Work, Energy & Power

Question paper 7

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Work, Energy & Power
Sub Topic	
Paper Type	Theory
Booklet	Question paper 7

Time Allowed: **71 minutes**

Score: **/59**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1 A small ball is thrown horizontally with a speed of $4.0\,m\,s^{-1}$. It falls through a vertical height of 1.96 m before bouncing off a horizontal plate, as illustrated in Fig. 3.1.

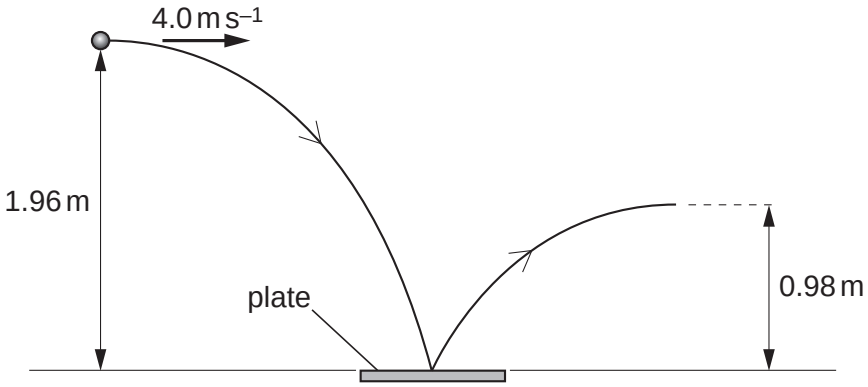

Fig. 3.1

Air resistance is negligible.

(a) For the ball, as it hits the horizontal plate,

(i) state the magnitude of the horizontal component of its velocity,

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

(ii) show that the vertical component of the velocity is $6.2\,m\,s^{-1}$.

[1]

(b) The components of the velocity in **(a)** are both vectors.

Complete Fig. 3.2 to draw a vector diagram, to scale, to determine the velocity of the ball as it hits the horizontal plate.

Fig. 3.2

velocity = ...$m\,s^{-1}$

at ..... ° to the vertical
[3]

(c) After bouncing on the plate, the ball rises to a vertical height of 0.98 m.

(i) Calculate the vertical component of the velocity of the ball as it leaves the plate.

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

(ii) The ball of mass 34 g is in contact with the plate for a time of 0.12 s.

Use your answer in **(c)(i)** and the data in **(a)(ii)** to calculate, for the ball as it bounces on the plate,

1. the change in momentum,

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

2. the magnitude of the average force exerted by the plate on the ball due to this momentum change.

force = ... N [2]

2 Two parallel plates P and Q are separated by a distance of 7.6 mm in a vacuum. There is a potential difference of 250 V between the plates, as illustrated in Fig. 4.1.

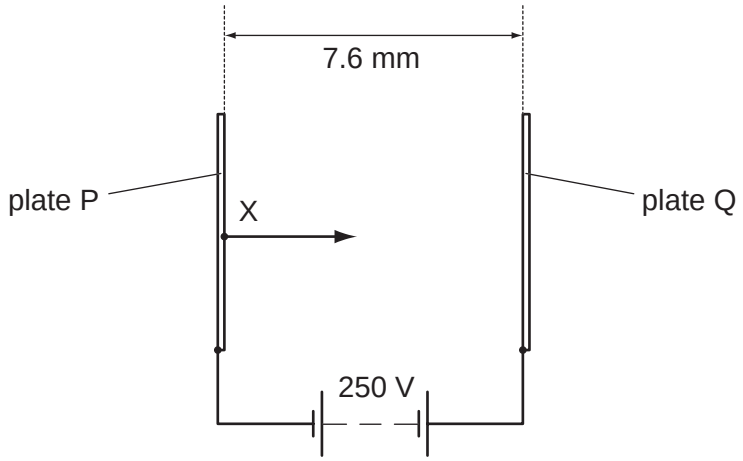

Fig. 4.1

Electrons are produced at X on plate P. These electrons accelerate from rest and travel to plate Q.
The electric field between the plates may be assumed to be uniform.

(a) (i) Determine the force on an electron due to the electric field.

force = …….. N [3]

(ii) Show that the change in kinetic energy of an electron as it moves from plate P to plate Q is 4.0×10^{-17} J.

[2]

(iii) Determine the speed of an electron as it reaches plate Q.

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

(b) The positions of the plates are adjusted so that the electric field between them is not uniform. The potential difference remains unchanged.
State and explain the effect, if any, of this adjustment on the speed of an electron as it reaches plate Q.

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.....

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..... [3]

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

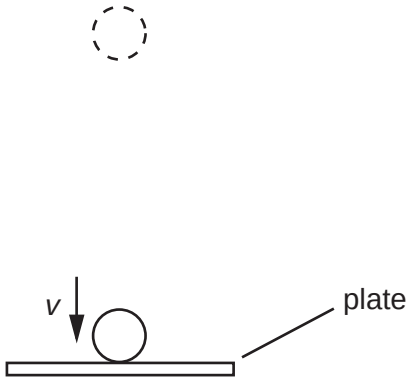

Fig. 4.1

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]

(b) Just before impact with the plate, the ball of mass 35 g has speed 4.5 m s^{-1}. It bounces from the plate so that its speed immediately after losing contact with the plate is 3.5 m s^{-1}. The ball is in contact with the plate for 0.14 s.

Calculate, for the time that the ball is in contact with the plate,

(i) the average force, in addition to the weight of the ball, that the plate exerts on the ball,

magnitude of force = ... N

direction of force = ...
[4]

(ii) the loss in kinetic energy of the ball.

loss = ... J [2]

(c) State and explain whether linear momentum is conserved during the bounce.

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.....

.....

..... [3]

4 Two large flat metal plates A and B are placed 9.0 cm apart in a vacuum, as illustrated in Fig. 5.1.

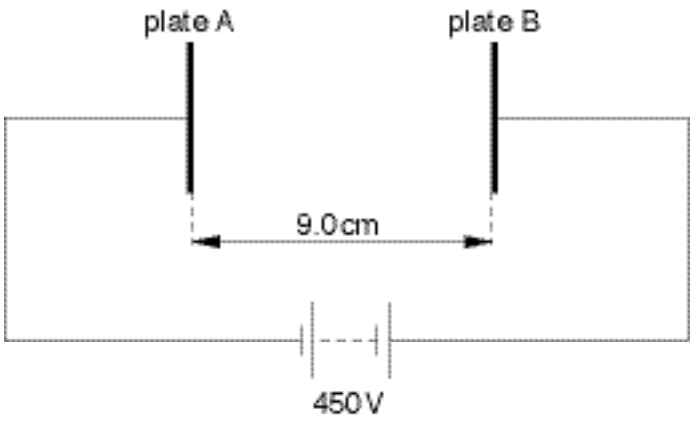

Fig. 5.1

A potential difference of 450 V is maintained between the plates by means of a battery.

(a) **(i)** On Fig. 5.1, draw an arrow to indicate the direction of the electric field between plates A and B.

(ii) Calculate the electric field strength between A and B.

field strength = ... $N\,C^{-1}$

[3]

(b) An electron is released from rest at the surface of plate A.

(i) Show that the change in electric potential energy in moving from plate A to plate B is 7.2×10^{-17} J.

(ii) Determine the speed of the electron on reaching plate B.

speed = …….. $m\,s^{-1}$
[4]

(c) On the axes of Fig. 5.2, sketch a graph to show the variation with distance *d* from plate A of the speed *v* of the electron. [1]

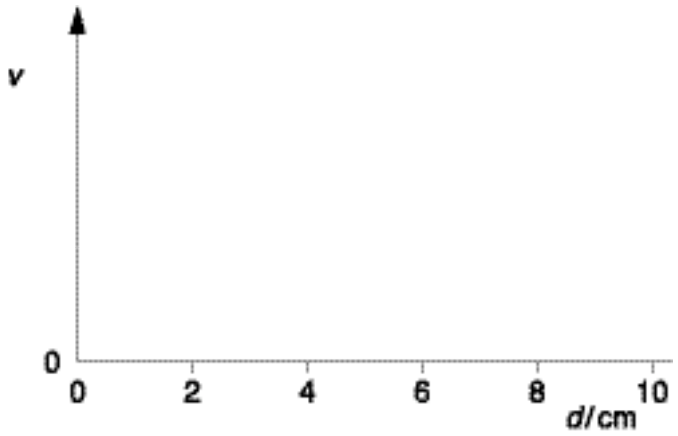

Fig. 5.2

5 **(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 8.0° to the horizontal, as illustrated in Fig. 2.1.

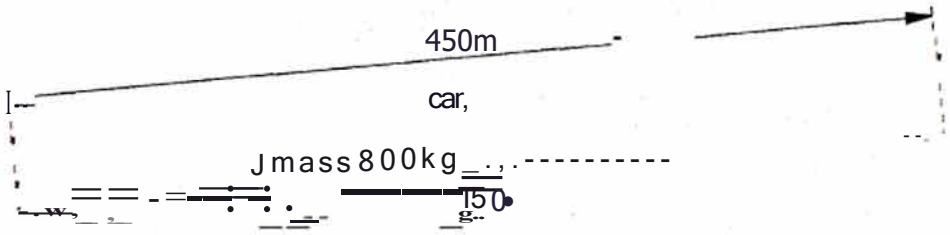

Fig. 2.1

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]

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]