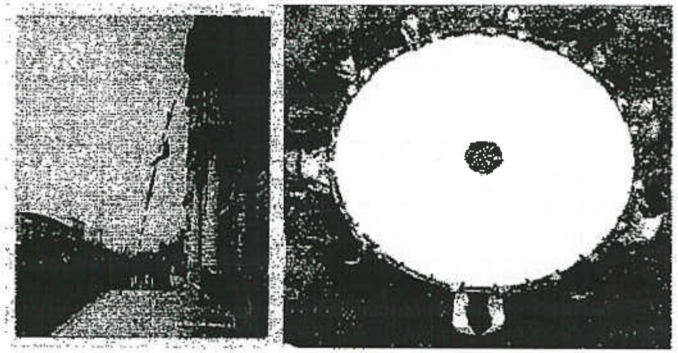
$A$ : ________ $B$ : ________ $C$ : ________

(c) (i) Show that $T = 15$ s. (2 marks)

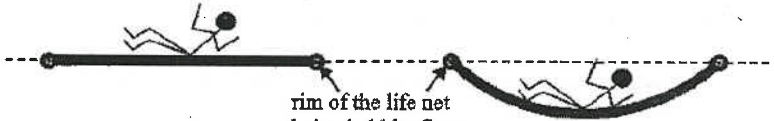
(ii) Hence estimate the height of the building. (2 marks)

22. <HKDSE 2019 Paper-IB-3>

A life net is a rescue equipment formerly used by firefighters. It gives people on the upper floors of a burning building an opportunity to jump to safety, usually to ground level. It became obsolete due to advances in firefighting technology.



The practical height limit for successful use of life nets is about six storeys, although a few people once have survived jumps from an eight-storey building into a life net with various degree of injuries. The diagrams below explain its working principle.




When a person hits the net, it deforms and puts the person to a stop in a longer time as compared to hitting the solid ground.

(a) A person falls from a height of 12 m above a life net with negligible initial speed. Neglect air resistance and the size of the person. ($g = 9.81$ m s$^{-2}$)

(i) Estimate (1) the vertical speed $v$ and (2) the time of fall $t$ of the person just before hitting the life net. (4 marks)

(ii) If this falling person of mass 70 kg is stopped in 0.3 s by the life net, estimate the average force acting on the person by the net within this time interval. (3 marks)

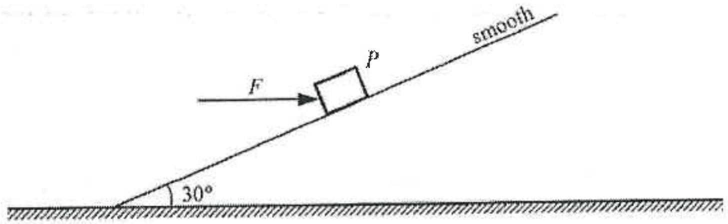
(iii) What form of energy is stored by the life net during the deceleration of the falling person ? (1 mark)

(b) (i) Give a reason why there exists a height limit of using life nets. (1 mark)

*(ii) The falling person might hit the rim of the net, thus the person or the firemen holding the rim would be injured. Explain why it is not easy for a person jumping from a height to reach the life net's central part. (2 marks)

23. < HKDSE 2020 Paper 1B -5>

gure 5.1




(a) A block $P$ of mass 10 kg is kept stationary on a smooth incline by a horizontal force $F$ as shown in Figure 5.1. The incline makes an angle of 30° with the horizontal. ($g = 9.81$ m s$^{-2}$)

(i) On Figure 5.1, indicate and label all other forces acting on $P$. (2 marks)

(ii) Find the magnitudes of the force $F$ and the force exerted by the block on the incline respectively. (3 marks)

(b) Now $F$ is removed and neglect air resistance.

(i) What is the magnitude of the acceleration of the block ? (1 mark)

(ii) Explain whether the force exerted by the block on the incline would increase, decrease or remain unchanged when compared with that in (a)(ii). (2 marks)

**HKEAA's Marking Scheme is prepared for the markers' reference. It should not be regarded as a set of model answers. Students and teachers who are not involved in the marking process are advised to interpret the Marking Scheme with care.**

## Question Solution

1. (a) (i) Acceleration = slope = 0 [1]

Resultant force = 0 [1]

(ii) Frictional force = $m\,g \sin\theta$ [1]

$= (0.5) \times (9.81) \times \sin 30^\circ$

$= 2.45$ N [1]

(b) (i) acceleration = slope

$= \dfrac{(0 - 0.8)}{(2.5 - 1)}$ [1]

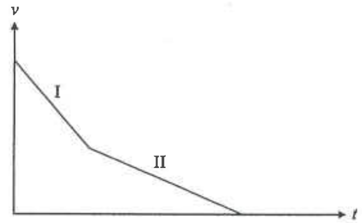
$= -0.53$ m s$^{-2}$ [1]

(ii) distance travelled = area

$= \frac{1}{2} \times (0.8) \times (1.5)$ [1]

$= 0.6$ m [1]

(c)




< Negative slope drawn at I > [1]

< Turning point drawn when the block passes *B* > [1]

< Negative slope drawn at II > [1]

< Slope of I is steeper than that of II > [1]

( since the friction at *BC* is greater, the deceleration of the block at I is greater than that at II )

2. (a) $F_1 = 0.5$ N [1]

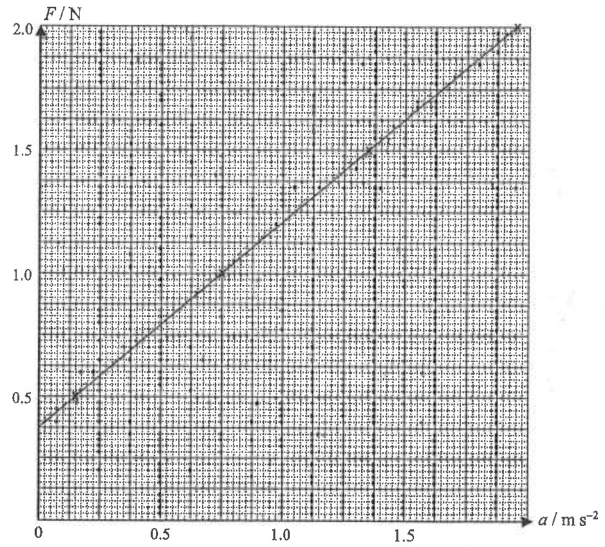
(observed from the graph when the extension is 0.10 m)

(b) (i) $F_2 = 1.0$ N $F_3 = 1.5$ N $F_4 = 2.0$ N

< all the three forces are correct > [1]



2. (a) (ii)




< Correct labelled axes > [1]

< Correct scale > [1]

< Correct points > [1]

< Straight line > [1]

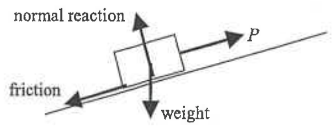
(iii) Slope = 0.83 [1]

Intercept on *F* axis = 0.375 [1]

Equation : $F = 0.83\,a + 0.375$ [1]

(iv) $F_o$ is the friction acting on the trolley by the runway [2]

3. (a)




< normal reaction force > [1]

< friction > [1]

< weight > [1]

(b) Attach a paper tape which is connected to a ticker tape timer to the block. [1]

The dots on the tape should be evenly spaced. [1]

3. (c) (i) Intercept = 12 [1]

Slope = $\dfrac{62-12}{0.5-0}$ = 100 [2]

The equation is $P = 100 \sin\theta + 12$ [1]

(ii) The intercept represents the frictional force between the block and the plane. [1]

The slope represents the weight of the block. [1]

4. (a) By $v = u + at$

$\therefore$ (0) = (16) + $a$ (4.5 − 0.5) $\therefore a = -4 \text{ m s}^{-2}$ [1]

(b) (i) $F_1$ is the weight of the framework. [1]

$F_2$ is the normal reaction force acting on the framework by the lorry. [1]

(ii) $F_1$ and $F_2$ are not action and reaction pair [1]

since they act on the same body. [1]

(iii) Friction = $m a$ [1]

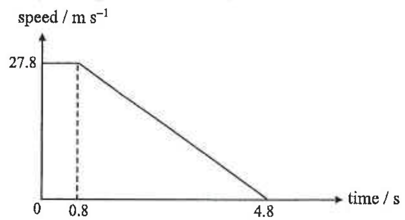
= 1000 × 4 = 4000 N [1]

(iv) Any **TWO** of the following : [2]

* The lorry accelerates hardly.
* The lorry is travelling up along an inclined road.
* The lorry is turning round a corner.

5. (a) $t = \dfrac{80}{27.8}$ = 2.88 s [1]

(b) (i)




< Two axes correctly labelled with units > [1]
< From 0 s to 0.8 s correct > [1]
< From 0.8 s to 4.8 s correct > [1]

(ii) Stopping distance = area under the $v$ - $t$ graph [1]

= $\frac{1}{2}$ (0.8 + 4.8) × 27.8

= 77.8 m [1]

As the stopping distance is less than 80 m, the car will not hit the lorry. [1]



5. (b) (iii) Deceleration of the car = slope = $\dfrac{27.8}{4}$

= 6.95 m s$^{-2}$ [1]

Average braking force = $m a$ [1]

= 1200 × 6.95

= 8340 N [1]

(c) When the car is running downhill on the slope, there is a component of weight acting on it down the slope. [1]

Part of the braking force is used to overcome this component, [1]

thus the net braking force is reduced and the deceleration is decreased. [1]

As a result, the stopping distance becomes larger and distance between 2 arrows should be larger than 80 m. [1]

6. The compressed air exerts a force on the water to push the water out. [1]

By Newton's third law, [1]

the water exerts an opposite reaction force on the rocket to lift it up. [1]

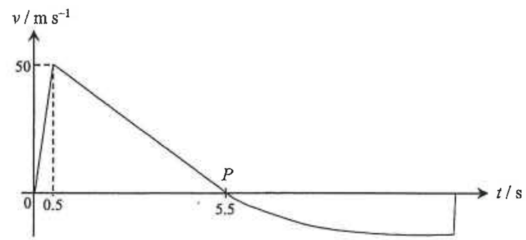
**OR**

When the water is pushed down, the water acquires a downward momentum. [1]

By the principle of conservation of momentum, [1]

the rocket acquires an upward momentum and rises. [1]

7. (a)




[1]

(b) Maximum height = area from 0 to 5.5 s

= $\dfrac{50 \times 5.5}{2}$ [1]

= 137.5 m < accept 138 m > [1]

(c) acceleration $a$ = slope in phase 1 = $\dfrac{50}{0.5}$ = 100 m s$^{-2}$ [1]

$R - mg = ma$ [1]

$R$ − (80)(10) = (80)(100)

$\therefore$ $R$ = 8800 N [1]

7. (d) Initially, the air resistance exerted by the parachute $R$ is smaller than the weight $mg$ of the dummy. [1]

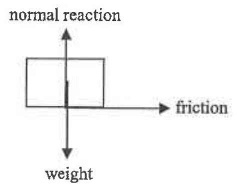
Since a net downward force acts on the dummy, thus the dummy accelerates downwards. [1]

As the speed of dummy increases, the air resistance $R$ increases.

Finally, when the air resistance just equals the weight of the dummy, i.e. $R = mg$ [1]

the resultant force is zero and the dummy fall with a uniform velocity.

8. (a) (i)




< Any one force with label correct > [1]

< The other forces with label correct > [1]

(ii) By $s = ut + \frac{1}{2}at^2$

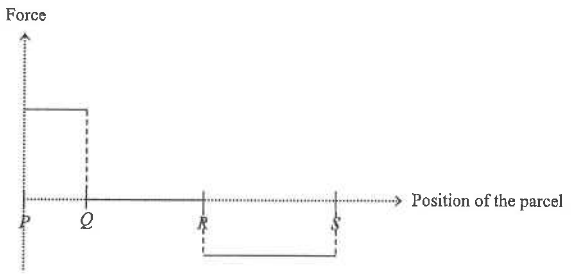
$\therefore$ $(5) = (0) + \frac{1}{2}a(2)^2$

$\therefore$ $a = 2.5\ \text{m s}^{-2}$ [1]

$F = ma$ [1]

$= 10 \times 2.5 = 25\ \text{N}$ [1]

(b)




< $P$ to $Q$ : a horizontal line above or below the $x$-axis > [1]

< $Q$ to $R$ : a horizontal line at the $x$-axis > [1]

< $R$ to $S$ : a horizontal line at the opposite side of the line $PQ$ > [1]

9. (a) Player $X$ exerts an action force on the ground when he jumps. [1]

By Newton's third law, the ground exerts an equal reaction force on him. [1]

If the normal reaction is greater than his weight, he can jump up with an initial acceleration. [1]



9. (b) $v^2 = u^2 + 2as$ < OR > $\frac{1}{2}mu^2 = mgh$ [1]

$(0) = u^2 + 2(-9.81)(3 - 2.25)$ $\frac{1}{2}mu^2 = m(9.81)(3 - 2.25)$

$u = 3.84\ \text{m s}^{-1}$ $u = 3.84\ \text{m s}^{-1}$ [1]

(c) The initial vertical speed of Player $Z$ should be the same as Player $X$ [1]

since the acceleration due to gravity is independent of the mass. [1]

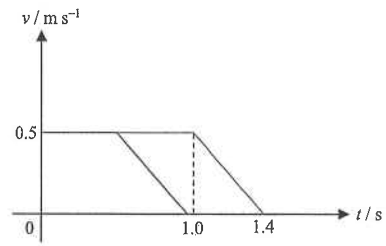
10. (a) (i) From $t = 0$ to 1.0 s, the balloon puck moves with uniform velocity. [1]

From $t = 1$ to 1.4 s, the balloon puck decelerates uniformly from 0.5 m s$^{-1}$ to zero. [1]

(ii) After $t = 1.0$ s, the balloon puck does not release air. [1]

Friction acts on the puck to oppose the motion. [1]

(b)




< shorter time to come to rest > [1]

< same slope of deceleration > [1]

11. (a) (i) Weight of the passenger and the supporting force exerted by the seat are acting on the passenger. [1]

These two forces balance each other. [1]

(ii) They are not action-reaction pair [1]

since they act on the same body. [1]

**OR**

since they are different types of forces. [1]

(b) (i) The weight is the same as the one at the top. [1]

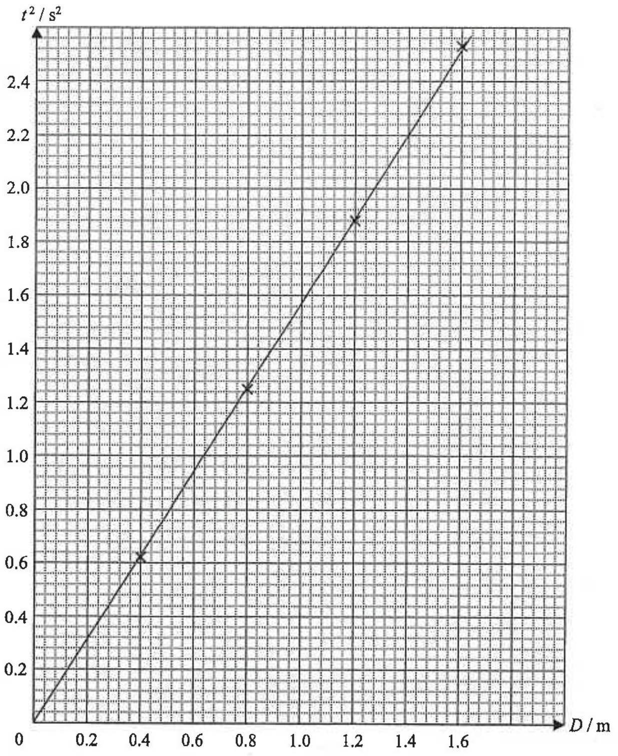
The supporting force by the seat is zero (**OR** smaller). [1]

(ii) There is no supporting force by the seat to the passenger. [1]

**OR**

There is no normal reaction acting on the passenger. [1]

12. (a) (i)




| $D$ | $t^2$ |
|---|---|
| 0.4 | 0.62 |
| 0.8 | 1.25 |
| 1.2 | 1.88 |
| 1.6 | 2.53 |

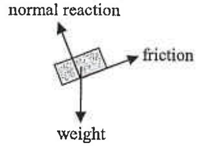
< Correct labelled axes with units > [1]
< Correct scale > [1]
< Correct points plotted > [1]
< Straight line drawn > [1]

(ii) slope = 1.57 $s^2\ m^{-1}$ [1]
< accept 1.5 – 1.6 ; accept 2 sig. fig. ; accept no unit >

(iii) By $s = \frac{1}{2}at^2$ $\therefore$ slope of the graph $= \frac{2}{a}$ [1]

$a = \frac{2}{\text{slope}} = 1.27\ m\ s^{-2}$ < accept 1.25 – 1.33 ; accept 2 sig. fig. > [1]

(b)

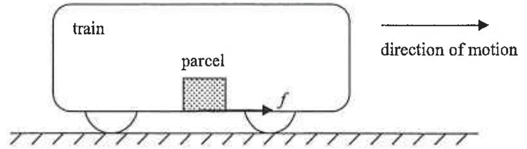



< 3 forces drawn correctly > [1]
< names of 3 forces correct with correct spelling > [1]



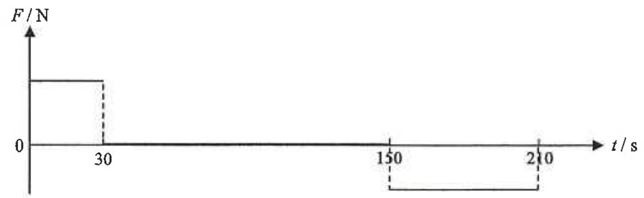
12. (c) $mg \sin\theta - f = ma$ [1]
$(0.178)(9.81)\sin 25° - f = (0.178)(1.27)$
$f = 0.512$ N < accept 0.506 N – 0.530 N > [1]

13. (a)




< Friction towards the right > [1]

(b)




< From $t = 30$ to 150 s, $F$ is zero > [1]
< From $t = 150$ to 210 s, $F$ is negative and its magnitude is smaller than that in the first 30 s > [1]

(c) $a$ = slope $= \frac{36}{30} = 1.2\ m\ s^{-2}$ [1]
$F = ma = 15 \times 1.2 = 18$ N [1]

(d) $d$ = area [1]
$= \frac{1}{2}(120 + 210) \times 36 = 5940$ m [1]

14. (a) Resultant force acting on Susan during the first 5 s $= ma = 45 \times 1.6$ [1]
$= 72$ N [1]

(b) Resultant force acting on Susan after 5 s = 0 N [1]

15. (a) $v^2 = u^2 + 2as$ [1]
$(15)^2 = 0 + 2a(75)$ $\therefore a = 1.5\ m\ s^{-2}$ [1]

(b) $F - mg = ma$ [1]
$F - (1500)(9.81) = (1500)(1.5)$ [1]
$\therefore F = 16965$ N < accept 17000 N > [1]

16. (a) Weight of the balloon = 750 × 9.81 = 7360 N [1]

$\therefore$ (8000) = (7360) + $T$ [1]

$\therefore$ $T$ = 640 N < accept 643 N > [1]

(b) (i) Upward force − weight = $m\,a$ [1]

$\therefore$ (8000) − (7360) = (750) $a$ [1]

$\therefore$ $a$ = 0.853 m s$^{-2}$ < accept 0.840 − 0.865 > [1]

(ii) $s = u\,t + \frac{1}{2}a\,t^2$ [1]

= (0) + $\frac{1}{2}$(0.853) (60)$^2$ = 1540 m < accept 1500 − 1580 > [1]

(iii) Since the weight of the balloon is reduced, [1]
the upward net force is increased, [1]
thus the upward acceleration is increased. [1]

17. (a) $d = u\,t$ = (10) × (0.2) [1]
= 2 m [1]

(b) $s = \frac{1}{2}(u + v)\,t = \frac{1}{2}(10 + 0) \times (2)$ [1]
= 10 m [1]

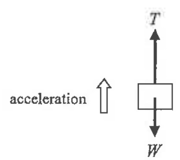
< OR >

$v = u + a\,t$ $\therefore$ (0) = (10) + $a$ (2) $\therefore$ $a$ = −5 m s$^{-2}$ [1]

$s = u\,t + \frac{1}{2}a\,t^2$ = (10) × (2) + $\frac{1}{2}$(−5) × (2)$^2$ = 10 m [1]

(c) As the mass of the bicycle increases, by Newton's second law, [1]
the deceleration of the bicycle would become smaller for the same braking force. [1]
As a result, the stopping distance would increase, and the chance of having an accident is larger. [1]

18. (a)




< Upward force labelled with $T$ or tension > [1]
( labelled with $F$ not accepted )

< Downward force labelled with $W$ or $mg$ or weight > [1]

As the acceleration is upwards, the net force is upwards, thus tension $T$ is greater than $mg$. [1]
As the tension increases, the extension of the spring increases, thus $h$ decreases. [1]

(b) Reading of the balance = 5 + 2 × 0.5 = 6 N [1]

By $T - Mg = Ma$

$\therefore$ (6) − (5) = $(\frac{5}{9.81})a$ < do not accept $g$ = 10 m s$^{-2}$ > [1]

$\therefore$ $a$ = 1.96 m s$^{-2}$ < accept 1.962 m s$^{-2}$ > < do not accept 2 m s$^{-2}$ > [1]



18. (c) If $a_y = -0.5\,g$

$\therefore$ $a_y = -g\cos\theta = -0.5\,g$ [1]

$\therefore$ $\theta$ = 60°

Since the angle is greater than 45°, the display is landscape. [1]

OR

At 45°, magnitude of $a_y$ = $g\cos 45°$ = 0.707$g$ [1]

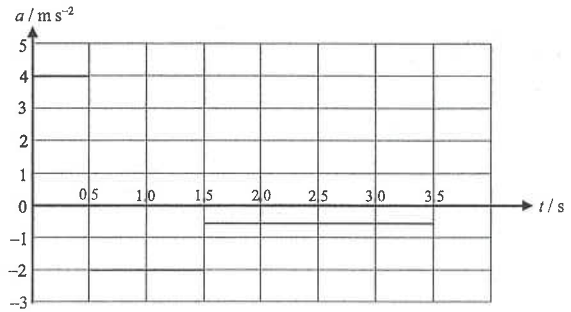
When magnitude of $a_y$ = 0.5 $g$, it is less than that of 45°, thus the display is landscape. [1]

19. (a) From $t$ = 0.5 s to 1.5 s, the block moves up the inclined plane with uniform deceleration. [1]
From $t$ = 1.5 s to 3.5 s, the block moves down the inclined plane with uniform acceleration. [1]

(b) (i) $a$ = | slope | = $\left|\frac{-1-0}{3.5-1.5}\right|$ [1]

= 0.5 m s$^{-2}$ < no mark for − 0.5 m s$^{-2}$ > [1]

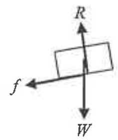
(ii)




< a horizontal line at $a$ = − 2 m s$^{-2}$ > [1]

< a horizontal line at $a$ = − 0.5 m s$^{-2}$ > [1]

(c)




< Weight $W$ and normal reaction $R$ correctly drawn and labelled > [1]
< Friction $f$ correctly drawn and labelled > [1]
[ Weight can be labelled with $mg$ ] [ Names of forces instead of symbols are accepted ]

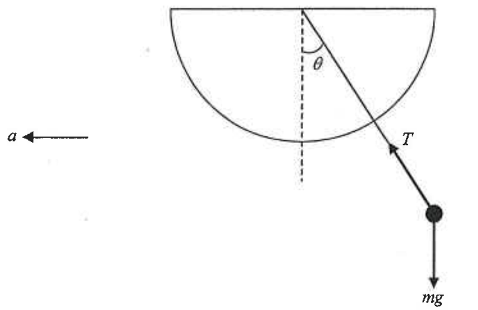
(d) Upward motion : $mg\sin\theta + f = m\,a_1$ = (1) × (2) = 2 [1]

Downward motion : $mg\sin\theta - f = m\,a_2$ = (1) × (0.5) = 0.5 [1]

Combine the two equations : $2f$ = 2 − 0.5

$\therefore$ $f$ = 0.75 N [1]

20.




< set-up of apparatus with force diagram : tension $T$ and weight $mg$ drawn > [1]

Tie one end of the string to the metal ball and the other end through the hole of the protractor. [1]

When the train is at rest,
held fixed the protractor in the plane along the direction of motion such that the string is on the 90° mark. [1]

When the train is accelerating with acceleration $a$,
the string will make an angle $\theta$ with the vertical. Measure the angle $\theta$. [1]

Resolve the tension $T$ into vertical component and horizontal component.

The horizontal component of the tension provides the net force for acceleration $a$.

$\therefore\ T\sin\theta = ma$

The vertical component of the tension balances the weight of the metal ball.

$\therefore\ T\cos\theta = mg$ [1]

Combine the two equations : $\tan\theta = \frac{a}{g}$ $\therefore\ a = g\tan\theta$ [1]

21. (a) $a$ = slope = $\frac{6}{2}$ [1]

$= 3\ \text{m s}^{-2}$ [1]

(b) $A$ : 395 N $B$ : 569 N $C$ : 685 N [1]

In stage $B$, balance reading = weight

$\therefore\ 569 = mg = m \times 9.81$ [1]

$\therefore\ m = 58.0\ \text{kg}$ [1]

(c) (i) At $C$ : $R - mg = ma$

$\therefore\ 685 - 569 = 58a$ $\therefore\ a = 2\ \text{m s}^{-2}$ (upwards) [1]

By $v = u + at$

$\therefore\ (0) = (6) + (-2)(T - 12)$ [ since $a$ is upwards, it undergoes deceleration ] [1]

$\therefore\ T = 15\ \text{s}$

(ii) Height = area under graph

$= \frac{1}{2}(15 + 10) \times (6)$ [1]

$= 75\ \text{m}$ [1]

# Hong Kong Diploma of Secondary Education Examination

## Physics – Compulsory part (必修部分)

**Section A – Heat and Gases (熱和氣體)**
1. Temperature, Heat and Internal energy (溫度、熱和內能)
2. Transfer Processes (熱轉移過程)
3. Change of State (形態的改變)
4. General Gas Law (普適氣體定律)
5. Kinetic Theory (分子運動論)

**Section B – Force and Motion (力和運動)**
1. Position and Movement (位置和移動)
2. Newton's Laws (牛頓定律)
3. Moment of Force (力矩)
4. Work, Energy and Power (作功、能量和功率)
5. Momentum (動量)
6. Projectile Motion (拋體運動)
7. Circular Motion (圓周運動)
8. Gravitation (引力)

**Section C – Wave Motion (波動)**
1. Wave Propagation (波的推進)
2. Wave Phenomena (波動現象)
3. Reflection and Refraction of Light (光的反射及折射)
4. Lenses (透鏡)
5. Wave Nature of Light (光的波動特性)
6. Sound (聲音)

**Section D – Electricity and Magnetism (電和磁)**
1. Electrostatics (靜電學)
2. Electric Circuits (電路)
3. Domestic Electricity (家居用電)
4. Magnetic Field (磁場)
5. Electromagnetic Induction (電磁感應)
6. Alternating Current (交流電)

**Section E – Radioactivity and Nuclear Energy (放射現象和核能)**
1. Radiation and Radioactivity (輻射和放射現象)
2. Atomic Model (原子模型)
3. Nuclear Energy (核能)

## Physics – Elective part (選修部分)

**Elective 1 – Astronomy and Space Science (天文學和航天科學)**
1. The universe seen in different scales (不同空間標度下的宇宙面貌)
2. Astronomy through history (天文學的發展史)
3. Orbital motions under gravity (重力下的軌道運動)
4. Stars and the universe (恆星和宇宙)

**Elective 2 – Atomic World (原子世界)**
1. Rutherford's atomic model (盧瑟福原子模型)
2. Photoelectric effect (光電效應)
3. Bohr's atomic model of hydrogen (玻爾的氫原子模型)
4. Particles or waves (粒子或波)
5. Probing into nano scale (窺探納米世界)

**Elective 3 – Energy and Use of Energy (能量和能源的使用)**
1. Electricity at home (家居用電)
2. Energy efficiency in building (建築的能源效率)
3. Energy efficiency in transportation (運輸業的能源效率)
4. Non-renewable energy sources (不可再生能源)
5. Renewable energy sources (可再生能源)

**Elective 4 – Medical Physics (醫學物理學)**
1. Making sense of the eye (眼的感官)
2. Making sense of the ear (耳的感官)
3. Medical imaging using non-ionizing radiation (非電離輻射醫學影像學)
4. Medical imaging using ionizing radiation (電離輻射醫學影像學)