

**PHYSICS  
PAPER II**

**Question 1**

- a. Three wires  $X, Y$  and  $Z$  are made from the same material but have different dimensions. Table 1.1 shows the length and diameter of each wire.

Each wire is subjected to the same tensile force  $F$ .

| Wire | Length | Diameter |
|------|--------|----------|
| $X$  | $L$    | $d$      |
| $Y$  | $2L$   | $d$      |
| $Z$  | $L$    | $2d$     |

**Table 1.1**

- i. Rank the wires according to their extension from greatest to least.

**[1]**

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- ii. Explain your ranking.

**[2]**

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- iii. State and explain which wire stores the most elastic potential energy when it is subjected to the same force  $F$ .

**[2]**

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- b. In a safety test a car is driven into a solid barrier.

Fig 1.2 shows how the force acting on the car varies with time during the test.

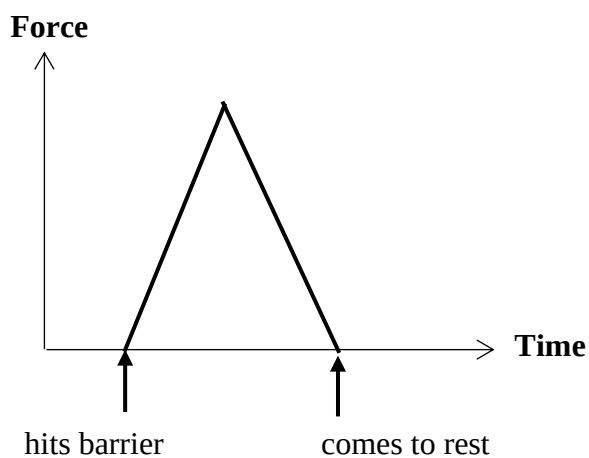


**Fig 1.2**

- i. State the physical quantity represented by the area under the graph.

**[1]**

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- ii. The car has mass 1200 kg and is travelling at 20 m/s when it hits the barrier. The front of the car has a 'crumple zone' that is designed to collapse in the collision. The car comes to rest in a time of 0.15 s.

1. Calculate the force exerted on the car during the

**[2]**

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2. Explain how a crumple zone reduces injuries to passengers if a car has a collision.

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### Question 2

- a. Five rods of different lengths are mounted vertically on the same base. When the base is made to oscillate horizontally at frequency  $f$ , rod number 3 oscillates with a large amplitude while other rods oscillate with small amplitudes, as shown in Fig 2.1.

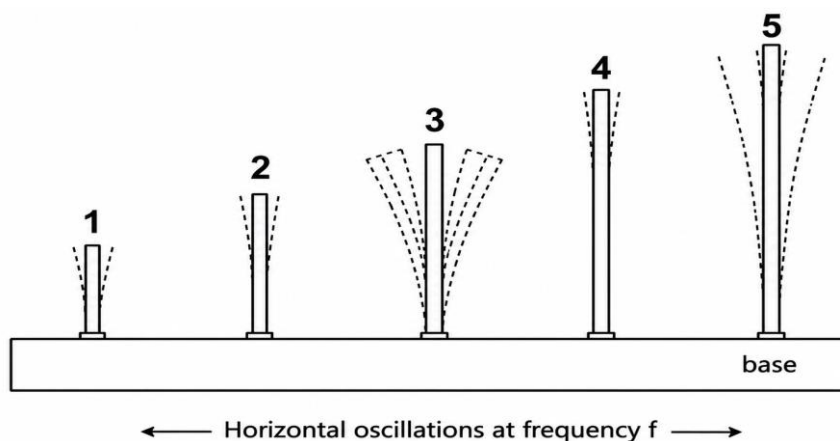


Fig 2.1

- i. Explain this observation.

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- ii. During an earthquake, the graph in Fig. 2.2 shows how displacement of the ground varies with time close to three buildings, A, B and C. Table 2.1 shows the natural frequencies of the three buildings.

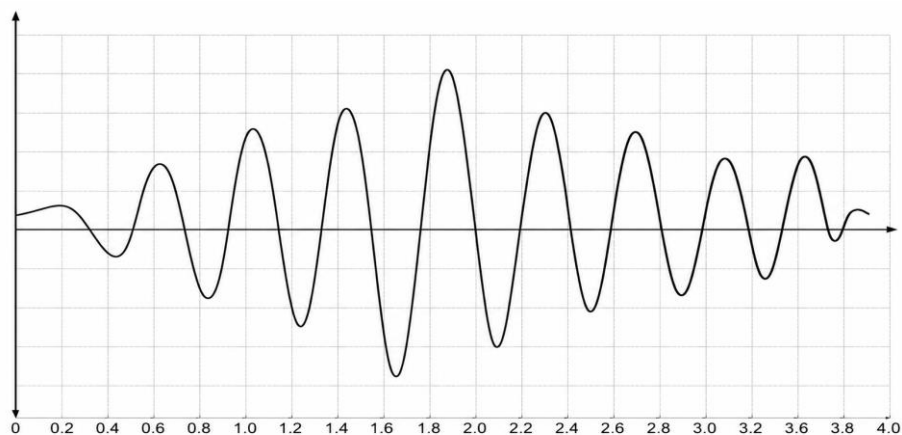


**Fig 2.2**

Table 2.1 shows the natural frequencies of three different buildings.

| Building | Natural frequency |
|----------|-------------------|
| A        | 0.50 Hz           |
| B        | 2.0 Hz            |
| C        | 8.0 Hz            |

**Table 2.1**

1. Explain how each building will respond to the earthquake.

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2. Suggest how excessive vibrations in a building can be reduced.

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- b. A student investigates how the electric field strength  $E$  around a small charged sphere varies with distance  $d$ .

Fig 2.3 shows the variation of  $E$  with  $\frac{1}{d^2}$ .

Where  $d$  is the distance from the sphere.

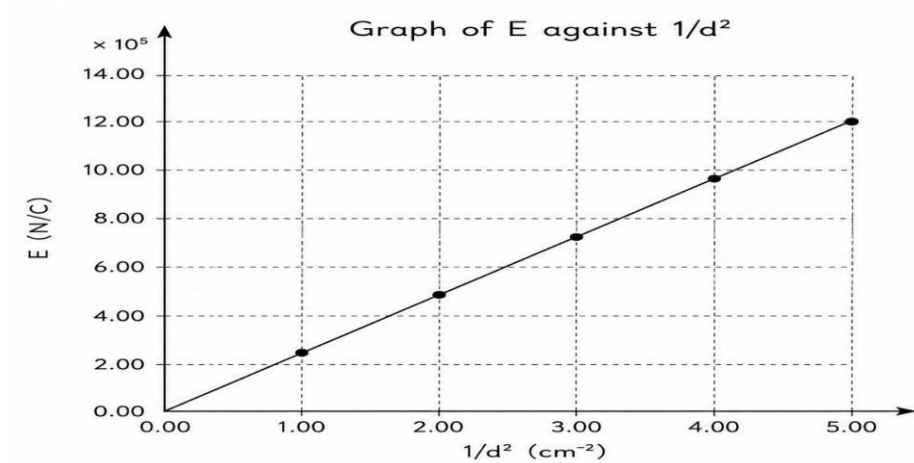


Fig. 2.3

- i. Define electric field strength.

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- ii. By referring to the graph describe the relationship between electric field strength and the distance from the point charge.

[1]

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- iii. Use information from the graph to calculate the magnitude of the electric charge on the sphere.

[2]

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### Question 3

- a. A student investigates how the resistivity of three different materials, A, B and C, change with temperature. The results are shown in Fig. 3.1.

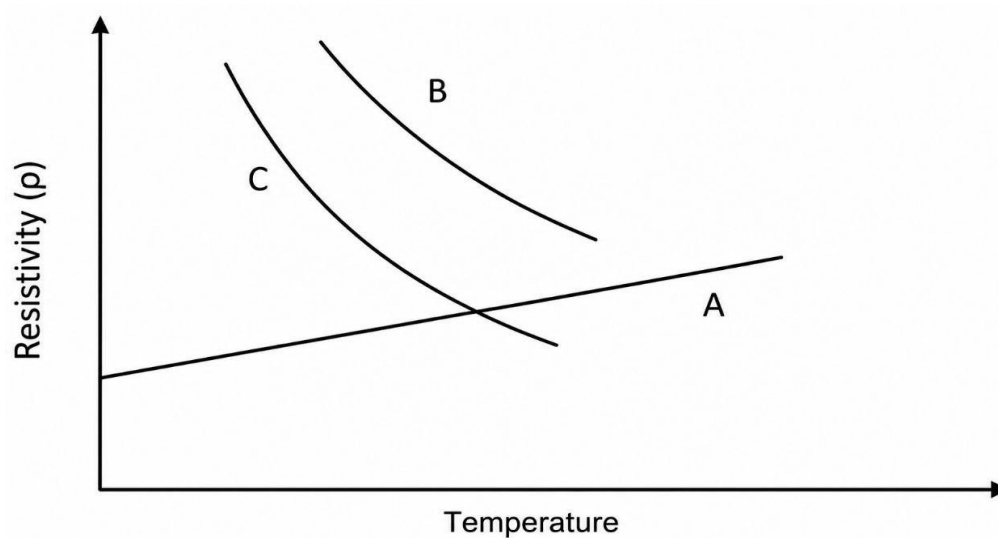


**Fig 3.1**

- i. Identify the material types represented by A, B and C.

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- ii. Explain why the resistivity of A increases with temperature while the resistivity of material C decreases with temperature.

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- b. A student constructs a circuit containing a 12 V power supply, four resistors, and a voltmeter as shown in Fig. 3.2. The resistance values are shown on the diagram. The voltmeter reading is 3.0 V.

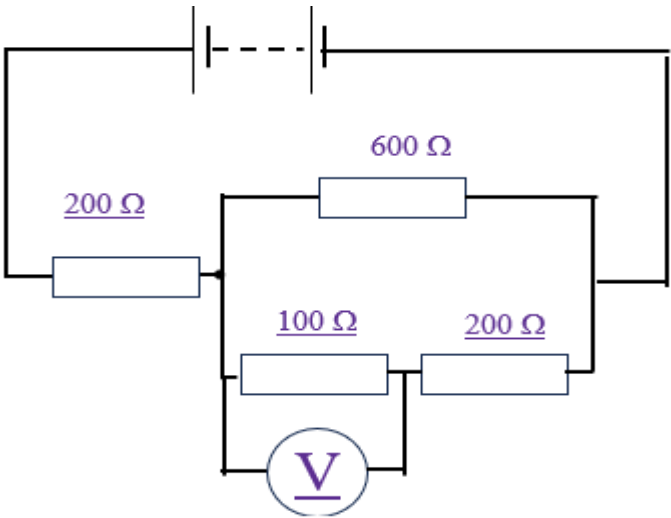


Fig 3.2

- i. Use Kirchhoff's circuit laws to determine the current in the  $600\ \Omega$  resistor and the voltage of the supply. Show your working.

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- ii. State Kirchhoff's circuit laws

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#### Question 4

- a. The graph in Fig. 4.1 below shows the sinusoidal variation of voltage and current with time.

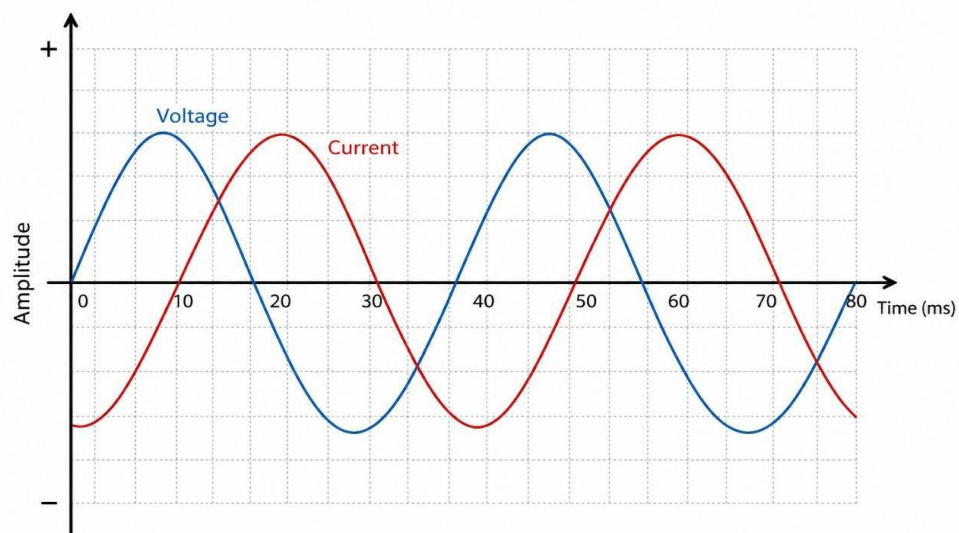


Fig 4.1

- i. Define reactance.

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- ii. The inductor has an inductance  $L$  of 0.50 H and is connected to a 240 V, 50 Hz supply. Calculate the inductive reactance  $X_L = \omega L$  of the circuit.

[1]

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- iii. A capacitor is connected in series with the inductor to form a resonant circuit.  
Show that the capacitance of the capacitor required for the circuit to resonate at a frequency of 50 Hz is 20  $\mu\text{F}$ .

[3]

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- b. A student investigates photoelectric mission from a metal surface. Light of frequency  $8.0 \times 10^{14}$  Hz is directed onto the surface.

The work function  $\phi$  of the metal is 2.0 eV.

- i. Explain what is meant by the work function of a metal.

[1]

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- ii. Calculate the maximum kinetic energy of electrons emitted from the surface.

Give your answer in electron volts (eV).

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- iii. The student repeats the experiment using light of frequency  $4.0 \times 10^{14}$  Hz with much higher intensity.

State and explain whether or not photoelectrons will be emitted.

[2]

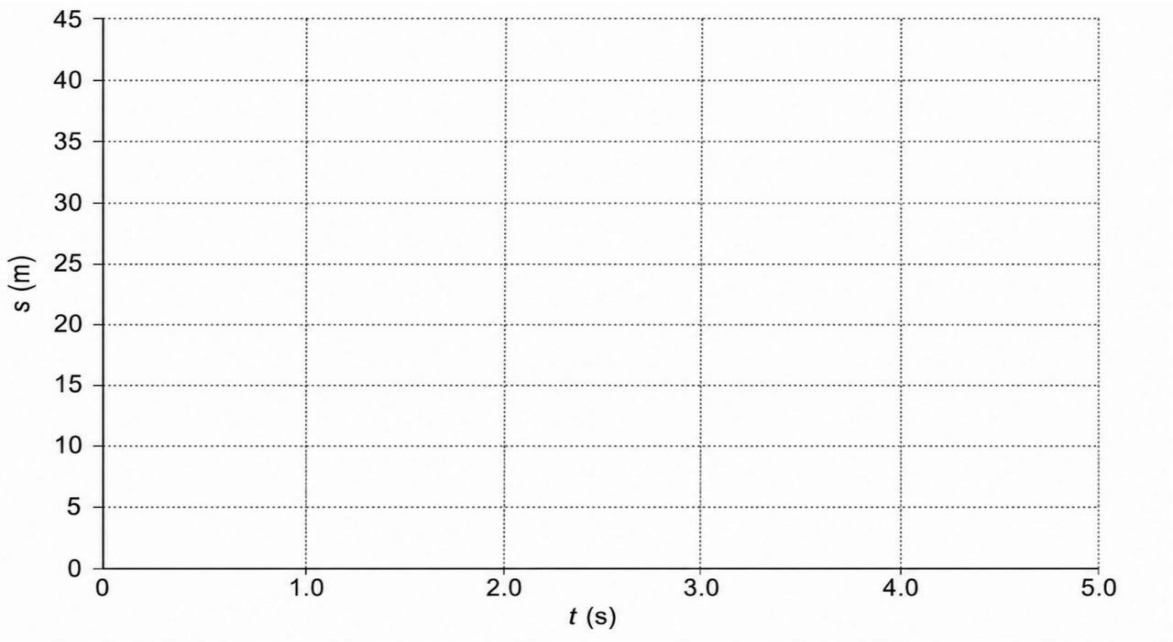
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**Question 5**

- a. Table 5.1 shows the displacement  $s$  of a trolley at successive times  $t$  as it moves along a straight, horizontal track.

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|---------|---|-----|-----|------|------|------|
| t ( s ) | 0 | 1.0 | 2.0 | 3.0  | 4.0  | 5.0  |
| s (m)   | 0 | 2.0 | 7.0 | 15.0 | 26.0 | 40.0 |

**Table 5.1**



- i. Plot a graph of  $s$  against  $t$  using the data in Table 5.1 in fig 5.1. Draw a smooth curve of best fit.

[2]

**Fig 5.1**

- ii. Use the graph in a(i) to determine the instantaneous velocity of the trolley at a time  $t$  of 2.5 s. Show your working by drawing on the diagram

[3]

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- b. A force of 50 N acts on a body at an angle of  $30^\circ$  above the horizontal as shown in Fig. 5.2

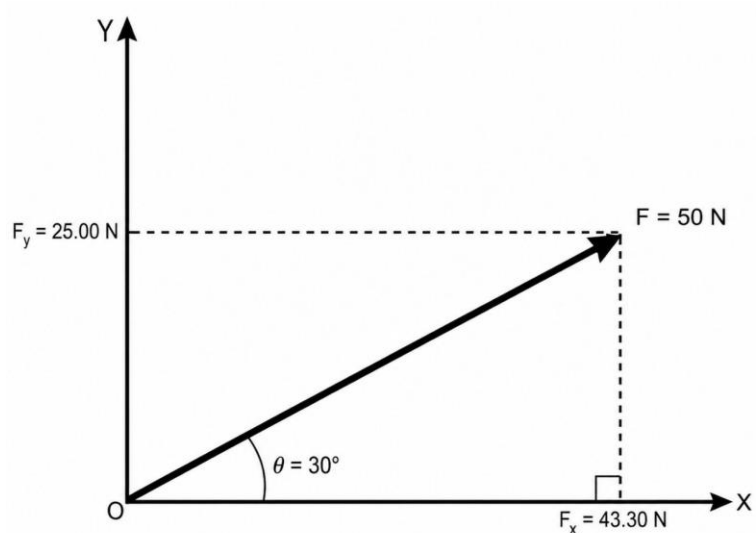


Fig 5.2

- i. Explain what is meant by resolution of vectors. [1]

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- ii. Calculate the horizontal component  $F_x$  and the vertical component  $F_y$  of this force. [2]

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- iii. Show that the sum of the two component vectors has a magnitude of 50 N [2]

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### Question 6

- a. A radioactive source has an initial activity of 800 Bq. After 24 hours, the activity has fallen to 150 Bq.

- i. State what is meant by the half-life of a radioactive isotope. [1]

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- ii. Show that the half-life of the source is about 10 hours.

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- iii. A sample of nuclear waste contains a radioactive isotope with a long half-life. The isotope has a half-life of 1.0 years. A radiation detector placed close to the container records a count rate of 3200 cpm in a place where the background count is 30 cpm. A waste-management engineer claims that the sample will become completely safe in 10 years.

Discuss whether this claim is reasonable. Support your argument with a calculation

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- b. A body of mass 0.20 kg oscillates with SHM of amplitude  $x_0 = 0.050$  m and frequency  $f = 2.2$  Hz.

- i. Show that the total energy of the oscillator is about 10 mJ.

[2]

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- ii. The oscillator is damped and the amplitude falls to  $\frac{x_0}{3}$ .

Calculate the energy transferred to the surroundings

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### Question 7

- a. An alternating current (a.c.) supply is connected across a resistor of resistance  $110\ \Omega$ , as shown in Fig. 7.1. The frequency of the supply voltage is 50 Hz and the peak value of the supply voltage is 340 V.

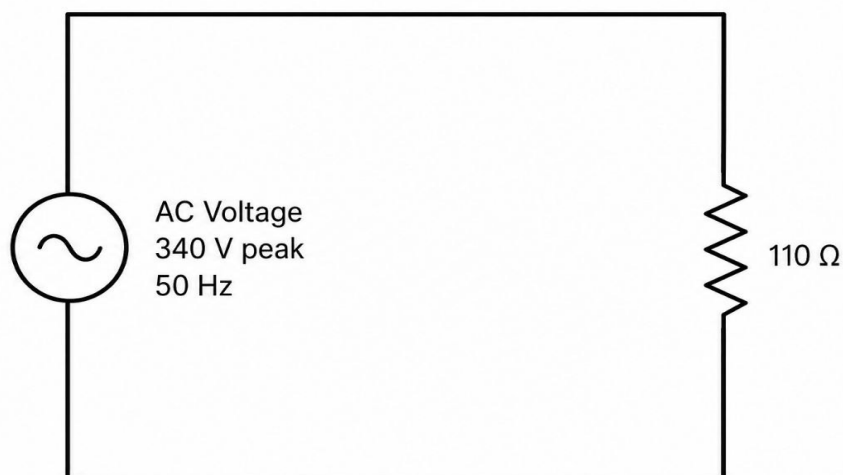


**Fig 7.1**

- i. Calculate the root-mean-square (r.m.s.) voltage  $V_{\text{rms}}$  of the supply.

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- ii. Calculate the r.m.s. current in the resistor

**[1]**

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- iii. Fig. 7.2 shows the variation of the potential difference  $V$  across the capacitor and the corresponding alternating current with  $t$ .

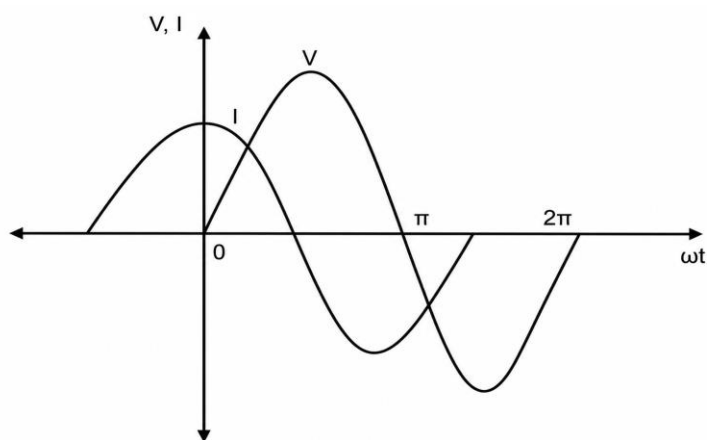


**Fig 7.2**

State the phase relationship, between the current  $I$  and the potential difference  $V$ .

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- iv. Using the relationship between charge  $Q$  and potential difference  $V$  for a capacitor, explain why the current  $I$  is zero when the potential difference  $V$  is at its maximum value.

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- b. The Hubble constant  $H_0$  is estimated to be  $70 \text{ kms}^{-1}\text{Mpc}^{-1}$ . The recession speed  $v$  of the distant galaxy is determined to be  $4200 \text{ km s}^{-1}$   $4200 \text{ kms}^{-1}$ .

i. State Hubble's law

[1]

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ii. Calculate the distance to the galaxy, in metres. ( $1 \text{ Mpc} = 3.086 \times 10^{22} \text{ m}$ )

[2]

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iii. Use the Hubble constant to estimate the age of the universe in years

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