Basic exercise — Short questions

6.1

1 Give an example of contact forces and an example of non-contact forces. (2 marks)

hammering , magnetic force

2 State the SI unit of force. (1 mark)

Newton (N)

3 What equipment can be used to measure force? (1 mark)

spring balance

6.2

4 Why did sailors on Titanic fail to stop the ship when they saw an iceberg ahead? (1 mark)

It is because the mass and hence the inertia of Titanic was too great.

5 A car is moving forwards. Give two cases that there is net force acting on the car. (2 marks)

The car is accelerating or decelerating.

6 An aeroplane flies with constant velocity. Find the net force acting on it. (1 mark)

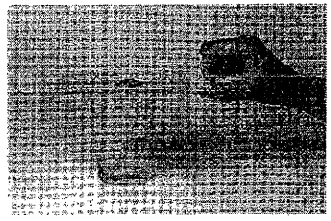
The net force is zero.

7 How does a spaceship move in outer space when its engines are shut down? (1 mark)

It moves in constant speed.

★8 In the figure, when the paper is flicked off sharply with a finger, how will the coin move? Explain briefly. (2 marks)

The coin will drop into the glass because of inertia to stay in its position.



★9 Consider a moving car is braked suddenly.

(a) How will the driver and passengers react if they do not fasten seat-belts? (1 mark)

They will move forwards and knock the windows.

(b) What is the use of seat-belts? (2 marks)

It provides the force that changes the state of motion of the persons inside, thus protecting them from injuries.

6.3

10 A stone of mass 3 kg accelerates downwards at 10 m s^{-2}. Find the net force acting on it. (2 marks)

$F = ma = 3 \times 10 = 30$ N (downwards)

11 A plane accelerates forwards at 2 m s^{-2}. If the net force acting on it is 800 000 N, find the mass of the plane. (2 marks)

$m = \frac{F}{a} = \frac{800000}{2} = 400000$ kg

12 In an ice hockey game, Joe pushes his teammate Ken with a force of 90 N to the right. The mass of Ken is 60 kg and he is initially at rest. Assume the friction on the ice is negligible.

(a) Find the acceleration of Ken. (2 marks)

$a = \frac{F}{m} = \frac{90}{60} = 1.5\ ms^{-2}$

(b) If Joe applies the force for 1 s, find the distance travelled by Ken in 1 s. (2 marks)

Helper: Which of u, v, s, t and a are known? Which equation of motion should we use?

$s = ut + \frac{1}{2}at^2 = 0 + \frac{1}{2}(1.5) \times 1^2 = 0.75$ m

13 A car of mass 1000 kg accelerates uniformly along a straight line from rest to 30 m s^{-1} in 4 s.

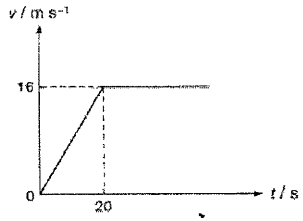
(a) Find the acceleration of the car. (2 marks)

$a = \frac{v-u}{t} = \frac{30-0}{4} = 7.5\ ms^{-2}$

(b) If friction is negligible, find the average braking force of the car. (2 marks)

?

★ **14** A car of mass 1000 kg moves along a straight road. The figure below shows the v–t graph of the car.



Helper: What is the relation between the slope of the v–t graph and the acceleration of the car?

(a) Find the acceleration of the car from $t = 0$ to 20 s. (2 marks)

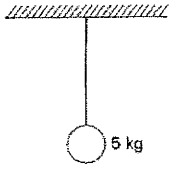
$a = \frac{16}{20} = 0.8\ m s^{-2}$

(b) What is the net force acting on the car from $t = 0$ to 20 s? (2 marks)

$F = ma = 1000 \times 0.8 = 800\ N$

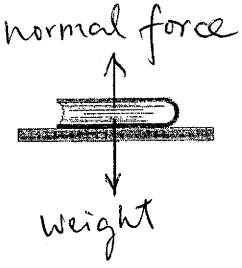
6.4

15 In the figure, a ball of mass 5 kg is hung from a ceiling with a string. Find the tension in the string. (2 marks)



$T = mg = 5 \times 10 = 50\ N$

16 In the figure, a book is at rest on a horizontal table. Draw the free-body diagram for the book. (2 marks)



17 A car of mass 1500 kg is parked on a horizontal road.

(a) Find the weight of the car. (2 marks)

$W = mg = 1500 \times 10 = 15000\ N$

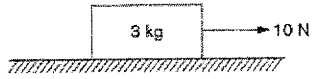
(b) Find the normal reaction acting on the car. (2 marks)

normal reaction $= -15000\ N$

18 Give two differences between mass and weight. (2 marks)

Mass is a measure of inertia, weight is a gravitational force. Mass is the same everywhere, but weight depends on the gravitational pull.

19 A block of mass 3 kg is pulled forwards by a horizontal force of 10 N on a rough horizontal surface. The friction acting on the block is 4 N.



(a) Find the net force acting on the block. (1 mark)

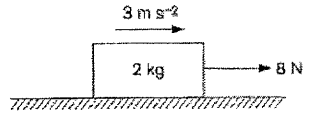
net force $= 10 - 4 = 6\ N$

(b) Find the acceleration of the block. (2 marks)

$6 = 3a$

$a = 2\ m s^{-2}$

20 A block of mass 2 kg is pulled by a horizontal force of 8 N on a rough horizontal surface. It accelerates forwards at 3 m s^{-2}.



(a) Find the net force acting on the block. (2 marks)

net force $= ma = 2 \times 3 = 6\ N$

(b) Find the friction acting on the block. (1 mark)

$8 - f = 6$

$f = 2\ N$

★ **21** At lift-off, the initial acceleration of a rocket of mass 500 000 kg is 2.3 m s^{-2}.

(a) Find the weight of the rocket at lift-off. (2 marks)

Weight = mg = 500000 × 10
= 5000000 N

(b) Find the net force acting on the rocket at lift-off. (2 marks)

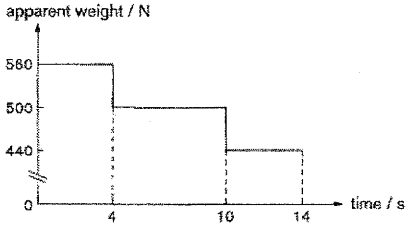
net force = ma = 500000 × 2.3
= 1150000 N

(c) Find the thrust of the rocket at lift-off. (2 marks)

thrust − 5000000 = 1150000
thrust = 6150000 N = 6.15×10^6 N

★ **22** A girl takes a lift from the ground floor to the top floor. The lift first accelerates uniformly from rest. Then it moves with constant speed. Finally it decelerates uniformly until it stops. The figure below shows how her apparent weight changes with time.

(a) Find the mass of the girl. (2 marks)



mass = 500 / 10
= 50 kg

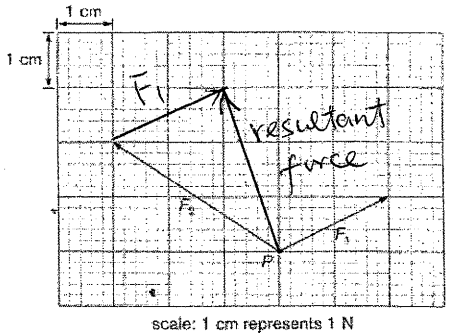
(b) Find the acceleration of the lift from $t = 0$ to 4 s. (2 marks)

560 − 500 = 50 a
a = 1.2 ms^{-2}

(c) Find the acceleration of the lift from $t = 10$ s to 14 s. (2 marks)

R − mg = ma
440 − 500 = 50 a
a = −1.2 ms^{-2}

23 The figure below shows two forces F_1 and F_2 acting on an object P.



scale: 1 cm represents 1 N

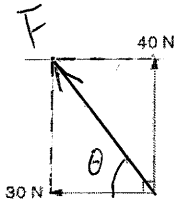
(a) Draw the resultant force acting on P in the figure. (2 marks)

(b) Find the magnitude of the resultant force from the above figure. (1 mark)

resultant force = $\sqrt{1^2 + 3^2}$
= 3.16 N

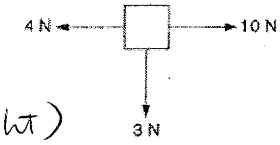
24 Two forces of magnitudes 30 N and 40 N are perpendicular to each other. Find the magnitude and direction of the resultant force. (4 marks)

F = $\sqrt{30^2 + 40^2}$ = 50 N
$\tan\theta = \frac{40}{30}$
θ = 53.1°
∴ The resultant force is 50 N with 53.1° to the horizontal.



25 In the figure, two horizontal forces and a vertical force act on a block.

(a) Find the net horizontal force acting on the block. (2 marks)

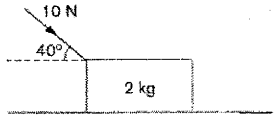


net horizontal force
= 10 − 4 = 6 N (to the right)

(b) Find the magnitude of the resultant force acting on the block. (2 marks)

resultant force = $\sqrt{6^2 + 3^2}$
= 6.71 N

26 A wooden box of mass 2 kg is pushed by a force of 10 N on a smooth horizontal road.



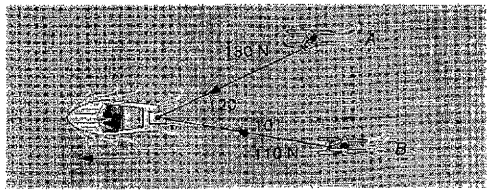
(a) Find the horizontal pushing force. (2 marks)

horizontal pushing force
$= 10 \cos 40°$
$= 7.66 N$

(b) Find the acceleration of the wooden block along the horizontal direction. (2 marks)

$a = \frac{F}{m}$
$= \frac{7.66}{2}$
$= 3.83 m s^{-2}$

27 ★ A speedboat pulls two water skiers *A* and *B* forwards. The figure shows the tensions acting on them and the angles formed by the ropes and the line of travel of the speedboat.



(a) Find the magnitude of the force along the line of travel exerted by the skiers on the speedboat. (3 marks)

horizontal force
$= 130 \cos 20° + 110 \cos 10°$
$= 230 N$

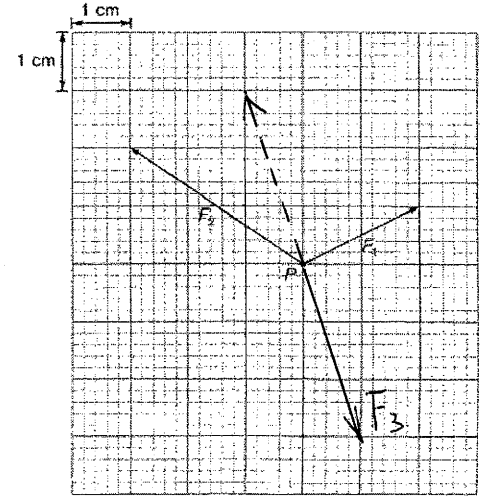
(b) Find the magnitude of the force perpendicular to the line of travel exerted by the skiers on the speedboat. (3 marks)

perpendicular force
$= 130 \sin 20° - 110 \sin 10°$
$= 25.4 N$ (upwards)

(c) Find the magnitude and direction of the resultant force exerted by the skiers on the speedboat. (4 marks)

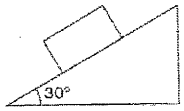
magnitude $= \sqrt{230^2 + 25.4^2}$
$= 232 N$
$\tan \theta = \frac{25.4}{232}$
$\theta = 6.27°$
∴ The resultant force is 232N with 6.27° to the horizontal.

Refer to **Q23**. If an additional force F_3 acts on *P*, the net force acting on *P* will be zero. Draw F_3 in the figure. (2 marks)

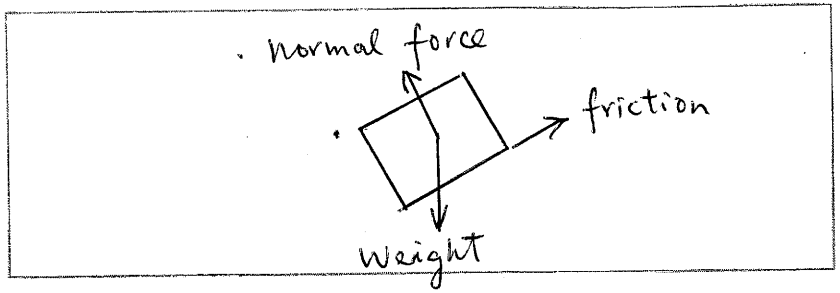


scale : 1 cm represents 1 N

29 In the figure, a block of mass 10 kg is at rest on a rough inclined plane.



(a) Draw the free-body diagram for the block. (3 marks)



(b) Find the net force acting on the block. (1 mark)

net force is zero.

(c) Find the magnitude of the normal reaction acting on the block. (2 marks)

normal reaction = $mg\cos\theta$
$= 10 \times 10 \cos 30° = 86.6\,N$

(d) Find the magnitude of the friction acting on the block. (2 marks)

friction = $mg\sin\theta$
$= 10 \times 10 \sin 30° = 50\,N$

6.6

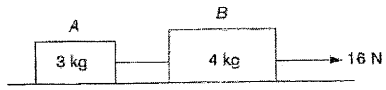
30 Give an example of an action and reaction pair. (1 mark)

The force of a book exerted on a table and the force of table exerted on the book.

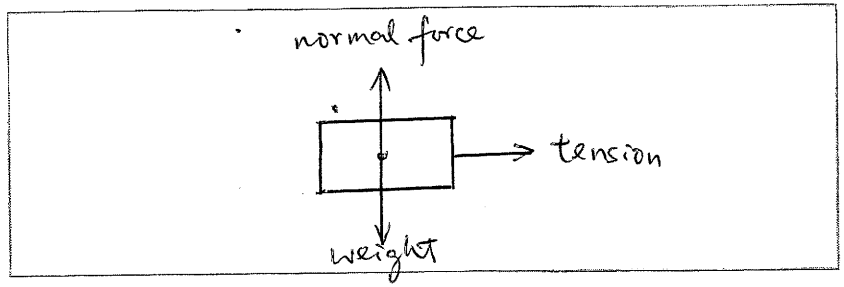
★ 31 Patrick stands still on a skateboard. How will the skateboard move if he jumps to the right? Explain briefly according to Newton's third law of motion. (4 marks)

If Patrick jumps to the right, the force exerted on him by the board is towards the right. By Newton's third law, an equal but opposite force is exerted on the board. So the board moves to the left.

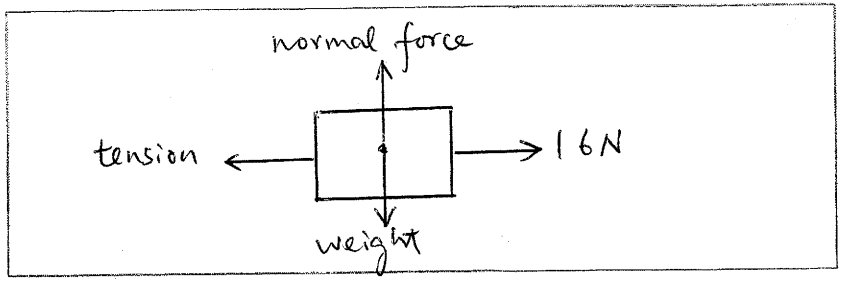
★ 32 Blocks A and B are connected by a light inextensible string and placed on a smooth horizontal surface. The masses of A and B are 3 kg and 4 kg respectively. A horizontal force of 16 N now acts on B.



(a) Draw the free-body diagram for block A. (3 marks)



(b) Draw the free-body diagram for block B. (4 marks)



(c) Find the acceleration of the system of blocks. (2 marks)

Helper: As the blocks are connected by the inextensible string, their accelerations are equal.

$\because F = ma$

$\therefore a = \frac{16}{3+4} = 2.29\ ms^{-2}$

(d) Find the tension in the string. (2 marks)

$T = m_A \cdot a$
$= 3 \times 2.29 = 6.86\,N$

II Revision

Multiple-choice

Section A

1 Which of the following are contact forces?
(1) Tension in a string
(2) Friction
(3) Magnetic force
A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

A

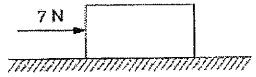
2 If no net force acts on a car moving along a smooth straight road, what will happen to the speed of the car?
A Increase gradually.
B Decrease gradually.
C First increase, then decrease.
D No change.

D

3 A car travels with constant velocity along a straight line. It suddenly turns right. How will passengers move?
A Moving forwards.
B Moving backwards.
C Moving to the left.
D Moving to the right.

A

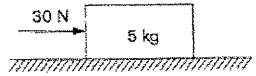
4



A block moves with constant velocity on a rough surface. Find the friction acting on it.
A 1 N
B 3 N
C 5 N
D 7 N

D

5



A block accelerates to the right at 5 m s^{-2} on a rough surface. Find the friction acting on it.
A 1 N
B 3 N
C 5 N
D 7 N

$30 - f = 5 \times 5$

C

6 Which of the following about weight are **correct**?
(1) Weight is a vector.
(2) The unit of weight is newton.
(3) Weight is the gravitational force exerted by the Earth on an object.
A (1) and (2) only
B (1) and (3) only
C (2) and (3) only
D (1), (2) and (3)

D

7 With a thrust of 2×10^6 N, a space shuttle accelerates forwards at 1.05 m s^{-2} in outer space. Find the mass of the space shuttle.
A 1.90×10^4 kg
B 1.90×10^5 kg
C 1.90×10^6 kg
D 1.90×10^7 kg

B

$2 \times 10^6 - mg = m \times 1.05$

8 At lift-off, the mass of a rocket is 25 000 kg and the thrust acting on the rocket is 290 000 N. Find the acceleration of the rocket.

Helper: First, find the net force acting on the rocket.

A 1.6 m s^{-2}
B 10 m s^{-2}
C 10.6 m s^{-2}
D 11.6 m s^{-2}

$290000 - 250000 = 250000a$

A

★**9** Statements: (For instructions, see inside back cover.)
1st statement: The weight of an object does not change from place to place.
2nd statement: The mass of an object does not change from place to place.

D

Section B

10 A car of mass 1500 kg accelerates on a rough road. The force provided by the car engine is 4000 N. The friction acting on the car is 800 N. Find the acceleration of the car.
A 0.53 m s^{-2}
B 2.13 m s^{-2}
C 2.67 m s^{-2}
D 3.2 m s^{-2}

$4000 - 800 = 1500a$

B

11 A stone weighs 20 N on the moon. Which of the following statements is/are **correct**?
(1) The stone has the same mass on the moon and the Earth.
(2) The mass of the stone is 2 kg.
(3) The stone weighs less than 20 N on the Earth.
A (1) only
B (2) only
C (1) and (3) only
D (2) and (3) only

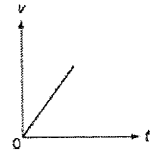
A

12 When a skydiver reaches terminal speed in mid-air, what is the relation between the air resistance f acting on him and his weight W?
A $f > W$
B $f < W$
C $f = W$
D There is no specific relation between them.

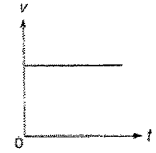
C

13 Drop a ball-bearing into a tall glass tube of glycerine. Which of the following diagrams best describes the variation of the velocity of the ball-bearing with time?

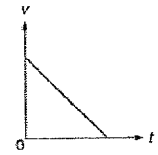
A



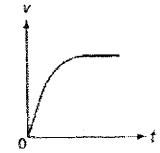
B



C



D



D

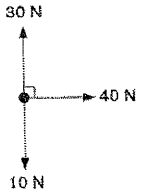
14 ★ A trolley moves down an inclined plane with constant velocity. Which of the following statements is/are **correct**?

(1) The net force acting on the trolley is zero.
(2) No friction acts on the trolley.
(3) The inclined plane is rough.

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

B

(For Q15–16.) Two vertical forces and a horizontal force act on an object.



15 ★ Find the magnitude of the resultant force.

A 20 N
B 44.7 N
C 56.6 N
D 60 N

$\sqrt{(30-10)^2+40^2}$

B

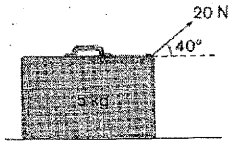
16 ★ Find the angle formed by the resultant force with the horizontal.

A 26.6°
B 36.9°
C 53.1°
D 63.4°

$\tan\theta = \frac{30-10}{40}$

A

17 ★



A suitcase of mass 5 kg is pulled by a force of 20 N on a horizontal road as shown. Find the normal reaction exerted by the ground on the suitcase.

A 37.1 N
B 50 N
C 62.9 N
D 65.3 N

$50 - 20\sin 40°$

A

★18 Statements: (For instructions, see inside back cover.)

1st statement: The net force acting on a stationary object is zero.
2nd statement: If an object moves at constant velocity, the net force acting on it is zero.

B

★19 Statements: (For instructions, see inside back cover.)

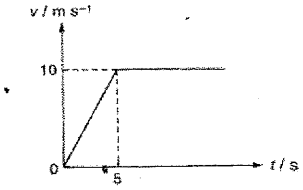
1st statement: The net force acting on a stationary object must be zero.
2nd statement: If the net force acting on an object is zero, it must be at rest.

C

Conventional

Section A

1 A trolley of mass 5 kg moves on a horizontal surface. The figure below shows the v-t graph of the trolley.



(a) Find the acceleration of the trolley in the first 5 s. (2 marks)

$a = \frac{10}{5} = 2\ m s^{-2}$

(b) Find the net force acting on the trolley in the first 5 s. (2 marks)

net force $= ma$
$= 5 \times 2 = 10\ N$

(c) Describe and explain the motion of the trolley after $t = 5$ s according to Newton's first law of motion. (2 marks)

The trolley moves in constant velocity because the net force is zero.

2 An object weighs 5000 N on the Earth.

(a) Find the mass of the object. (2 marks)

$\text{mass} = \frac{5000}{10} = 500\ kg$

(b) The acceleration due to gravity on the Mars is 3.7 m s^{-2}. Find the weight of the object on the Mars. (2 marks)

weight on the Mars $= 500 \times 3.7$
$= 1850\ N$

3 A car travelling at 100 km h^{-1} stops in 8 s. The mass of the car is 1000 kg.

(a) Find the average deceleration of the car. (2 mark

$a = \frac{v-u}{t} = \frac{0 - \frac{100}{3.6}}{8} = -3.47\ ms^{-2}$

∴ The deceration is $3.47\ ms^{-2}$.

(b) Find the average braking force acting on the car. (2 mark

$F = ma$

$= 1000(-3.47) = -3470\ N$ (backward)

4 A helicopter of mass 1200 kg can ascend and descend vertically in the air.

(a) If the helicopter rises with constant speed, find the uplifting force provided by the engine. (2 mark

uplifting force $= 1200 \times 10 = mg$

$= 12000\ N$ (upwards)

(b) If the helicopter rises with uniform acceleration of 1.5 m s^{-2}, find the uplifting force acting on it. (2 mark

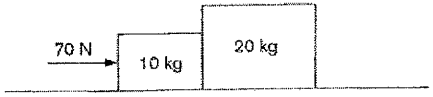
$F - mg = ma$

$F - 1200 \times 10 = 1200 \times 1.5$

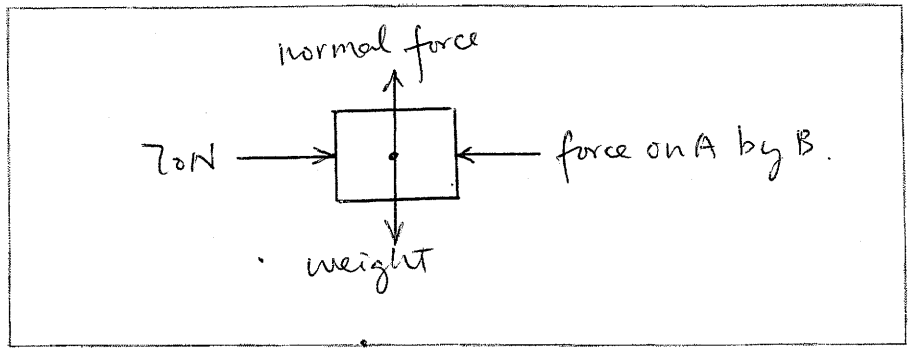
$F = 13800\ N$ (upwards)

Section B

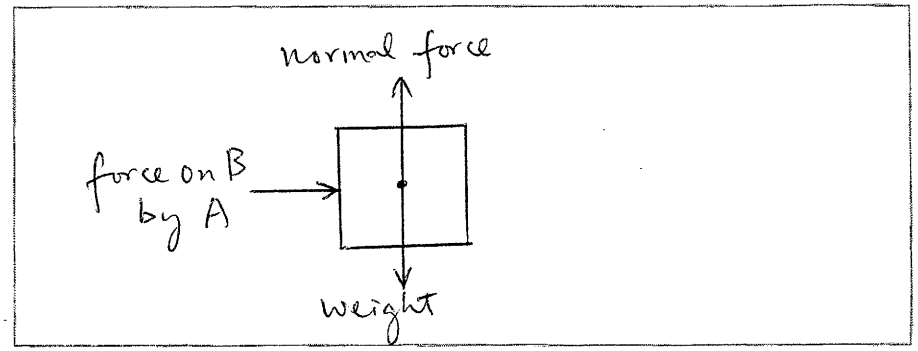
5 Two blocks *A* and *B* are placed in contact on a smooth surface. The masses of *A* and *B* are 10 kg and 20 kg respectively. A horizontal force of 70 N acts on *A* so that the two blocks move to the right together.



(a) Draw the free-body diagram for block *A*. (4 marks)



(b) Draw the free-body diagram for block *B*. (3 marks)



(c) Find the acceleration of each block. (2 marks)

$\because F = ma$

$\therefore a = \frac{70}{10+20} = 2.33\ ms^{-2}$ (to the right)

(d) Find the net force acting on block *B*. (2 marks)

net force on B $= 20 \times 2.33$

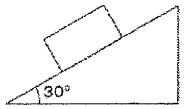
$= 46.7\ N$ (to the right)

(e) Find the force exerted by block *B* on block *A*. (1 mark)

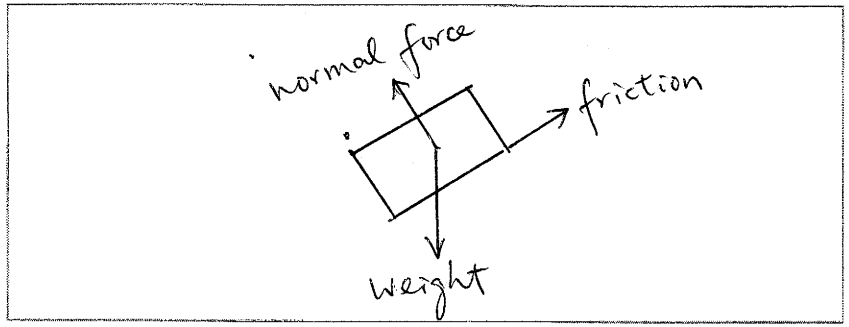
force exerted by B on A = − force exerted by A on B.

$= -46.7\ N$ (to the left)

6 A wooden box of mass 10 kg moves down with constant velocity on an inclined plane.



(a) Draw the free-body diagram for the box. (3 marks)



(b) Find the normal reaction acting on the box. (2 marks)

normal reaction $= mg\cos\theta$

$= 10 \times 10 \cos 30° = 86.6\,N$

(c) Find the friction acting on the box. (2 marks)

friction $= mg\sin\theta$

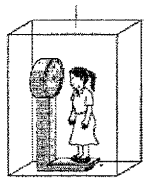
$= 10 \times 10 \sin 30° = 50\,N$

(d) If the inclined plane is smooth, find the acceleration of the box when it moves down. (2 marks)

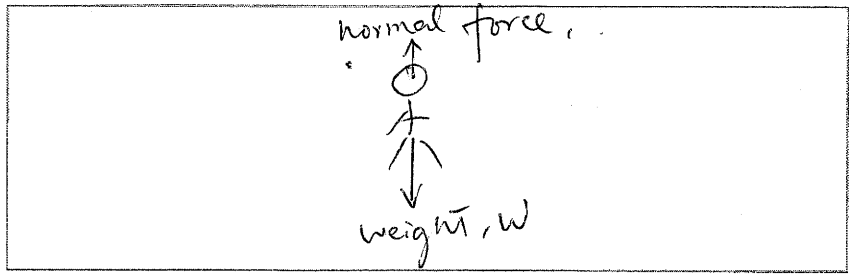
$mg\sin\theta = ma$

$a = 10\sin 30° = 5\ ms^{-2}$

★**7** A girl of mass 50 kg weighs herself on a scale inside a lift. The unit of the scale is N.



(a) Draw the free-body diagram for the girl. (2 marks)



(b) Find the reading of the scale in each of the following situations.

(i) The lift is stationary. (1 mark)

reading $= mg = 50 \times 10 = 500\,N$

(ii) The lift travels upwards with uniform acceleration of 2 m s^{-2}. (2 marks)

$-mg = ma$

$= 50 \times 10 + 50 \times 2$

$= 600\,N$

∴ The reading is 600N

(iii) The lift travels downwards with uniform acceleration of 2 m s^{-2}. (2 marks)

$mg - \quad = ma$

$= 50 \times 10 - 50 \times 2$

$= 400\,N$

∴ The reading is 400N.

★8 Read the following passage and answer the questions that follow.

Public light buses registered on or after 1 August 2004 are required to be fitted with seat belts and high back passenger seats. Seat belts and high back seats padded with soft materials are proved to be very effective in protecting passengers. Passengers must wear seat belts if they are provided for his/her seat on public light buses. Any passenger who fails to comply with the new law is liable to a maximum fine of $5000 and 3 months' imprisonment.

(Source: http://www.td.gov.hk/FileManager/TC/Content_174/plb_seat_belt.pdf)

(a) Which two new facilities on public light buses are effective in protecting passengers? (2 marks)

seat belt and high back passenger seats

(b) In case of accidents, passengers are securely fastened to the seats by the seat-belts. State the case that seat-belts are found to be effective. (1 mark)

The car collicles head-on with other objects.

(c) Why are high back seats padded with soft materials? In case of accidents, which part(s) of the body of a passenger do they protect? (3 marks)

When the car is collided from the back, the head of the passenger will move backward by inertia. High back seats padded with soft material is used to protect passenger's head and neck from injury.