

Physical Quantities & Units

Question paper 3

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Physical Quantities & Units
Sub Topic	
Paper Type	Theory
Booklet	Question paper 3

Time Allowed: 84 minutes

Score: /70

Percentage: /100

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

1 (a) The current in a wire is I . Charge Q passes one point in the wire in time t . State

(i) the relation between I , Q and t ,

..... [1]

(ii) which of the quantities I , Q and t are base quantities.

.....
..... [2]

(b) The current in the wire is due to electrons, each with charge q , that move with speed v along the wire. There are n of these electrons per unit volume. For a wire having a cross-sectional area S , the current I is given by the equation

$$I = nSqv^k,$$

where k is a constant.

(i) State the units of I , n , S , q and v in terms of the base units.

I

n

S

q

v

[3]

(ii) By considering the homogeneity of the equation, determine the value of k .

$k =$ [2]

2 Make reasonable estimates of the following quantities.

(a) the frequency of an audible sound wave

frequency = Hz [1]

(b) the wavelength, in nm, of ultraviolet radiation

wavelength = nm [1]

(c) the mass of a plastic 30 cm ruler

mass = g [1]

(d) the density of air at atmospheric pressure

density = kg m^{-3} [1]

3 (a) Derive the SI base unit of force.

SI base unit of force = [1]

(b) A spherical ball of radius r experiences a resistive force F due to the air as it moves through the air at speed v . The resistive force F is given by the expression

$$F = crv,$$

where c is a constant.

Derive the SI base unit of the constant c .

SI base unit of c = [1]

- (c) The ball is dropped from rest through a height of 4.5 m.
- (i) Assuming air resistance to be negligible, calculate the final speed of the ball.

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

- (ii) The ball has mass 15 g and radius 1.2 cm.

The numerical value of the constant c in the equation in (b) is equal to 3.2×10^{-4} when measured using the SI system of units.

Show quantitatively whether the assumption made in (i) is justified.

[3]

4 Make estimates of the following quantities.

(a) the speed of sound in air

speed = [1]

(b) the density of air at room temperature and pressure

density = [1]

(c) the mass of a protractor

mass = [1]

(d) the volume, in cm^3 , of the head of an adult person

volume = cm^3 [1]

5 (a) State the difference between a scalar quantity and a vector quantity.

scalar:

.....

vector:

..... [2]

(b) Two forces of magnitude 6.0 N and 8.0 N act at a point P. Both forces act away from point P and the angle between them is 40°. Fig. 1.1 shows two lines at an angle of 40° to one another.

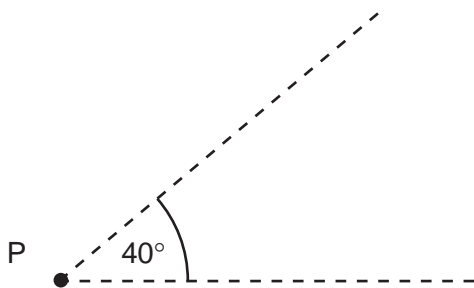


Fig. 1.1

On Fig. 1.1, draw a vector diagram to determine the magnitude of the resultant of the two forces.

magnitude of resultant = N [4]

6 Complete Fig. 1.1 to show each quantity and its unit.

[4]

<i>quantity</i>	<i>unit</i>
speed	ms ⁻¹
density
.....	s ⁻¹
electric field strength
.....	kgms ⁻¹

Fig.1.1

7 (a) (i) Define *density*.

.....
.....

(ii) State the base units in which density is measured.

.....

[2]

(b) The speed v of sound in a gas is given by the expression

$$v = \sqrt{\left(\frac{\gamma p}{\rho}\right)},$$

where p is the pressure of the gas of density ρ . γ is a constant.

Given that p has the base units of $\text{kg m}^{-1} \text{s}^{-2}$, show that the constant γ has no unit.

[3]

- 8 (a) Define *speed* and *velocity* and use these definitions to explain why one of these quantities is a scalar and the other is a vector.

speed:

velocity:

.....

.....

[2]

- (b) A ball is released from rest and falls vertically. The ball hits the ground and rebounds vertically, as shown in Fig. 2.1.

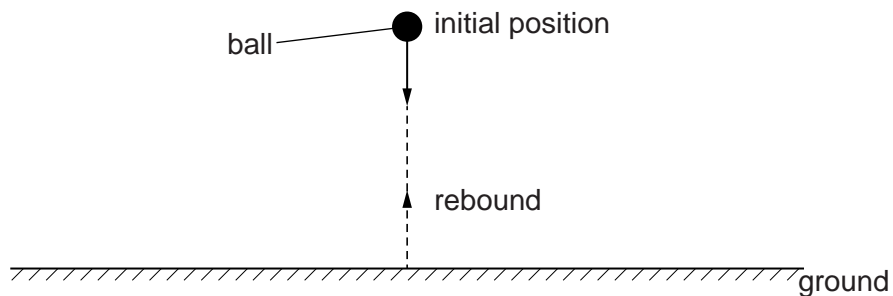


Fig. 2.1

The variation with time t of the velocity v of the ball is shown in Fig. 2.2.

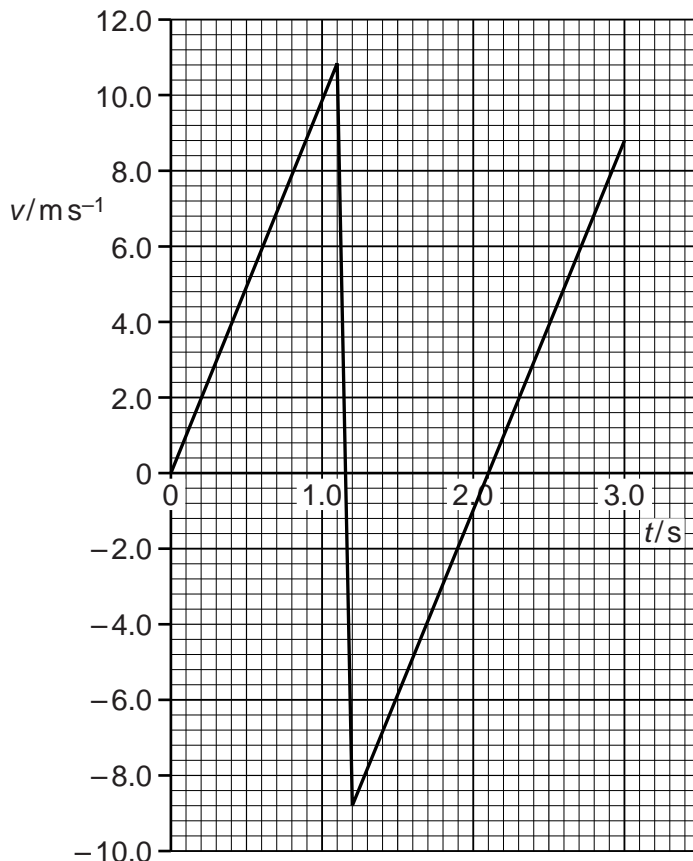


Fig. 2.2

Air resistance is negligible.

- (i) Without calculation, use Fig. 2.2 to describe the variation with time t of the velocity of the ball from $t = 0$ to $t = 2.1$ s.

.....

 [3]

- (ii) Calculate the acceleration of the ball after it rebounds from the ground. Show your working.

acceleration = ms⁻² [3]

(iii) Calculate, for the ball, from $t = 0$ to $t = 2.1$ s,

1. the distance moved,

distance = m [3]

2. the displacement from the initial position.

displacement = m [2]

(iv) On Fig. 2.3, sketch the variation with t of the speed of the ball.

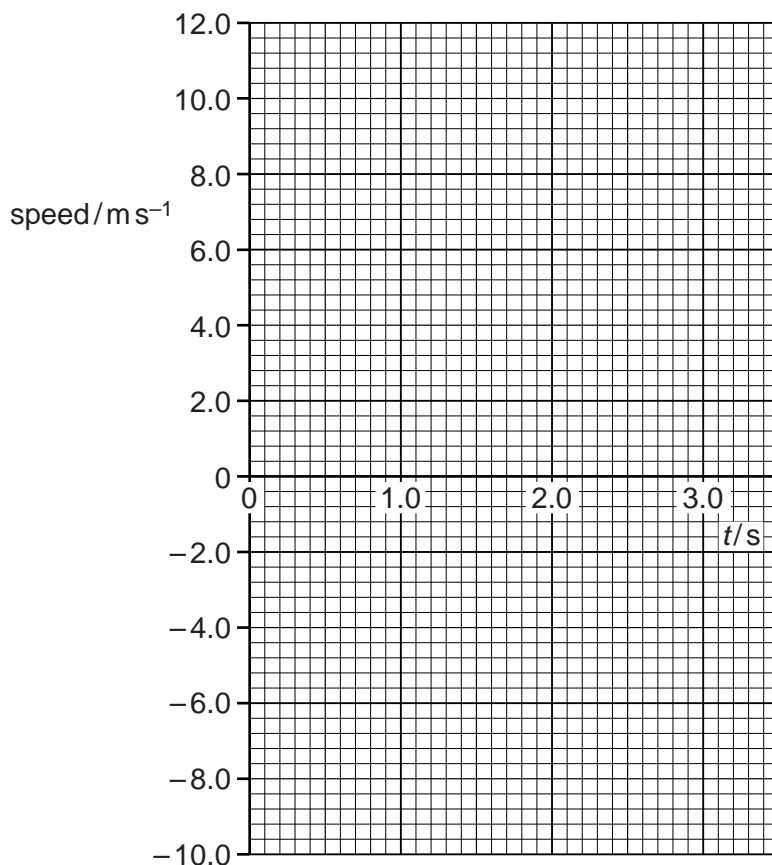


Fig. 2.3

9 Energy is stored in a metal wire that is extended elastically.

(a) Explain what is meant by *extended elastically*.

.....
..... [2]

(b) Show that the SI units of energy per unit volume are $\text{kg m}^{-1} \text{s}^{-2}$.

[2]

(c) For a wire extended elastically, the elastic energy per unit volume X is given by

$$X = C\varepsilon^2 E$$

where C is a constant,

ε is the strain of the wire,

and E is the Young modulus of the wire.

Show that C has no units.

[3]

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

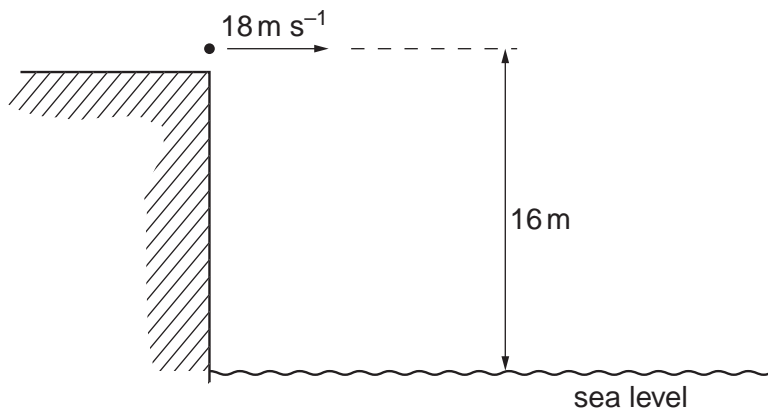


Fig. 4.1

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]

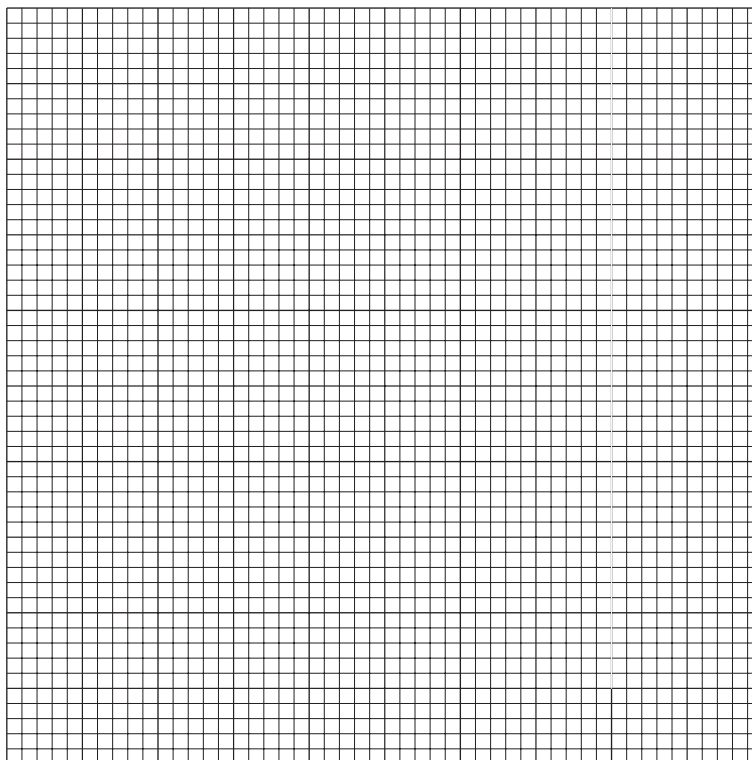


Fig. 4.2

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

angle = $^{\circ}$ [2]