CLASSIFIED

International Examinations Papers

Mob: +974 55249797 / 55258711
E-mail:rashed.saba@gmail.com

Work, energy and power: 5

TOPIC- Transforming energy (G.P.E.-K.E), Power(P=Fv), application of principle of conservation of energy- upward-downward motion

0 1 **(a)** Explain the concept of *work*.

....

....

.... [2]

(b) A table tennis ball falls vertically through air. Fig. 8.1 shows the variation of the kinetic energy E_K of the ball with distance h fallen. The ball reaches the ground after falling through a distance h_0.

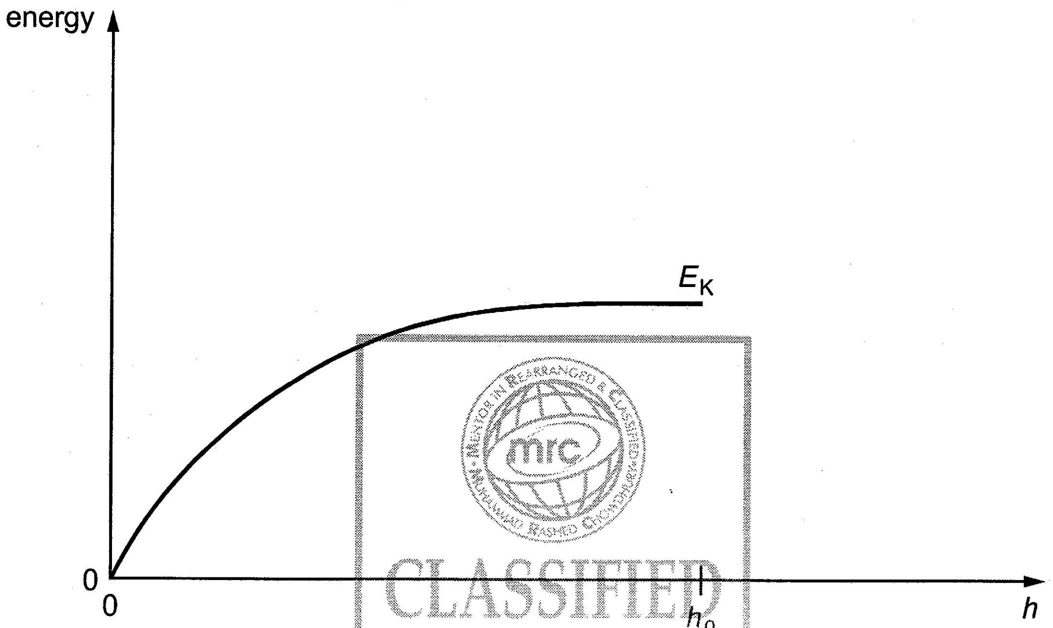

Fig. 8.1

(i) Describe the motion of the ball.

....

....

....

....

.... [3]

(ii) On Fig. 8.1, draw a line to show the variation with h of the gravitational potential energy E_P of the ball. At $h = h_0$, the potential energy is zero. [3]

0 2 A block is pulled on a horizontal surface by a force P as shown in Fig. 4.1.

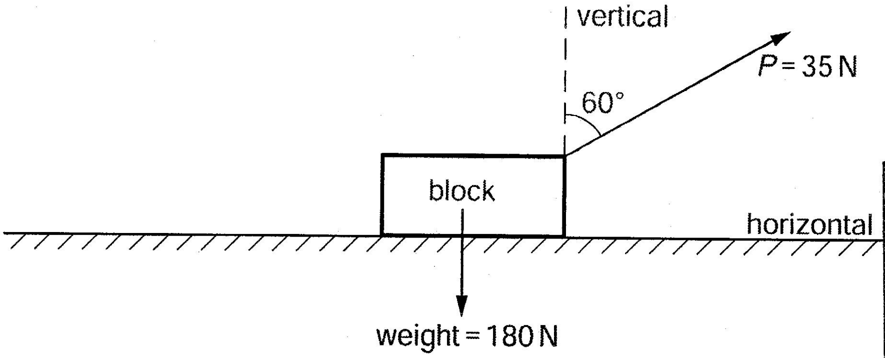

Fig. 4.1

The weight of the block is 180 N. The force P is 35 N at 60° to the vertical.
The block moves a distance of 20 m at constant velocity.

(a) Calculate

(i) the vertical force that the surface applies to the block (normal reaction force),

force = ... N [2]

(ii) the work done by force P.

work done = ... J [2]

(b) **(i)** Explain why the block continues to move at constant velocity although work is done on the block by force *P*.

....

....

....[1]

(ii) Explain, in terms of the forces acting, why the block remains in equilibrium.

....

....

....

....[2]

0 3 **(a)** State what is meant by *work done*.

....

.... [1]

(b) A trolley of mass 400 g is moving at a constant velocity of $2.5\,\text{m}\,\text{s}^{-1}$ to the right as shown in Fig. 3.1.

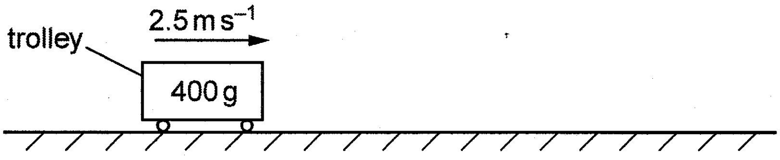

Fig. 3.1

Show that the kinetic energy of the trolley is 1.3 J.

[2]

(c) The trolley in **(b)** moves to point P as shown in Fig. 3.2.

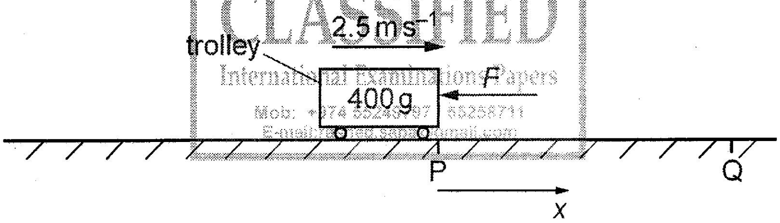

Fig. 3.2

At point P the speed of the trolley is $2.5\,\text{m}\,\text{s}^{-1}$.
A variable force F acts to the left on the trolley as it moves between points P and Q.
The variation of F with displacement x from P is shown in Fig. 3.3.

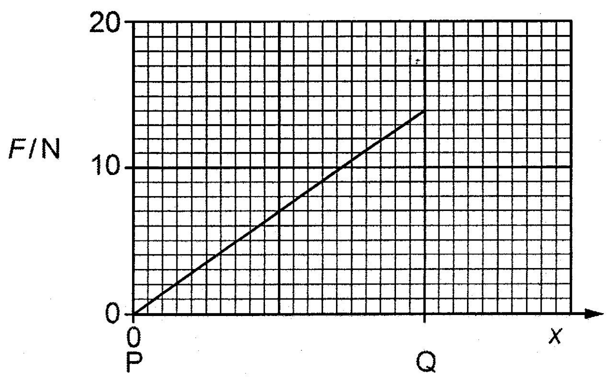

Fig. 3.3

For Examiner's Use

The trolley comes to rest at point Q.

For Examiner's Use

(i) Calculate the distance PQ.

distance PQ = ... m [3]

(ii) On Fig. 3.4, sketch the variation with x of velocity v for the trolley moving between P and Q.

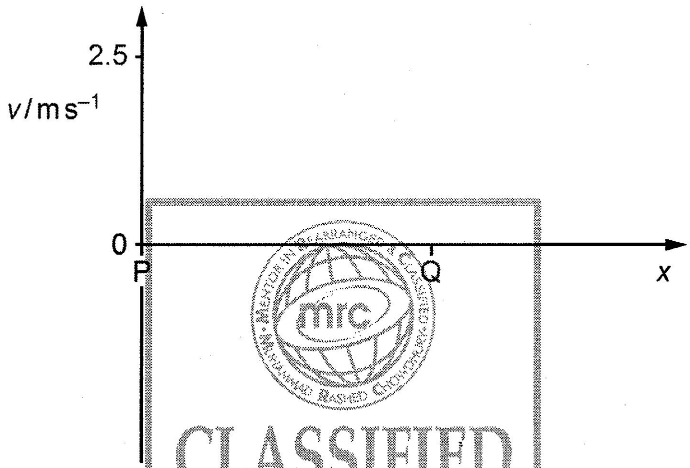

Fig. 3.4

[2]

Answer **all** the questions in the spaces provided.

Complete Fig. 1.1 to show each quantity and its unit. [4]

quantity	*unit*
speed	$m\,s^{-1}$
density	....
....	s^{-1}
electric field strength	....
....	$kg\,m\,s^{-1}$

Fig. 1.1

04 **(a)** **(i)** Define displacement.

....

....

(ii) Use your definition to explain how it is possible for a car to travel a certain distance and yet have zero displacement.

....

....

[3]

(b) A car starts from rest and travels upwards along a straight road inclined at an angle of 5.0° to the horizontal, as illustrated in Fig. 2.1.

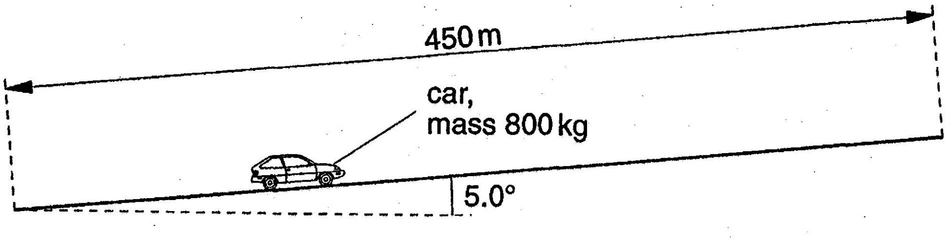

Fig. 2.1

The length of the road is 450 m and the car has mass 800 kg. The speed of the car increases at a constant rate and is 28 m s^{-1} at the top of the slope.

(i) Determine, for this car travelling up the slope,

1. its acceleration,

acceleration = ... m s^{-2} [2]

2. the time taken to travel the length of the slope,

time taken = ... s [2]

3. the gain in kinetic energy,

gain in kinetic energy = ... J [2]

For Examiner's Use

4. the gain in gravitational potential energy.

gain in potential energy = ... J [3]

(ii) Use your answers in (i) to determine the useful output power of the car.

power = ... W [3]

(iii) Suggest one reason why the actual power output of the car engine is greater than that calculated in (ii).

....

.... [2]

For Examiner's Use

5 **(a)** An object falls vertically from rest through air. State and explain the energy conversions that occur as the object falls.

....

....

....

.... [3]

(b) A ball of mass 150 g is thrown vertically upwards with an initial speed of $25\,m\,s^{-1}$.

(i) Calculate the initial kinetic energy of the ball.

kinetic energy = ... J [3]

(ii) The ball reaches a height of 21 m above the point of release.

For the ball rising to this height, calculate

1. the loss of energy of the ball to air resistance,

energy loss = ... J [3]

2. the average force due to the air resistance.

force = ... N [2]

6 (a) Define

(i) *force*,

....

.... [1]

(ii) *work done*.

....

.... [1]

(b) A force F acts on a mass m along a straight line for a distance s. The acceleration of the mass is a and the speed changes from an initial speed u to a final speed v.

(i) State the work W done by F.

[1]

(ii) Use your answer in (i) and an equation of motion to show that kinetic energy of a mass can be given by the expression

$$\text{kinetic energy} = \tfrac{1}{2} \times \text{mass} \times (\text{speed})^2.$$

[3]

(c) A resultant force of 3800 N causes a car of mass of 1500 kg to accelerate from an initial speed of $15\,m\,s^{-1}$ to a final speed of $30\,m\,s^{-1}$.

(i) Calculate the distance moved by the car during this acceleration.

distance = ... m [2]

(ii) The same force is used to change the speed of the car from $30\,m\,s^{-1}$ to $45\,m\,s^{-1}$. Explain why the distance moved is not the same as that calculated in **(i)**.

....

....

.... [1]

07 **(a)** **(i)** Explain what is meant by *work done*.

For Examiner's Use

....

.... [1]

(ii) Define *power*.

....

.... [1]

(b) Fig. 3.1 shows part of a fairground ride with a carriage on rails.

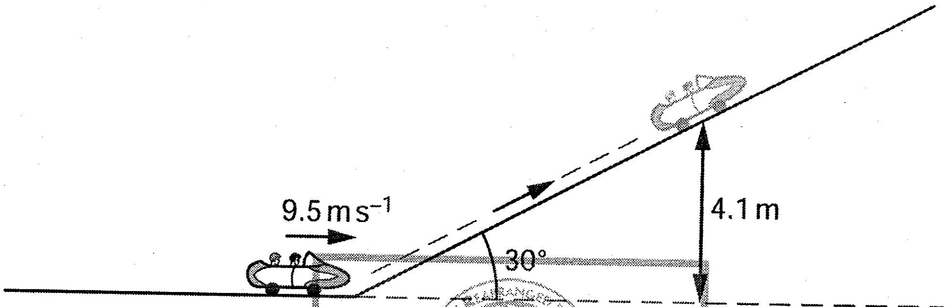

Fig. 3.1

The carriage and passengers have a total mass of 600 kg. The carriage is travelling at a speed of $9.5\,m\,s^{-1}$ towards a slope inclined at 30° to the horizontal. The carriage comes to rest after travelling up the slope to a vertical height of 4.1 m.

(i) Calculate the kinetic energy, in kJ, of the carriage and passengers as they travel towards the slope.

kinetic energy = ... kJ [3]

(ii) Show that the gain in potential energy of the carriage and passengers is 24 kJ.

[2]

(iii) Calculate the work done against the resistive force as the carriage moves up the slope.

For Examiner's Use

work done = ... kJ [1]

(iv) Use your answer in **(iii)** to calculate the resistive force acting against the carriage as it moves up the slope.

resistive force = ... N [2]

For Examiner's Use

08 **(a)** Explain what is meant by *work done*.

....

.... [1]

(b) A car is travelling along a road that has a uniform downhill gradient, as shown in Fig. 2.1.

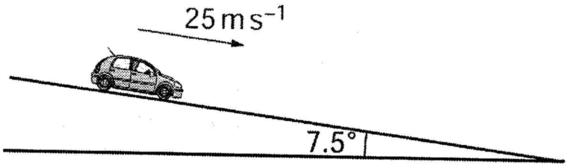

Fig. 2.1

The car has a total mass of 850 kg. The angle of the road to the horizontal is 7.5°.

Calculate the component of the weight of the car down the slope.

component of weight = ... N [2]

(c) The car in **(b)** is travelling at a constant speed of $25\,\mathrm{m\,s^{-1}}$. The driver then applies the brakes to stop the car. The constant force resisting the motion of the car is 4600 N.

(i) Show that the deceleration of the car with the brakes applied is $4.1\,\mathrm{m\,s^{-2}}$.

[2]

(ii) Calculate the distance the car travels from when the brakes are applied until the car comes to rest.

distance = ... m [2]

For Examiner's Use

(iii) Calculate

1. the loss of kinetic energy of the car,

loss of kinetic energy = ... J [2]

2. the work done by the resisting force of 4600 N.

work done = ... J [1]

(iv) The quantities in **(iii) part 1** and in **(iii) part 2** are not equal. Explain why these two quantities are not equal.

....

.... [1]

0 9 A motor is used to move bricks vertically upwards, as shown in Fig. 5.1.

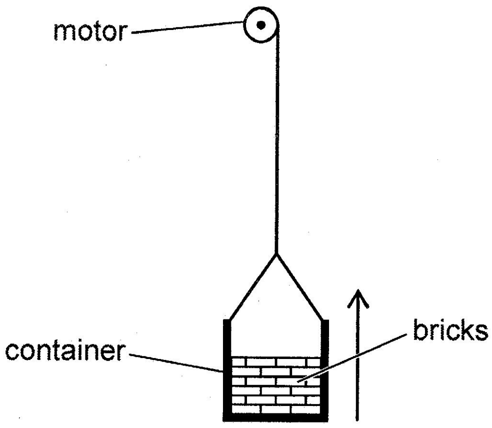

Fig. 5.1

The bricks start from rest and accelerate for 2.0 s. The bricks then travel at a constant speed of 0.64 m s^{-1} for 25 s. Finally the bricks are brought to rest in a further 3.0 s.

The total mass of the bricks is 25 kg.

(a) Determine the change in kinetic energy of the bricks

(i) in the first 2.0 s,

change in kinetic energy = ... J [2]

(ii) in the next 25 s,

change in kinetic energy = ... J [1]

(iii) in the final 3.0 s.

change in kinetic energy = ... J [1]

(b) The bricks are in a container. The weight of the container and bricks is 350 N.

Calculate, for the lifting of the bricks and container when travelling at constant speed,

(i) the gain in potential energy,

energy gain = ... J [3]

(ii) the power required.

power = ... W [2]

10 **(a)** Define *velocity*.

....

....[1]

(b) A ball of mass 0.45 kg leaves the edge of a table with a horizontal velocity v, as shown in Fig. 2.1.

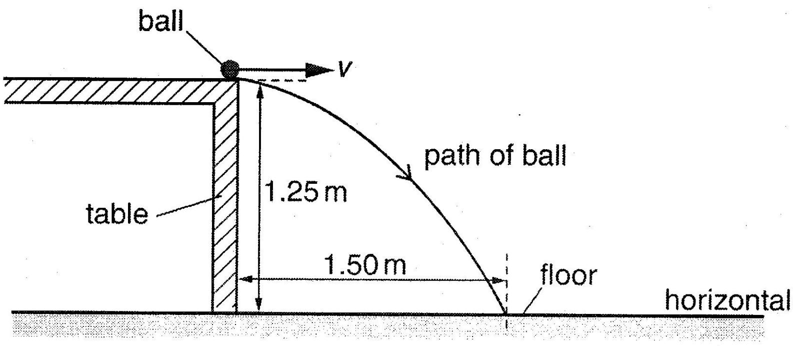

Fig. 2.1

The height of the table is 1.25 m. The ball travels a distance of 1.50 m horizontally before hitting the floor.

Air resistance is negligible.

Calculate, for the ball,

(i) the horizontal velocity v as it leaves the table,

v = ... m s^{-1} [3]

(ii) the velocity just as it hits the floor,

magnitude of velocity = ... $m s^{-1}$

angle to the horizontal = ... °
[4]

(iii) the kinetic energy just as it hits the floor,

kinetic energy = ... J [2]

(iv) the loss in gravitational potential energy as it falls from the table to the floor.

loss in potential energy = ... J [2]

(c) Explain why the kinetic energy of the ball in **(b)(iii)** does not equal the loss of gravitational potential energy in **(b)(iv)**.

....

....[1]

[Total: 13]

11 A steel ball falls from a platform on a tower to the ground below, as shown in Fig. 3.1.

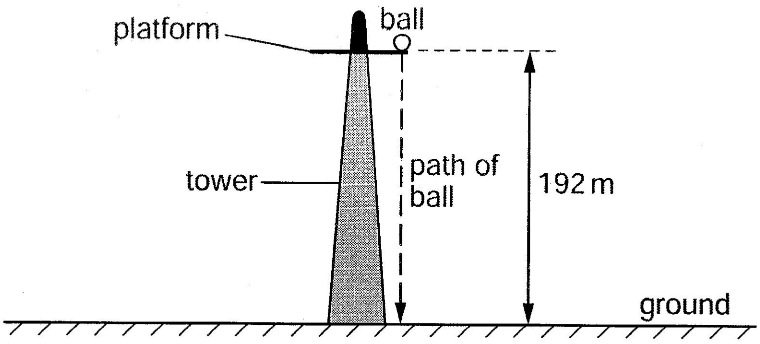

Fig. 3.1

The ball falls from rest through a vertical distance of 192 m. The mass of the ball is 270 g.

(a) Assume air resistance is negligible.

(i) Calculate

1. the time taken for the ball to fall to the ground,

time taken = ... s [2]

2. the maximum kinetic energy of the ball.

maximum kinetic energy = ... J [2]

(ii) State and explain the variation of the velocity of the ball with time as the ball falls to the ground.

....

.... [1]

(iii) Show that the velocity of the ball on reaching the ground is approximately 60 m s^{-1}.

[1]

(b) In practice, air resistance is not negligible. The variation of the air resistance R with the velocity v of the ball is shown in Fig. 3.2.

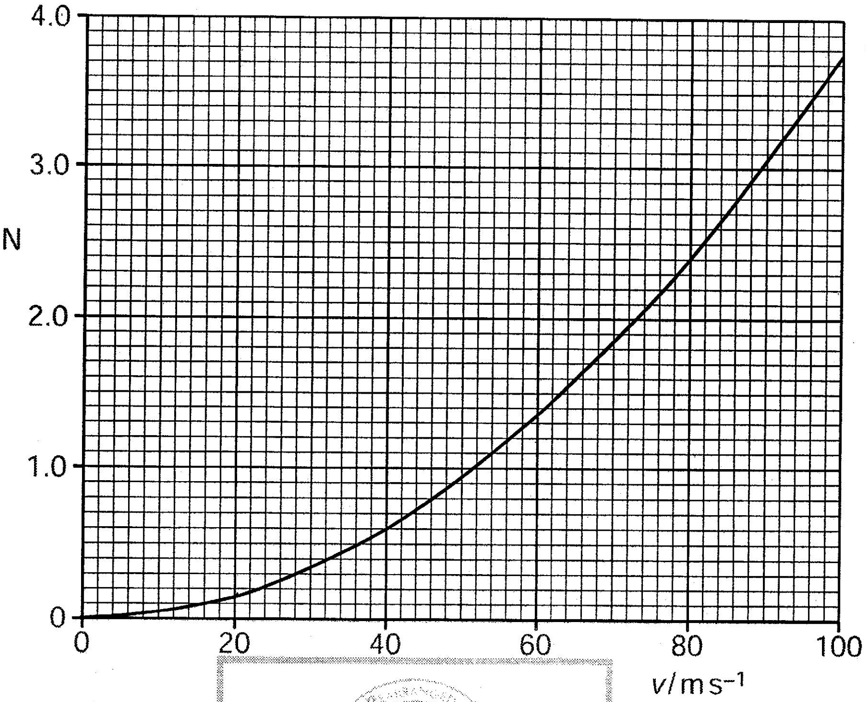

Fig. 3.2

(i) Use Fig. 3.2 to state and explain qualitatively the variation of the acceleration of the ball with the distance fallen by the ball.

....

....

....

....[3]

(ii) The speed of the ball reaches $40\,\text{m}\,\text{s}^{-1}$. Calculate its acceleration at this speed.

acceleration = ... $\text{m}\,\text{s}^{-2}$ [2]

(iii) Use information from **(a)(iii)** and Fig. 3.2 to state and explain whether the ball reaches terminal velocity.

....

....

....[2]

12 **(a)** Explain what is meant by *gravitational potential energy* and by *kinetic energy*.

gravitational potential energy: ....

....

kinetic energy: ....

.... [2]

(b) A motion sensor is used to measure the velocity of a ball falling vertically towards the ground, as illustrated in Fig. 3.1.

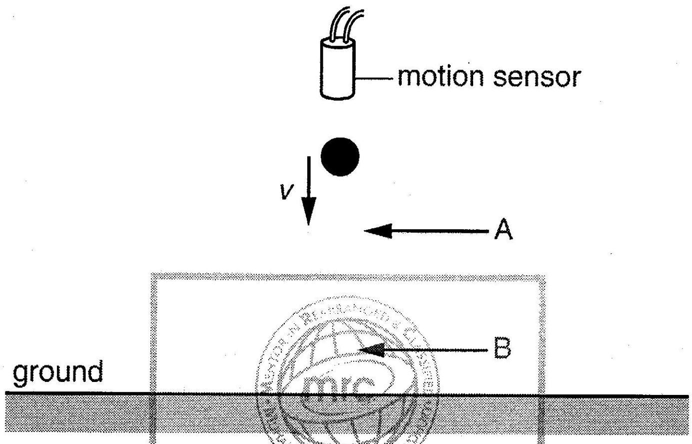

Fig. 3.1

The ball passes through points A and B as it falls. The ball has a mass of 1.5 kg.

The variation with time t of the velocity v of the ball as it falls from A to B is shown in Fig. 3.2.

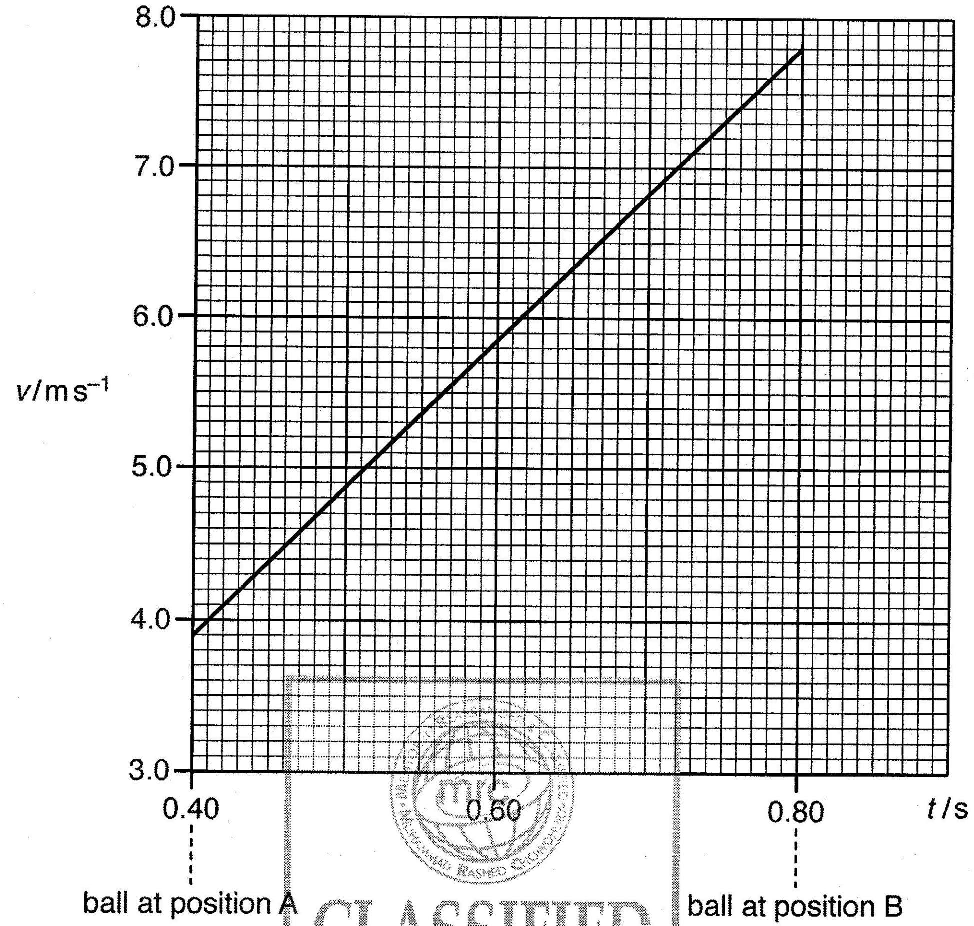

Fig. 3.2

Use Fig. 3.2 to calculate, for the ball falling from A to B,

(i) the displacement,

displacement = ...m [3]

(ii) the acceleration,

acceleration = ... m s^{-2} [2]

(iii) the change in kinetic energy.

change in kinetic energy = ...J [3]

(c) Show that the work done by the gravitational field on the ball in **(b)** as it moves from A to B is equal to the change in kinetic energy.

[2]

[Total: 12]

3 The variation with time t of the velocity v of a ball is shown in Fig. 2.1.

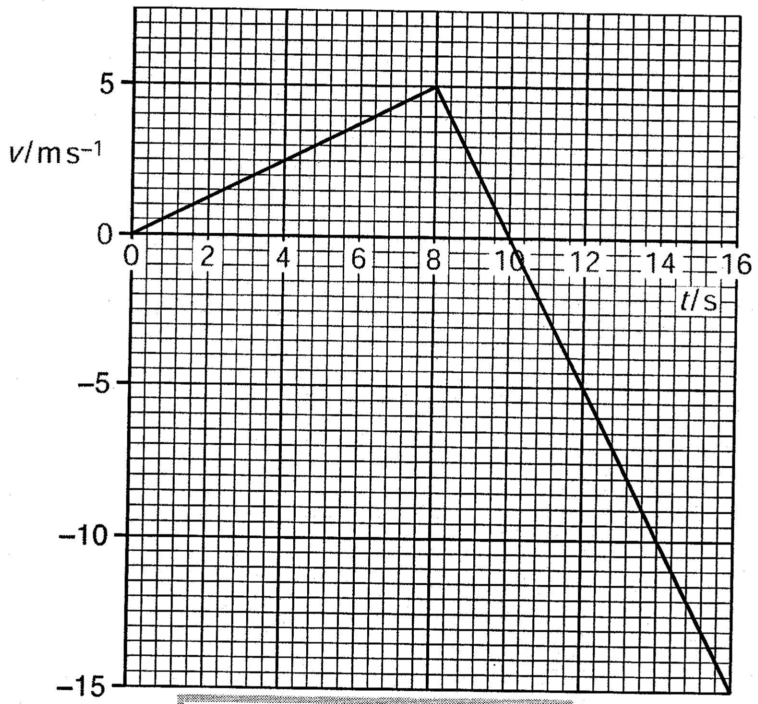

Fig. 2.1

The ball moves in a straight line from a point P at $t = 0$. The mass of the ball is 400 g.

(a) Use Fig. 2.1 to describe, without calculation, the velocity of the ball from $t = 0$ to $t = 16$ s.

....

....

....

....

....[2]

(b) Use Fig. 2.1 to calculate, for the ball,

(i) the displacement from P at $t = 10\,s$,

displacement = ... m [2]

(ii) the acceleration at $t = 10\,s$,

acceleration = ... $m\,s^{-2}$ [2]

(iii) the maximum kinetic energy.

kinetic energy = ... J [2]

(c) Use your answers in **(b)(i)** and **(b)(ii)** to determine the time from $t = 0$ for the ball to return to P.

time = ... s [2]

14 **(a)** A stone of mass 56 g is thrown horizontally from the top of a cliff with a speed of $18\,m\,s^{-1}$, as illustrated in Fig. 4.1.

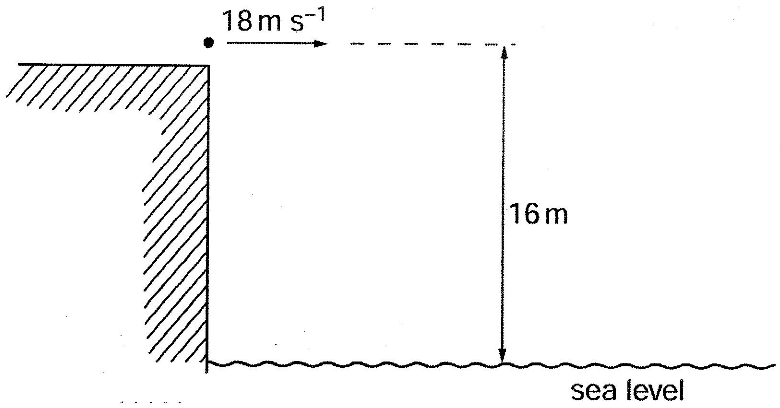

Fig. 4.1

The initial height of the stone above the level of the sea is 16 m. Air resistance may be neglected.

(i) Calculate the change in gravitational potential energy of the stone as a result of falling through 16 m.

change = ... J [2]

(ii) Calculate the total kinetic energy of the stone as it reaches the sea.

kinetic energy = ... J [3]

(b) Use your answer in **(a)(ii)** to show that the speed of the stone as it hits the water is approximately 25 m s^{-1}.

[1]

(c) State the horizontal velocity of the stone as it hits the water.

horizontal velocity = ... m s^{-1} [1]

(d) **(i)** On the grid of Fig. 4.2, draw a vector diagram to represent the horizontal velocity and the resultant velocity of the stone as it hits the water. [1]

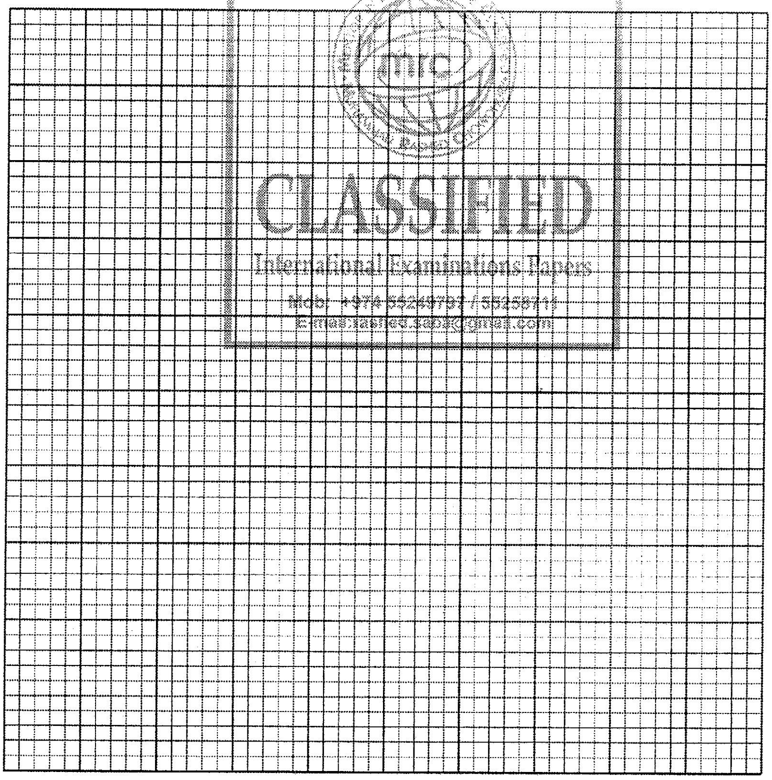

Fig. 4.2

(ii) Use your vector diagram to determine the angle with the horizontal at which the stone hits the water.

angle = ... ° [2]

5 Fig. 2.1 shows an object M on a slope.

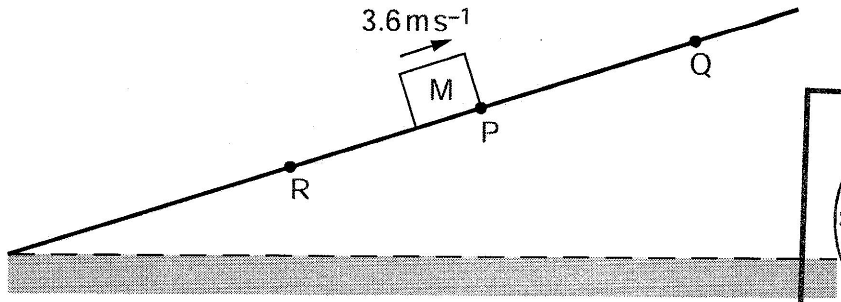

Fig. 2.1

M moves up the slope, comes to rest at point Q and then moves back down the slope to point R.
M has a constant acceleration of $3.0\,\mathrm{m\,s^{-2}}$ down the slope at all times.
At time $t = 0$, M is at point P and has a velocity of $3.6\,\mathrm{m\,s^{-1}}$ up the slope.
The total distance from P to Q and then to R is 6.0 m.

(a) Calculate, for the motion of M from P to Q,

(i) the time taken,

time = ... s [2]

(ii) the distance travelled.

distance = ... m [1]

(b) Show that the speed of M at R is $4.8\,\mathrm{m\,s^{-1}}$.

[2]

(c) On Fig. 2.2, draw the variation with time t of the velocity v of M for the motion P to Q to R.

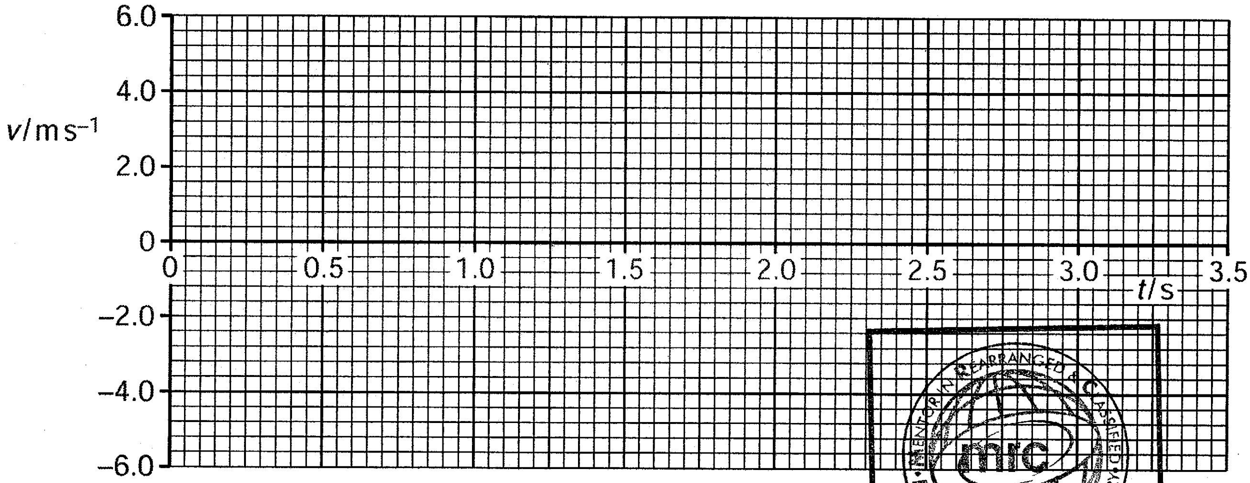

Fig. 2.2

[3]

(d) The mass of M is 450 g.

Calculate the difference in the kinetic energy of M at P and at R.

difference in kinetic energy = ... J [2]

16 A bullet of mass 2.0 g is fired horizontally into a block of wood of mass 600 g. The block is suspended from strings so that it is free to move in a vertical plane.
The bullet buries itself in the block. The block and bullet rise together through a vertical distance of 8.6 cm, as shown in Fig. 3.1.

For Examiner's Use

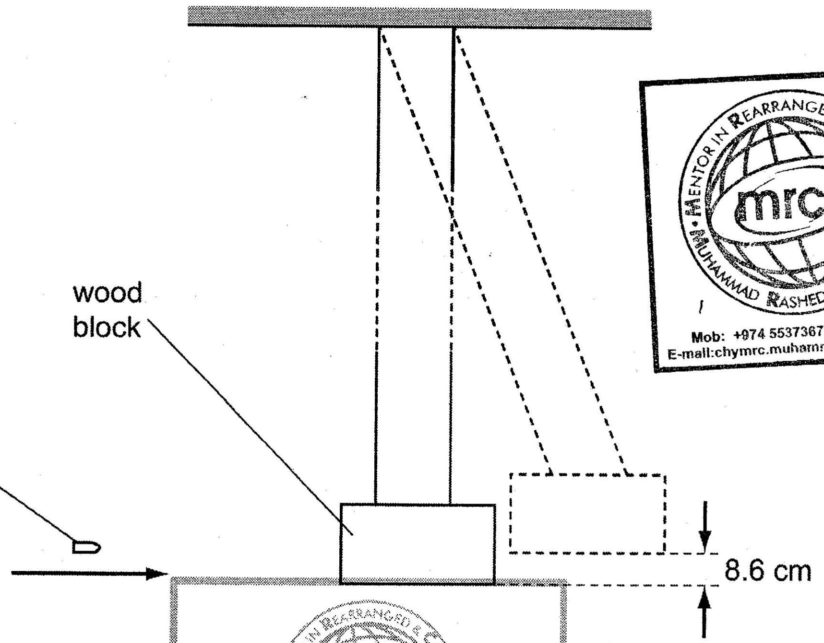

Fig. 3.1

(a) (i) Calculate the change in gravitational potential energy of the block and bullet.

change = ... J [2]

(ii) Show that the initial speed of the block and the bullet, after they began to move off together, was 1.3 m s^{-1}.

[1]

(b) Using the information in **(a)(ii)** and the principle of conservation of momentum, determine the speed of the bullet before the impact with the block.

For Examiner's Use

speed = ... $m\,s^{-1}$ [2]

(c) (i) Calculate the kinetic energy of the bullet just before impact.

kinetic energy = ... J [2]

(ii) State and explain what can be deduced from your answers to **(c)(i)** and **(a)(i)** about the type of collision between the bullet and the block.

....

....

....[2]

17 A ball has mass m. It is dropped onto a horizontal plate as shown in Fig. 4.1.

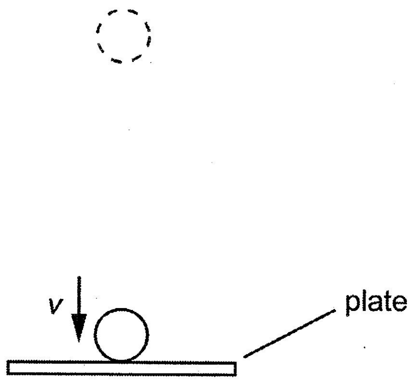

Fig. 4.1

Just as the ball makes contact with the plate, it has velocity v, momentum p and kinetic energy E_k.

(a) **(i)** Write down an expression for momentum p in terms of m and v.

....

(ii) Hence show that the kinetic energy is given by the expression

$$E_k = \frac{p^2}{2m}$$

[3]

Work, energy and power: 5

TOPIC- Transforming energy (G.P.E.-K.E),

For Examiner's Use

0 1 **(a)** **(i)** Define potential energy.

....

.... [1]

(ii) Distinguish between *gravitational* potential energy and *elastic* potential energy.

gravitational potential energy ....

....

elastic potential energy ....

.... [2]

(b) A small sphere of mass 51 g is suspended by a light inextensible string from a fixed point P.
The centre of the sphere is 61 cm vertically below point P, as shown in Fig. 3.1.

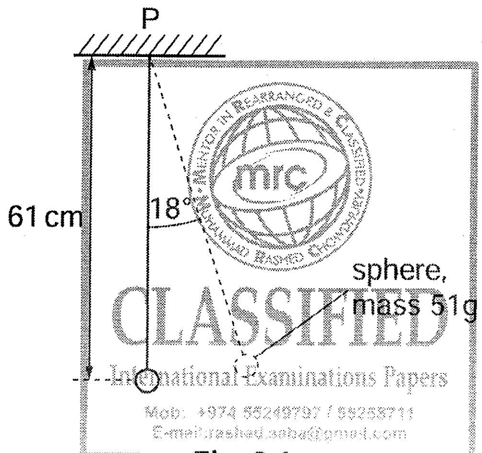

Fig. 3.1

The sphere is moved to one side, keeping the string taut, so that the string makes an angle of 18° with the vertical. Calculate

(i) the gain in gravitational potential energy of the sphere,

gain = ... J [2]

For Examiner's Use

(ii) the moment of the weight of the sphere about point P.

moment = ... N m [2]

0 2 **(a)** Distinguish between *gravitational potential energy* and *electric potential energy*.

For Examiner's Use

....

....

.... [2]

(b) A body of mass *m* moves vertically through a distance *h* near the Earth's surface. Use the defining equation for work done to derive an expression for the gravitational potential energy change of the body.

[2]

(c) Water flows down a stream from a reservoir and then causes a water wheel to rotate, as shown in Fig. 4.1.

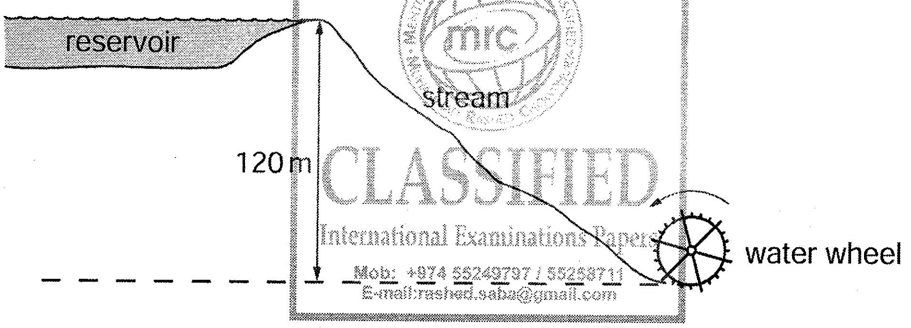

Fig. 4.1

As the water falls through a vertical height of 120 m, gravitational potential energy is converted to different forms of energy, including kinetic energy of the water. At the water wheel, the kinetic energy of the water is only 10% of its gravitational potential energy at the reservoir.

(i) Show that the speed of the water as it reaches the wheel is $15\,\mathrm{m\,s^{-1}}$.

[2]

(ii) The rotating water wheel is used to produce 110 kW of electrical power. Calculate the mass of water flowing per second through the wheel, assuming that the production of electric energy from the kinetic energy of the water is 25% efficient.

For Examiner's Use

mass of water per second = ... $kg\,s^{-1}$ [3]

3 A cyclist is moving up a slope that has a constant gradient. The cyclist takes 8.0 s to climb the slope.
The variation with time t of the speed v of the cyclist is shown in Fig. 3.1.

For Examiner's Use

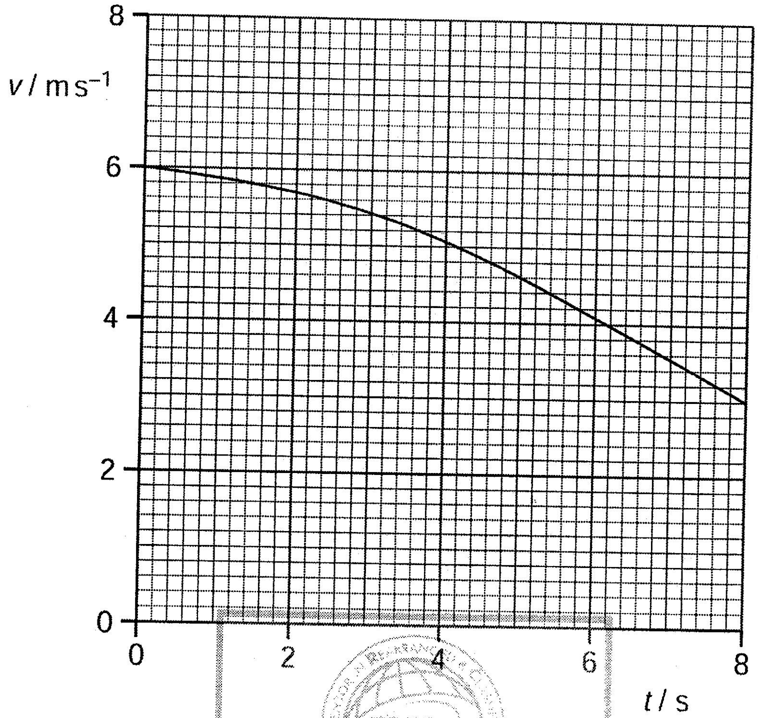

Fig. 3.1

(a) Use Fig. 3.1 to determine the total distance moved up the slope.

distance = ... m [3]

(b) The bicycle and cyclist have a combined mass of 92 kg.
The vertical height through which the cyclist moves is 1.3 m.

(i) For the movement of the bicycle and cyclist between $t = 0$ and $t = 8.0$ s,

1. use Fig. 3.1 to calculate the change in kinetic energy,

change = ... J [2]

2. calculate the change in gravitational potential energy.

change = ... J [2]

(ii) The cyclist pedals continuously so that the useful power delivered to the bicycle is 75 W.
Calculate the useful work done by the cyclist climbing up the slope.

work done = ... J [2]

(c) Some energy is used in overcoming frictional forces.

For Examiner's Use

(i) Use your answers in **(b)** to show that the total energy converted in overcoming frictional forces is approximately 670 J.

[1]

(ii) Determine the average magnitude of the frictional forces.

average force = ...N [1]

(d) Suggest why the magnitude of the total resistive force would not be constant.

....

....

....[2]

0 4 A ball of mass 0.030 kg moves along a curved track, as shown in Fig. 2.1.

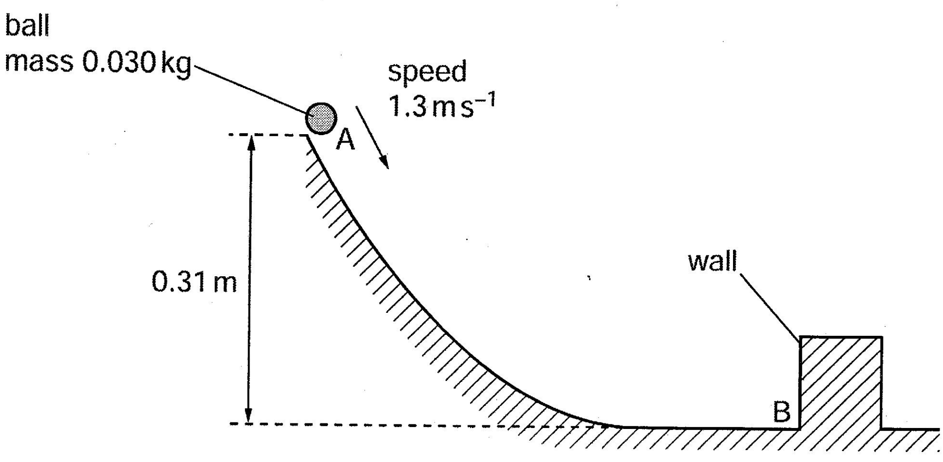

Fig. 2.1

The speed of the ball is 1.3 m s^{-1} when it is at point A at a height of 0.31 m.
The ball moves down the track and collides with a vertical wall at point B. The ball then rebounds back up the track. It may be assumed that frictional forces are negligible.

(a) Calculate the change in gravitational potential energy of the ball in moving from point A to point B.

change in gravitational potential energy = ... J [2]

(b) Show that the ball hits the wall at B with a speed of 2.8 m s^{-1}.

[3]

(c) The change in momentum of the ball due to the collision with the wall is 0.096 kg m s^{-1}. The ball is in contact with the wall for a time of 20 ms.

Determine, for the ball colliding with the wall,

(i) the speed immediately after the collision,

speed = ... m s^{-1} [2]

(ii) the magnitude of the average force on the ball.

force = ... N [2]

(d) State and explain whether the collision is elastic or inelastic.

....

....[1]

(e) In practice, frictional effects are significant so that the actual increase in kinetic energy of the ball in moving from A to B is 76 mJ. The length of the track between A and B is 0.60 m.

Use your answer in **(a)** to determine the average frictional force acting on the ball as it moves from A to B.

frictional force = ... N [2]

[Total: 12]

Mob: +974 55249797 / 55258711
E-mail:rashed.saba@gmail.com

Work, energy and power: 5

TOPIC- Power (P=Fv)

Answer **all** the questions in the spaces provided.

For Examiner's Use

0 1 **(a)** Define what is meant by

(i) *work done*,

....

....

.... [2]

(ii) *power*.

....

.... [1]

(b) A force F is acting on a body that is moving with velocity v in the direction of the force.

Derive an expression relating the power P dissipated by the force to F and v.

[2]

(c) A car of mass 1900 kg accelerates from rest to a speed of $27\,m\,s^{-1}$ in 8.1 s.

(i) Calculate the average rate at which kinetic energy is supplied to the car during the acceleration.

rate = ... W [2]

(ii) The car engine provides power at a constant rate. Suggest and explain why the acceleration of the car is **not** constant.

For Examiner's Use

....

....

.... [2]

For Examiner's Use

02 Two forces, each of magnitude F, form a couple acting on the edge of a disc of radius r, as shown in Fig. 5.1.

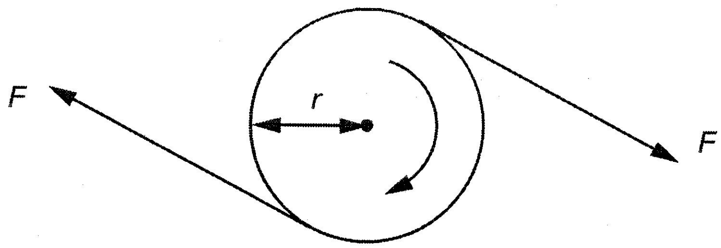

Fig. 5.1

(a) The disc is made to complete n revolutions about an axis through its centre, normal to the plane of the disc. Write down an expression for

(i) the distance moved by a point on the circumference of the disc,

distance = ...

(ii) the work done by one of the two forces.

work done = ...

[2]

(b) Using your answer to **(a)**, show that the work W done by a couple producing a torque T when it turns through n revolutions is given by

$$W = 2\pi nT.$$

[2]

For Examiner's Use

(c) A car engine produces a torque of 470 N m at 2400 revolutions per minute. Calculate the output power of the engine.

power = ... W [2]

For Examiner's Use

3 A shopping trolley and its contents have a total mass of 42 kg. The trolley is being pushed along a horizontal surface at a speed of 1.2 m s^{-1}. When the trolley is released, it travels a distance of 1.9 m before coming to rest.

(a) Assuming that the total force opposing the motion of the trolley is constant,

(i) calculate the deceleration of the trolley,

deceleration = ... m s^{-2} [2]

(ii) show that the total force opposing the motion of the trolley is 16 N.

[1]

(b) Using the answer in **(a)(ii)**, calculate the power required to overcome the total force opposing the motion of the trolley at a speed of 1.2 m s^{-1}.

power = ... W [2]

(c) The trolley now moves down a straight slope that is inclined at an angle of 2.8° to the horizontal, as shown in Fig. 3.1.

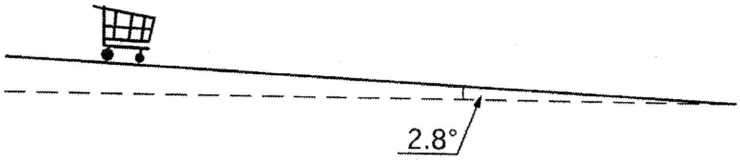

Fig. 3.1

The constant force that opposes the motion of the trolley is 16 N.

Calculate, for the trolley moving down the slope,

(i) the component down the slope of the trolley's weight,

component of weight = ... N [2]

(ii) the time for the trolley to travel from rest a distance of 3.5 m along the length of the slope.

time = ... s [4]

(d) Use your answer to **(c)(ii)** to explain why, for safety reasons, the slope is not made any steeper.

....

.... [1]

04 **(a)** Define *power*.

....

....[1]

(b) Fig. 3.1 shows a car travelling at a speed of $22\,m\,s^{-1}$ on a horizontal road.

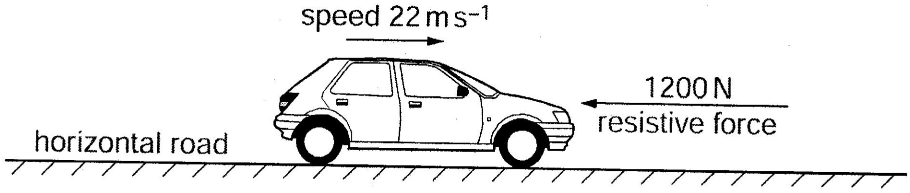

Fig. 3.1

The car has a mass of 1500 kg. A resistive force of 1200 N acts on the car.

Calculate

(i) the force F required from the car to produce an acceleration of $0.82\,m\,s^{-2}$,

F = ... N [3]

(ii) the power required to produce this acceleration.

power = ... W [2]

(c) The resistive force on the car is proportional to v^2, where v is the speed of the car. Suggest why the car has a maximum speed.

....

....[1]

0 5 **(a)** **(i)** Define *power*.

.... [1]

(ii) Use your definition in **(i)** to show that power may also be expressed as the product of force and velocity.

[2]

(b) A lorry moves up a road that is inclined at 9.0° to the horizontal, as shown in Fig. 2.1.

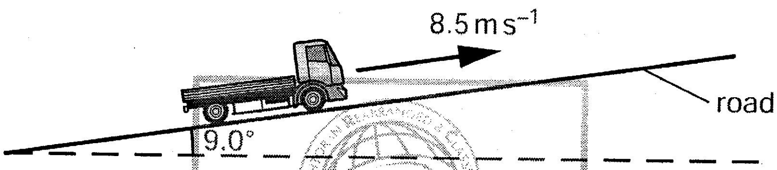

Fig. 2.1

The lorry has mass 2500 kg and is travelling at a constant speed of 8.5 m s^{-1}. The force due to air resistance is negligible.

(i) Calculate the useful power from the engine to move the lorry up the road.

power = ... kW [3]

(ii) State two reasons why the rate of change of potential energy of the lorry is equal to the power calculated in **(i)**.

1. ....

....

2. ....

....

[2]

CLASSIFIED

International Examinations Papers

Mob: +974 55249797 / 55258711
E-mail:rashed.saba@gmail.com

Work, energy and power: 5

TOPIC- Application of principle of conservation of energy- upward-downward motion

0 1 A ball is thrown from A to B as shown in Fig. 2.1.

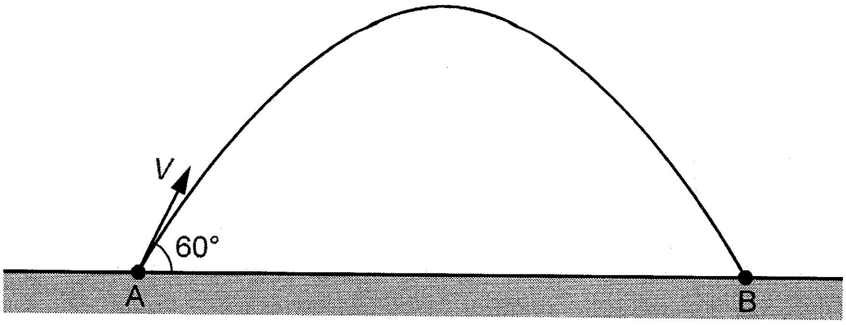

Fig. 2.1

The ball is thrown with an initial velocity V at 60° to the horizontal.
The variation with time t of the vertical component V_v of the velocity of the ball from t = 0 to t = 0.60 s is shown in Fig. 2.2.

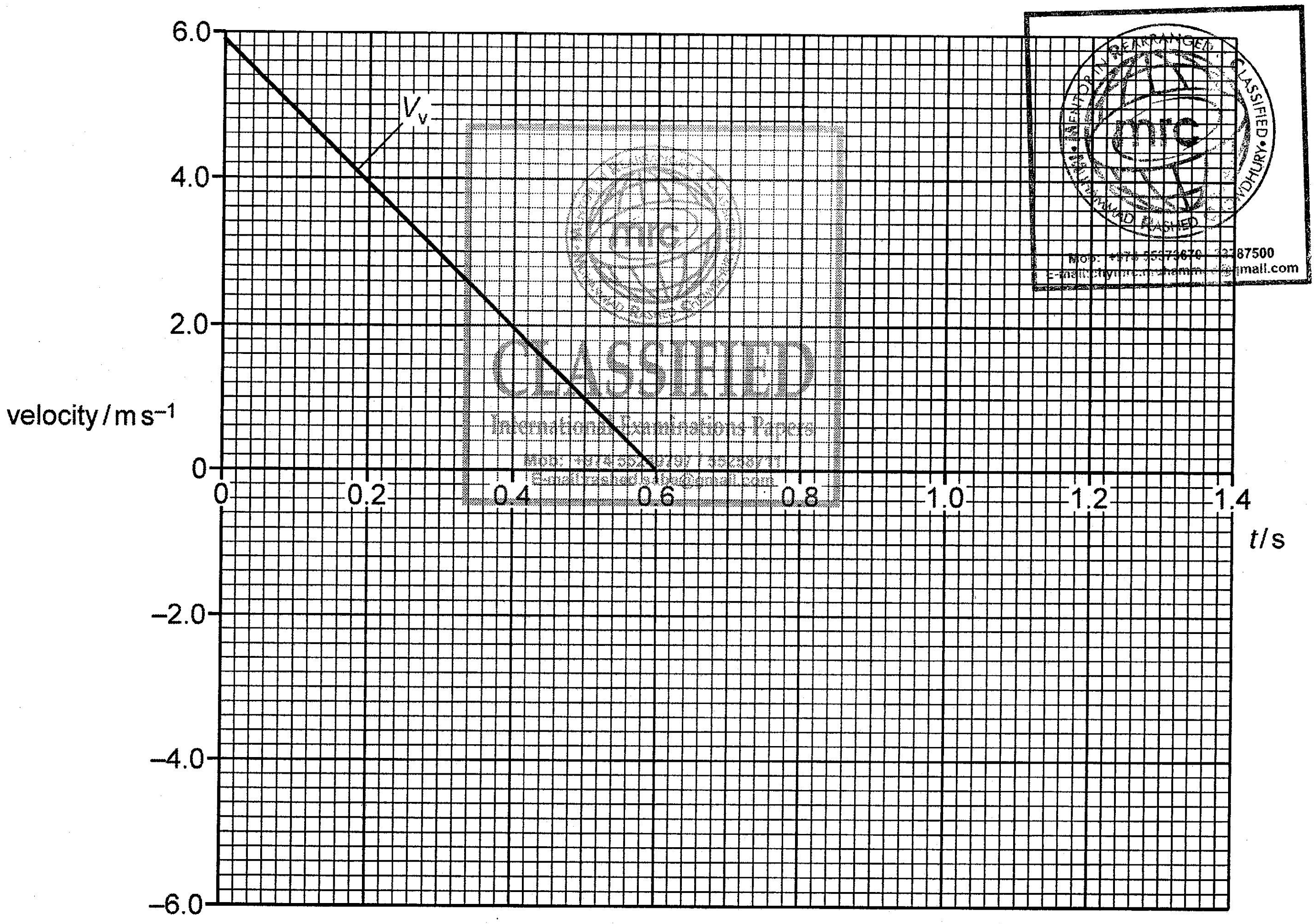

Fig. 2.2

Assume air resistance is negligible.

(a) **(i)** Complete Fig. 2.2 for the time until the ball reaches B. [2]

(ii) Calculate the maximum height reached by the ball.

height = ... m [2]

(iii) Calculate the horizontal component V_h of the velocity of the ball at time $t = 0$.

V_h = ... m s^{-1} [2]

(iv) On Fig. 2.2, sketch the variation with t of V_h. **Label** this sketch V_h. [1]

(b) The ball has mass 0.65 kg.
Calculate, for the ball,

(i) the maximum kinetic energy,

maximum kinetic energy = ... J [3]

(ii) the maximum potential energy above the ground.

maximum potential energy = ... J [2]

0 2 **(a)** Explain what is meant by *gravitational potential* energy and *kinetic* energy.

gravitational potential energy: ....

....

kinetic energy: ....

.... [2]

(b) A ball of mass 400 g is thrown with an initial velocity of $30.0\,\text{m}\,\text{s}^{-1}$ at an angle of 45.0° to the horizontal, as shown in Fig. 4.1.

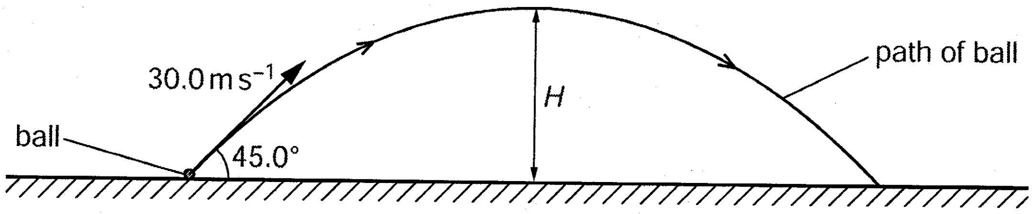

Fig. 4.1

Air resistance is negligible. The ball reaches a maximum height H after a time of 2.16 s.

(i) Calculate

1. the initial kinetic energy of the ball,

kinetic energy = ... J [3]

2. the maximum height H of the ball,

H = ... m [2]

3. the gravitational potential energy of the ball at height *H*.

potential energy = ... J [2]

(ii) 1. Determine the kinetic energy of the ball at its maximum height.

kinetic energy = ... J [1]

2. Explain why the kinetic energy of the ball at maximum height is not zero.

....

.... [1]

0 3 **(a)** Distinguish between gravitational potential energy and elastic potential energy.

For Examiner's Use

....

....

.... [2]

(b) A ball of mass 65g is thrown vertically upwards from ground level with a speed of $16\,m\,s^{-1}$. Air resistance is negligible.

(i) Calculate, for the ball,

1. the initial kinetic energy,

kinetic energy = ... J [2]

2. the maximum height reached,

maximum height = ... m [2]

(ii) The ball takes time t to reach maximum height. For time $\frac{t}{2}$ after the ball has been thrown, calculate the ratio

$$\frac{\text{potential energy of ball}}{\text{kinetic energy of ball}}.$$

ratio = ... [3]

(iii) State and explain the effect of air resistance on the time taken for the ball to reach maximum height.

....

....

.... [1]

04

(a) A ball is thrown vertically down towards the ground and rebounds as illustrated in Fig. 2.1.

For Examiner's Use

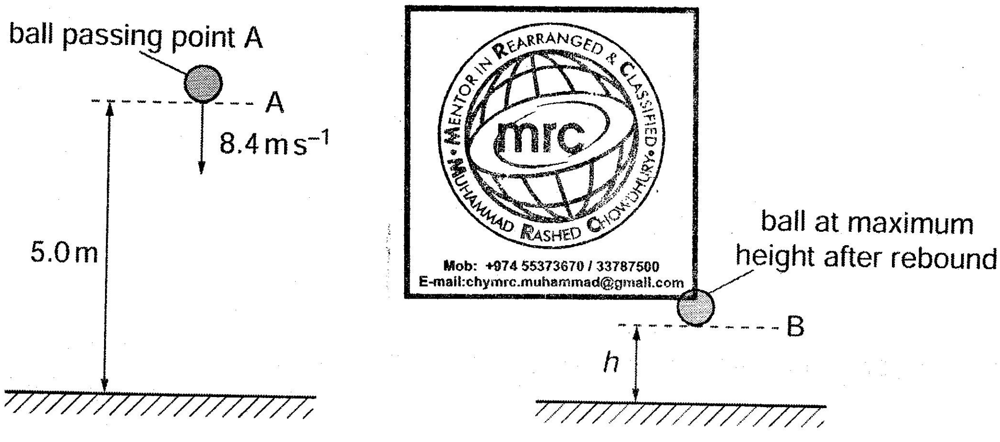

Fig. 2.1

As the ball passes A, it has a speed of $8.4\,\mathrm{m\,s^{-1}}$. The height of A is 5.0 m above the ground. The ball hits the ground and rebounds to B. Assume that air resistance is negligible.

(i) Calculate the speed of the ball as it hits the ground.

speed = ... $\mathrm{m\,s^{-1}}$ [2]

(ii) Show that the time taken for the ball to reach the ground is 0.47 s.

[1]

(b) The ball rebounds vertically with a speed of $4.2\,m\,s^{-1}$ as it leaves the ground. The time the ball is in contact with the ground is 20 ms. The ball rebounds to a maximum height *h*.

For Examiner's Use

The ball passes A at time $t = 0$. On Fig. 2.2, plot a graph to show the variation with time *t* of the velocity *v* of the ball. Continue the graph until the ball has rebounded from the ground and reaches B.

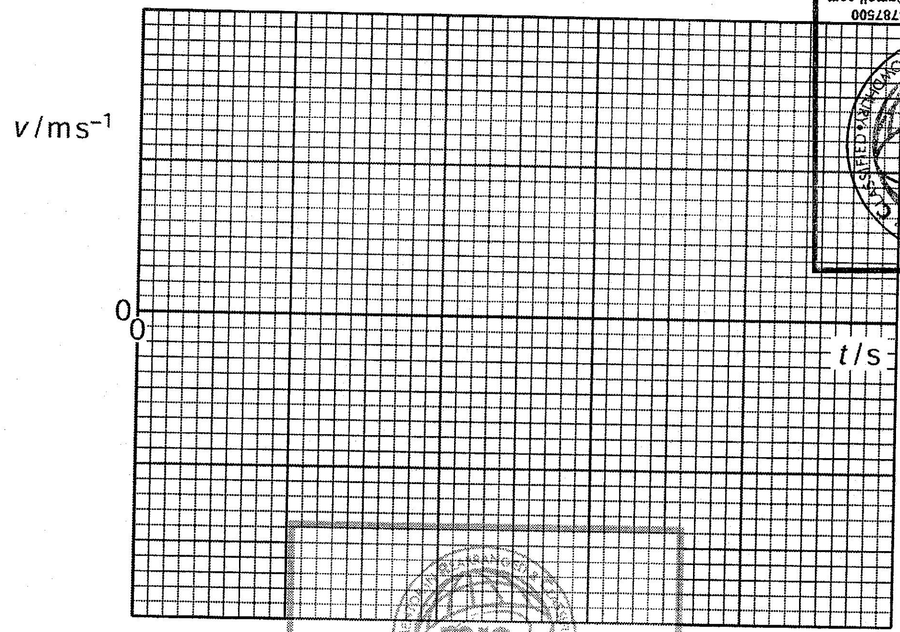

Fig. 2.2

[3]

(c) The ball has a mass of 0.050 kg. It moves from A and reaches B after rebounding.

(i) For this motion, calculate the change in

1. kinetic energy,

change in kinetic energy = ... J [2]

2. gravitational potential energy.

change in potential energy = ... J [3]

(ii) State and explain the total change in energy of the ball for this motion.

For Examiner's Use

....

....

....

....[2]

0 5 **(a)** Explain what is meant by *work done*.

....

....[1]

(b) A boy on a board B slides down a slope, as shown in Fig. 3.1.

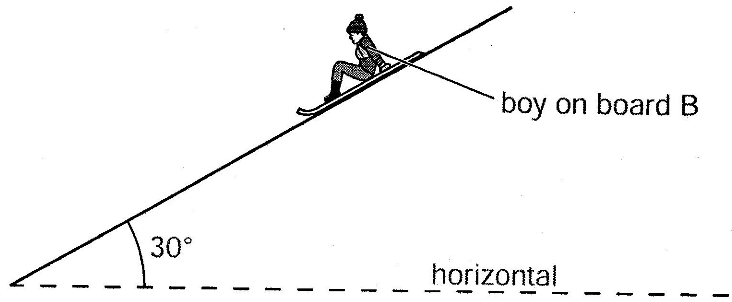

Fig. 3.1

The angle of the slope to the horizontal is 30°. The total resistive force F acting on B is constant.

(i) State a word equation that links the work done by the force F on B to the changes in potential and kinetic energy.

....

....[1]

(ii) The boy on the board B moves with velocity v down the slope. The variation with time t of v is shown in Fig. 3.2.

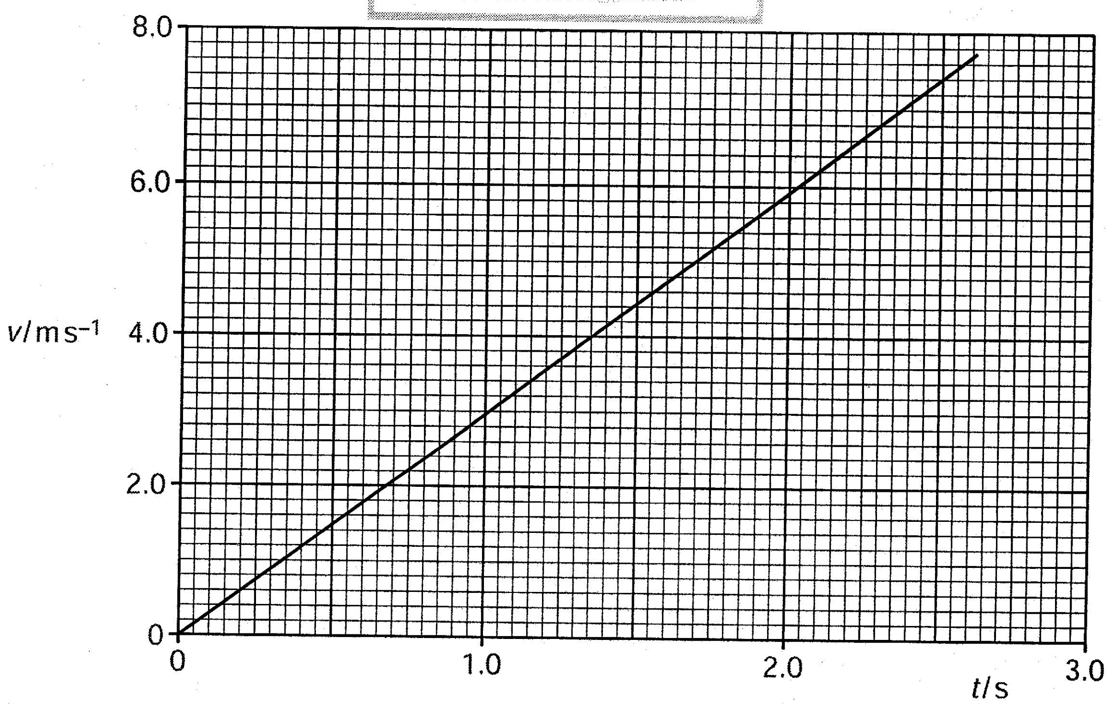

Fig. 3.2

The total mass of B is 75 kg.
For B, from $t = 0$ to $t = 2.5$ s,

1. show that the distance moved down the slope is 9.3 m,

[2]

2. calculate the gain in kinetic energy,

gain in kinetic energy = ... J [3]

3. calculate the loss in potential energy,

loss in potential energy = ... J [3]

4. calculate the resistive force F.

F = ... N [3]

0 6 Two planks of wood AB and BC are inclined at an angle of 15° to the horizontal. The two wooden planks are joined at point B, as shown in Fig. 2.1.

For Examiner's Use

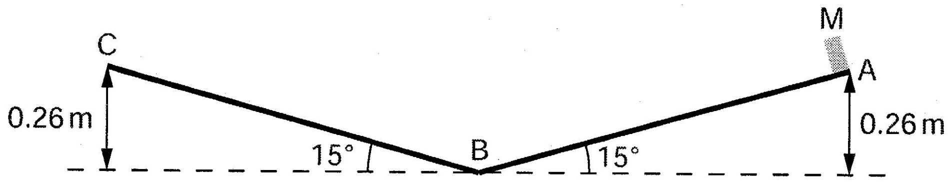

Fig. 2.1

A small block of metal M is released from rest at point A. It slides down the slope to B and up the opposite side to C. Points A and C are 0.26 m above B. Assume frictional forces are negligible.

(a) **(i)** Describe and explain the acceleration of M as it travels from A to B and from B to C.

....

....

....

.... [3]

(ii) Calculate the time taken for M to travel from A to B.

time = ... s [3]

(iii) Calculate the speed of M at B.

speed = ... $m s^{-1}$ [2]

(b) The plank BC is adjusted so that the angle it makes with the horizontal is 30°. M is released from rest at point A and slides down the slope to B. It then slides a distance along the plank from B towards C.

Use the law of conservation of energy to calculate this distance. Explain your working.

distance = ... m [2]