Work, Energy & Power

Question paper 5

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Work, Energy & Power
Sub Topic	
Paper Type	Theory
Booklet	Question paper 5

Time Allowed: **70 minutes**

Score: **/58**

Percentage: **/100**

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

1 **(a)** Use the definition of power to show that the SI base units of power are $kg\,m^2\,s^{-3}$.

[2]

(b) Use an expression for electrical power to determine the SI base units of potential difference.

units .....[2]

2 A spring is kept horizontal by attaching it to points A and B, as shown in Fig. 4.1.

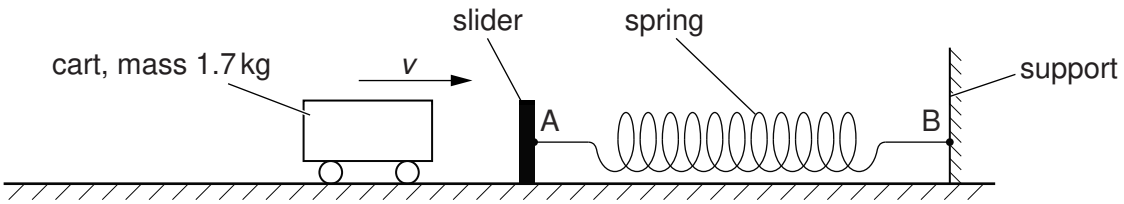

Fig. 4.1

Point A is on a movable slider and point B is on a fixed support. A cart of mass 1.7 kg has horizontal velocity v towards the slider. The cart collides with the slider. The spring is compressed as the cart comes to rest. The variation of compression x of the spring with force F exerted on the spring is shown in Fig. 4.2.

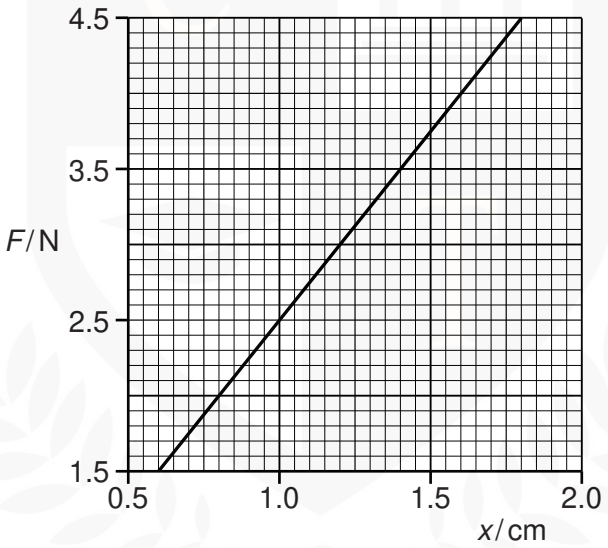

Fig. 4.2

Fig. 4.2 shows the compression of the spring for F = 1.5 N to F = 4.5 N. The cart comes to rest when F is 4.5 N.

(a) Use Fig. 4.2 to

(i) show that the compression of the spring obeys Hooke's law,

.....

.....

.....[2]

(ii) determine the spring constant of the spring,

spring constant = ... $N\,m^{-1}$ [2]

(iii) determine the elastic potential energy E_P stored in the spring due to the cart being brought to rest.

E_P = ... J [3]

(b) Calculate the speed v of the cart as it makes contact with the slider. Assume that all the kinetic energy of the cart is converted to the elastic potential energy of the spring.

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

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

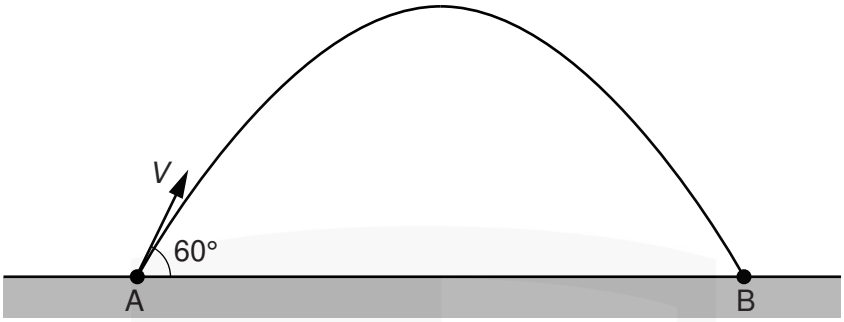

Fig. 2.1

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.

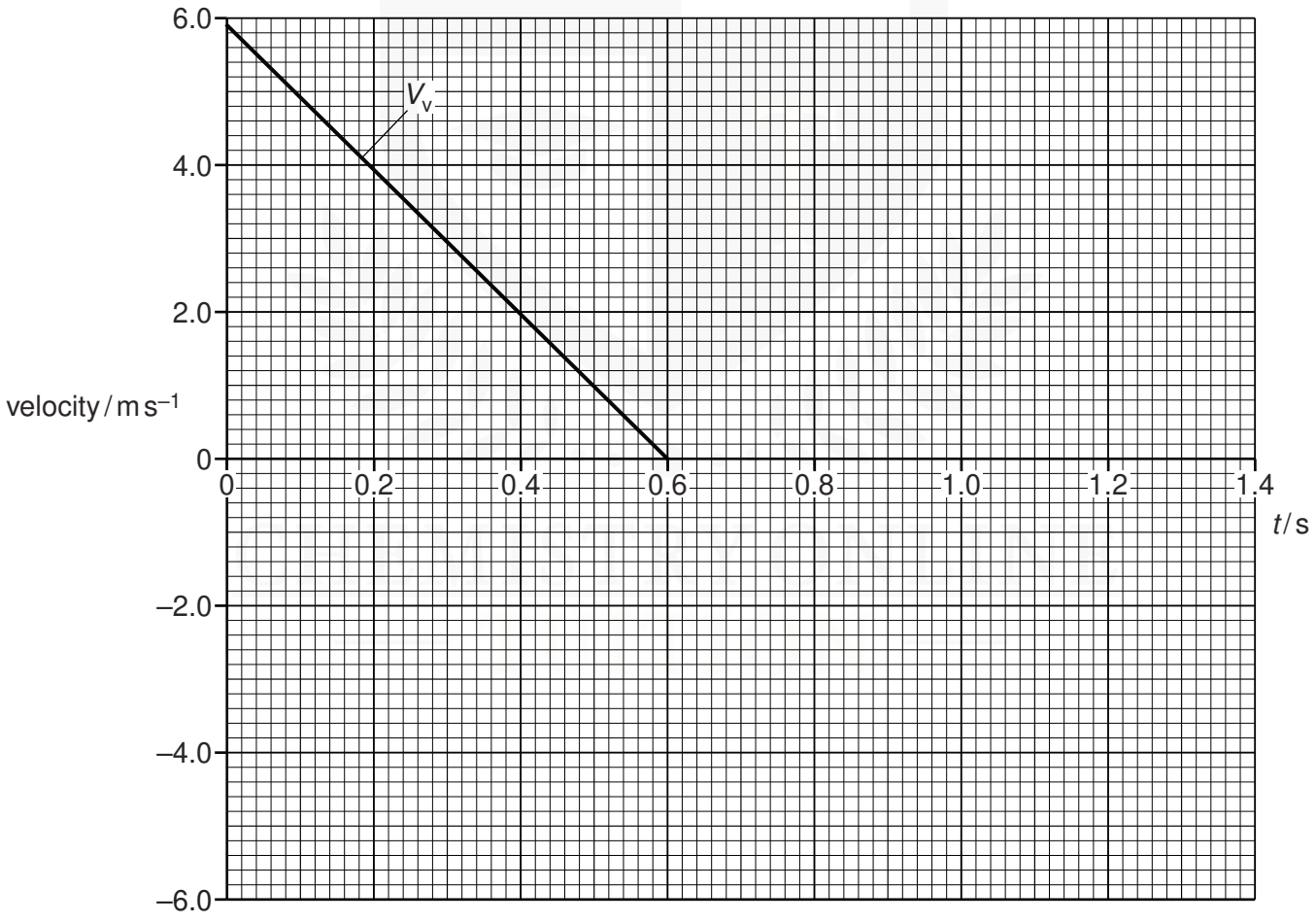

Fig. 2.2

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]

4 **(a)** State the principle of conservation of momentum.

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.....[2]

(b) A ball X and a ball Y are travelling along the same straight line in the same direction, as shown in Fig. 4.1.

Fig. 4.1

Ball X has mass 400 g and horizontal velocity 0.65 m s^{-1}.
Ball Y has mass 600 g and horizontal velocity 0.45 m s^{-1}.

Ball X catches up and collides with ball Y. After the collision, X has horizontal velocity 0.41 m s^{-1} and Y has horizontal velocity v, as shown in Fig. 4.2.

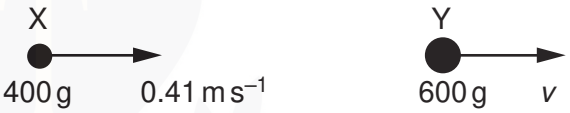

Fig. 4.2

Calculate

(i) the total initial momentum of the two balls,

momentum = ... Ns [3]

(ii) the velocity v,

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

(iii) the total initial kinetic energy of the two balls.

kinetic energy = ... J [3]

(c) Explain how you would check whether the collision is elastic.

.....

.....[1]

(d) Use Newton's third law to explain why, during the collision, the change in momentum of X is equal and opposite to the change in momentum of Y.

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.....[2]

5 **(a)** Determine the SI base units of power.

SI base units of power ..... [3]

(b) Fig. 1.1 shows a turbine that is used to generate electrical power from the wind.

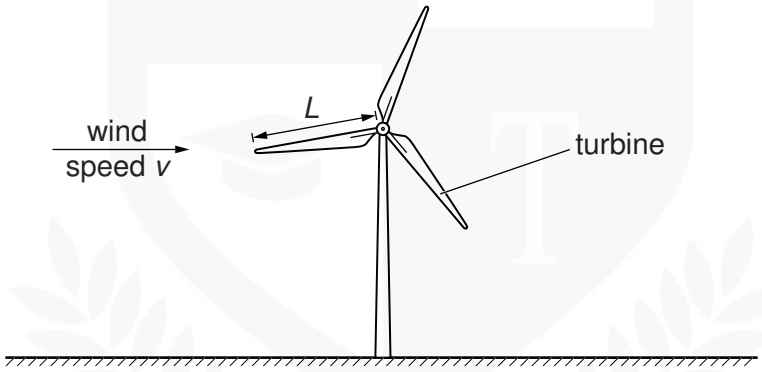

Fig. 1.1

The power P available from the wind is given by

$$P = CL^2\rho v^3$$

where L is the length of each blade of the turbine,
ρ is the density of air,
v is the wind speed,
C is a constant.

(i) Show that C has no units.

[3]

(ii) The length L of each blade of the turbine is 25.0 m and the density ρ of air is 1.30 in SI units. The constant C is 0.931.
The efficiency of the turbine is 55% and the electric power output P is 3.50×10^5 W.

Calculate the wind speed.

wind speed = ... $m\,s^{-1}$ [3]

(iii) Suggest two reasons why the electrical power output of the turbine is less than the power available from the wind.

1. .....

.....

2. .....

.....

[2]

6 **(a)** **(i)** State the principle of conservation of momentum.

.....

.....

.....[2]

(ii) State the difference between an elastic and an inelastic collision.

.....[1]

(b) An object A of mass 4.2 kg and horizontal velocity 3.6 m s^{-1} moves towards object B as shown in Fig. 3.1.

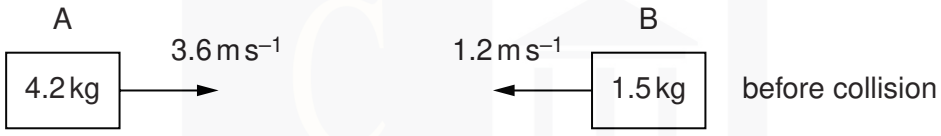

Fig. 3.1

Object B of mass 1.5 kg is moving with a horizontal velocity of 1.2 m s^{-1} towards object A.

The objects collide and then both move to the right, as shown in Fig. 3.2.

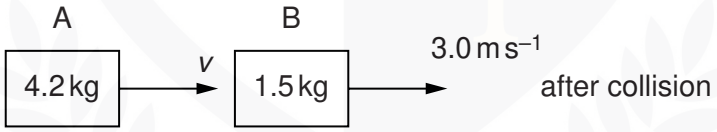

Fig. 3.2

Object A has velocity *v* and object B has velocity 3.0 m s^{-1}.

(i) Calculate the velocity *v* of object A after the collision.

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

(ii) Determine whether the collision is elastic or inelastic.