1 **(a)** **(i)** Distinguish between vector quantities and scalar quantities.

....

....

.... [2]

(ii) State whether each of the following is a vector quantity or a scalar quantity.

1. temperature

.... [1]

2. acceleration of free fall

.... [1]

3. electrical resistance

.... [1]

(b) A block of wood of weight 25 N is held stationary on a slope by means of a string, as shown in Fig. 1.1.

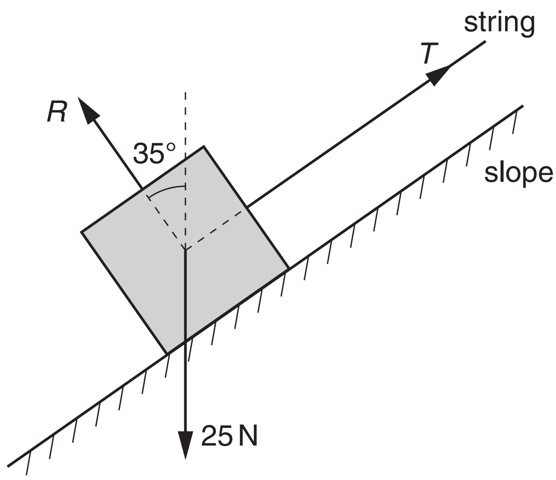

Fig. 1.1

The tension in the string is T and the slope pushes on the block with a force R that is normal to the slope.

Either by scale drawing on Fig. 1.1 or by calculation, determine the tension T in the string.

T = ... N [3]

2 A ball is thrown from a point P, which is at ground level, as illustrated in Fig. 2.1.

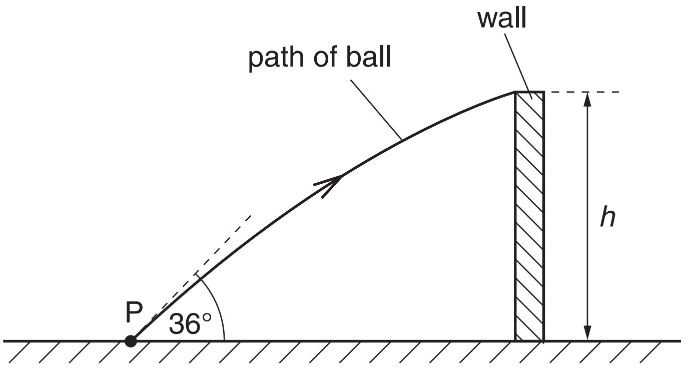

Fig. 2.1

The initial velocity of the ball is $12.4\,\mathrm{m\,s^{-1}}$ at an angle of 36° to the horizontal.
The ball just passes over a wall of height h. The ball reaches the wall 0.17 s after it has been thrown.

(a) Assuming air resistance to be negligible, calculate

(i) the horizontal distance of point P from the wall,

distance = ... m [2]

(ii) the height h of the wall.

h = ... m [3]

(b) A second ball is thrown from point P with the same velocity as the ball in **(a)**. this ball, air resistance is not negligible.
This ball hits the wall and rebounds.

On Fig. 2.1, sketch the path of this ball between point P and the point where it first hits the ground. [2]

3 **(a)** State what is meant by the *centre of gravity* of a body.

....

....

.... [2]

(b) A uniform rectangular sheet of card of weight W is suspended from a wooden rod. The card is held to one side, as shown in Fig. 3.1.

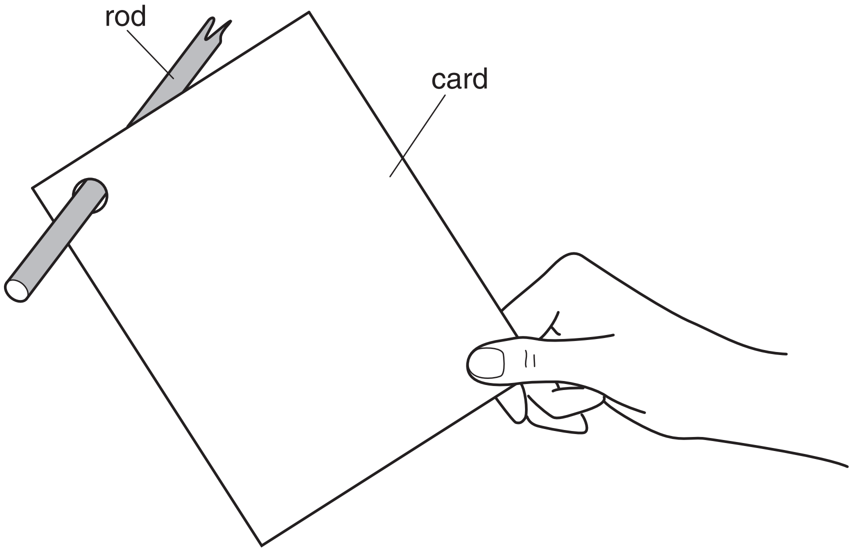

Fig. 3.1

On Fig. 3.1,

(i) mark, and label with the letter C, the position of the centre of gravity of the card, [1]

(ii) mark with an arrow labelled W the weight of the card. [1]

(c) The card in **(b)** is released. The card swings on the rod and eventually comes to rest.

(i) List the two forces, other than its weight and air resistance, that act on the card during the time that it is swinging. State where the forces act.

1. ....

....

2. ....

....
[3]

(ii) By reference to the completed diagram of Fig. 3.1, state the position in which the card comes to rest.
Explain why the card comes to rest in this position.

....

....

....[2]

4 **(a)** A metal wire has spring constant k. ces are applied to the ends of the wire to extend it within the limit of Hooke's law.
Show that, for an extension x, the strain energy E stored in the wire is given by

$$E = \tfrac{1}{2}kx^2.$$

[4]

(b) The wire in **(a)** is now extended beyond its elastic limit. The forces causing the extension are then removed.
The variation with extension x of the tension F in the wire is shown in Fig. 4.1.

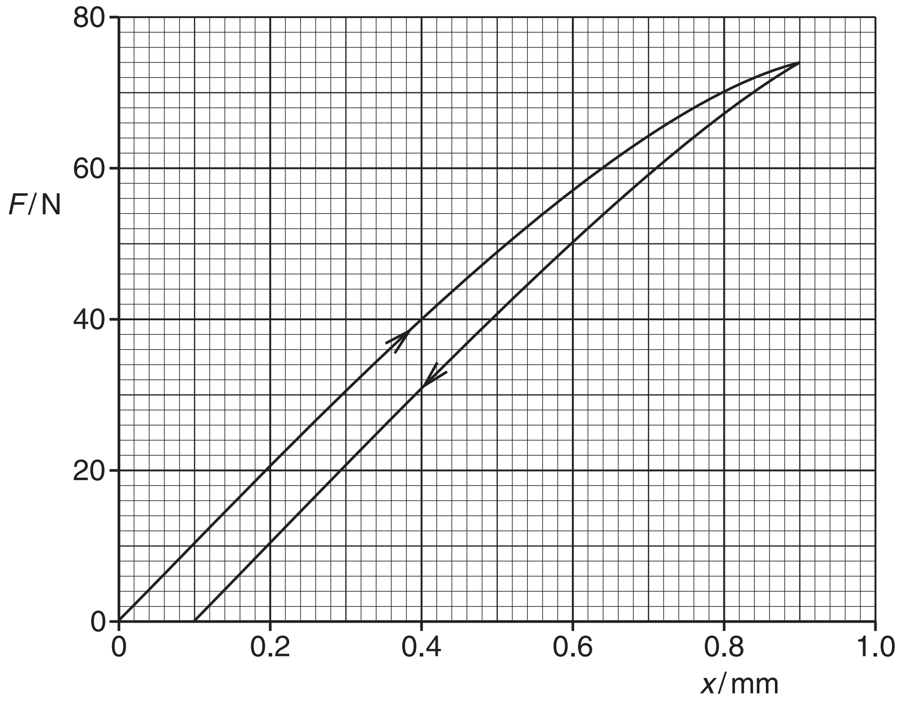

Fig. 4.1

Energy E_S is expended to cause a permanent extension of the wire.

(i) On Fig. 4.1, shade the area that represents the energy E_S. [1]

(ii) Fig. 4.1 to calculate the energy E_S.

E_S = ... mJ [3]

(iii) Suggest the change in the structure of the wire that is caused by the energy E_S.

....

....[1]

5 A student is studying a water wave in which all the wavefronts are parallel to one another. The variation with time t of the displacement x of a particular particle in the wave is shown in Fig. 5.1.

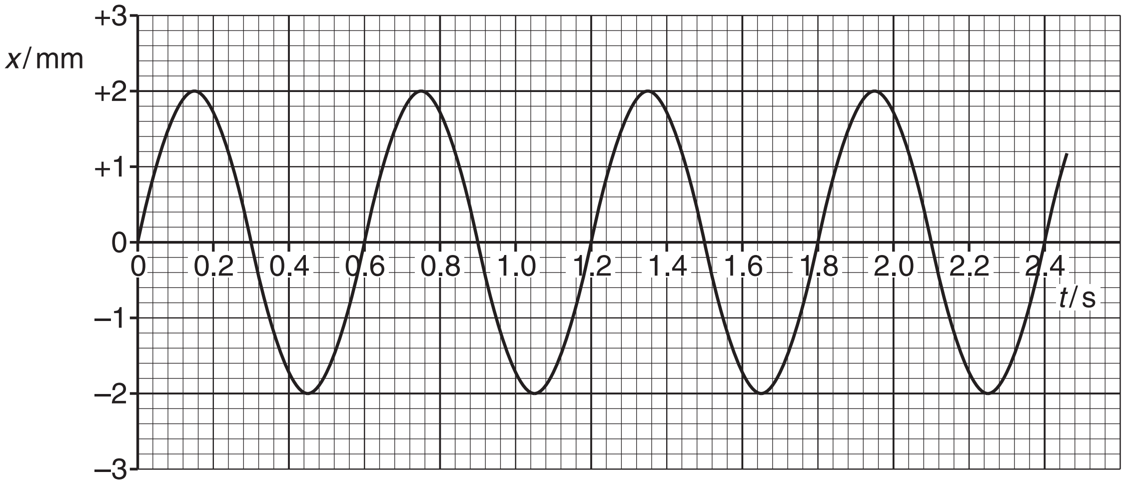

Fig. 5.1

The distance d of the oscillating particles from the source of the waves is measured.
At a particular time, the variation of the displacement x with this distance d is shown in Fig. 5.2.

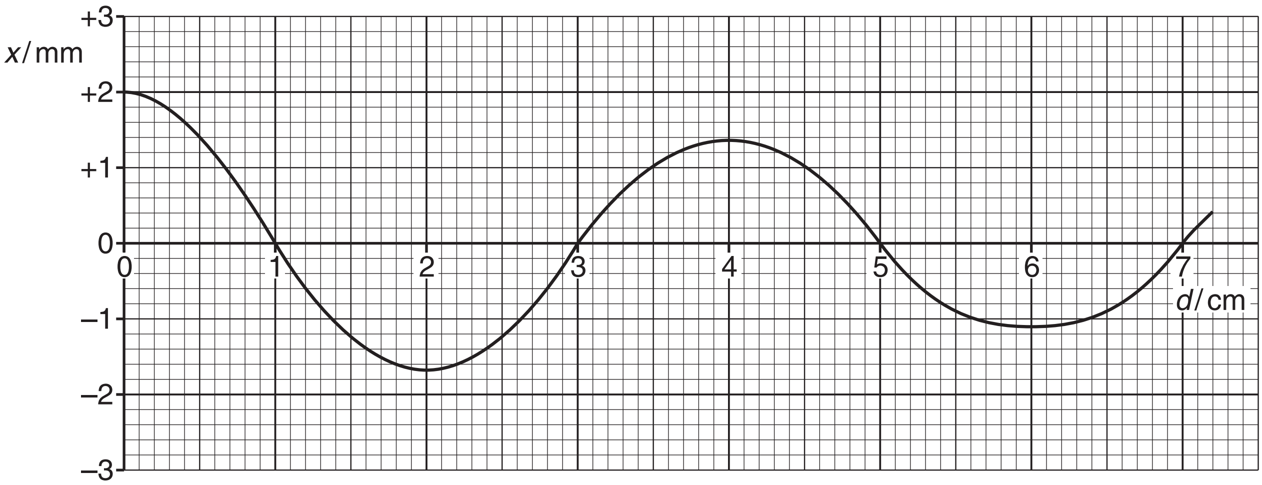

Fig. 5.2

(a) Define, for a wave, what is meant by

(i) *displacement*,

....

....[1]

(ii) *wavelength*.

....

....[1]

(b) Figs. 5.1 and 5.2 to determine, for the water wave,

(i) the period T of vibration,

T = ... s [1]

(ii) the wavelength λ,

λ = ... cm [1]

(iii) the speed v.

v = ... $cm\,s^{-1}$ [2]

(c) (i) Figs. 5.1 and 5.2 to state and explain whether the wave is losing power as it moves away from the source.

....

....

....[2]

(ii) Determine the ratio

$$\frac{\text{intensity of wave at source}}{\text{intensity of wave 6.0 cm from source}}.$$

ratio = ... [3]

6 The variation with temperature of the resistance R_T of a thermistor is shown in Fig. 6.1.

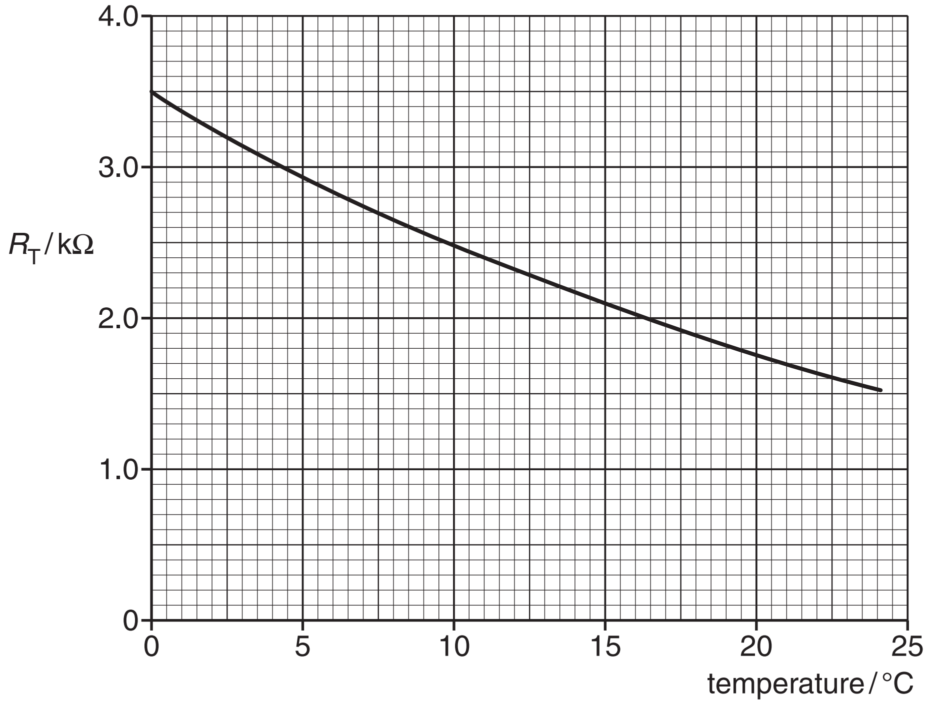

Fig. 6.1

The thermistor is connected into the circuit of Fig. 6.2.

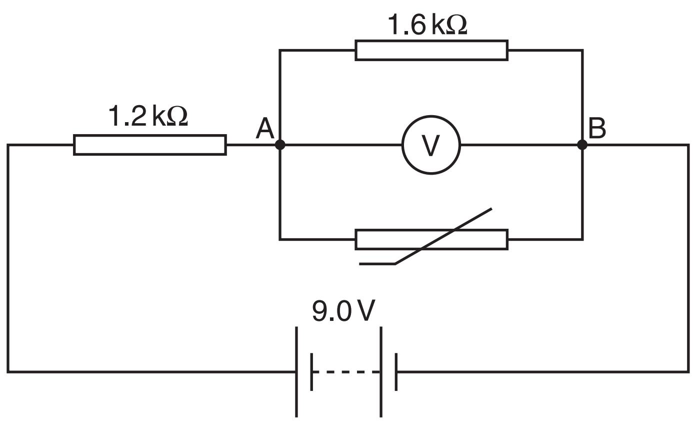

Fig. 6.2

The battery has e.m.f. 9.0 V and negligible internal resistance. The voltmeter has infinite resistance.

(a) the thermistor at 22.5 °C, calculate

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the reading on the voltmeter.

voltmeter reading = ...V [2]

(b) The temperature of the thermistor is changed. The voltmeter now reads 4.0 V.
Determine

(i) the total resistance between points A and B on Fig. 6.2,

resistance = ... Ω [2]

(ii) the temperature of the thermistor.

temperature = ... °C [2]

(c) A student suggests that the voltmeter, reading up to 10 V, could be calibrated to measure temperature.

Suggest two disadvantages of using the circuit of Fig. 6.2 with this voltmeter for the measurement of temperature in the range 0 °C to 25 °C.

1. ....

....

2. ....

....
[2]

7 The results of the α-particle scattering experiment provided evidence for the existence and small size of the nucleus.

(a) State the result that provided evidence for

(i) the small size of the nucleus, compared with the atom,

....

....

....[2]

(ii) the nucleus being charged and containing the majority of the mass of the atom.

....

....

....[2]

(b) The α-particles in this experiment originated from the decay of a radioactive nuclide. Suggest two reasons why β-particles from a radioactive source would be inappropriate for this type of scattering experiment.

1. ....

....

2. ....

....

[2]