1 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 $kg\,m^{-1}\,s^{-2}$.

[2]

(c) 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]

2 **(a)** Distinguish between *mass and weight*.

mass: .....

.....

weight: .....

.....

[2]

(b) An object O of mass 4.9 kg is suspended by a rope A that is fixed at point P. The object is pulled to one side and held in equilibrium by a second rope B, as shown in Fig. 2.1.

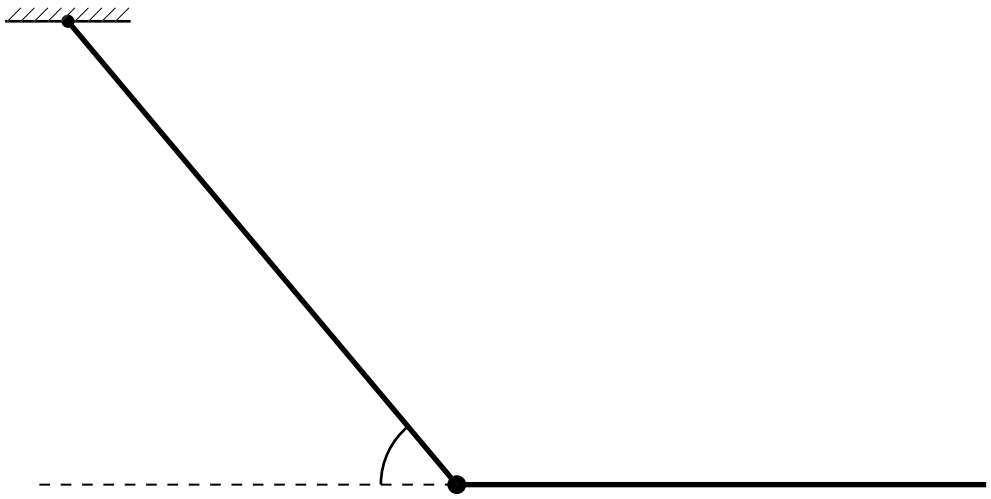

Fig. 2.1

Rope A is at an angle θ to the horizontal and rope B is horizontal. The tension in rope A is 69 N and the tension in rope B is *T*.

(i) On Fig. 2.1, draw arrows to represent the directions of all the forces acting on object O. [2]

(ii) Calculate

1. the angle θ,

θ = ...° [3]

2. the tension T.

T = ... N [2]

3 **(a)** An object falls vertically from rest through air. State and explain the energy conversions that occur as the object falls.

.....

.....

.....

..... [3]

(b) A ball of mass 150 g is thrown vertically upwards with an initial speed of 25 m s^{-1}.

(i) Calculate the initial kinetic energy of the ball.

kinetic energy = ... J [3]

(ii) The ball reaches a height of 21 m above the point of release.

the ball rising to this height, calculate

1. the loss of energy of the ball to air resistance,

energy loss = ... J [3]

2. the average force due to the air resistance.

force = ... N [2]

4 **(a)** Define *pressure*.

.....

..... [1]

(b) the kinetic model to explain the pressure exerted by a gas.

.....

.....

.....

.....

.....

..... [4]

(c) Explain whether the collisions between the molecules of an ideal gas are elastic or inelastic.

.....

.....

..... [2]

5 **(a)** State three conditions required for maxima to be formed in an interference pattern produced by two sources of microwaves.

1. .....

.....

2. .....

.....

3. .....

.....

[3]

(b) A microwave source M emits microwaves of frequency 12 GHz. Show that the wavelength of the microwaves is 0.025 m.

[3]

(c) Two slits S_1 and S_2 are placed in front of the microwave source M described in **(b)**, as shown in Fig 5.1.

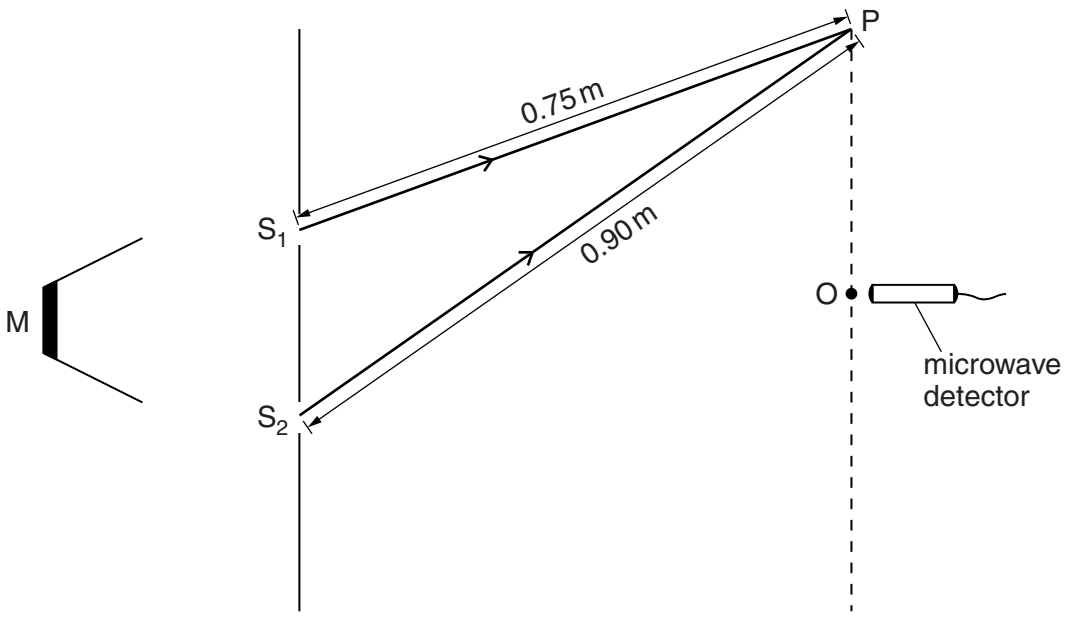

Fig. 5.1 (not to scale)

The distances S_1O and S_2O are equal. A microwave detector is moved from O to P. The distance S_1P is 0.75 m and the distance S_2P is 0.90 m.

The microwave detector gives a maximum reading at O.

State the variation in the readings on the microwave detector as it is moved slowly along the line from O to P.

.....

.....

.....

.....

..... [3]

(d) The microwave source M is replaced by a source of coherent light.

State two changes that must be made to the slits in Fig. 5.1 in order to observe an interference pattern.

1. .....

2. .....

[2]

6 Two resistors A and B have resistances R_1 and R_2 respectively. The resistors are connected in series with a battery, as shown in Fig. 6.1.

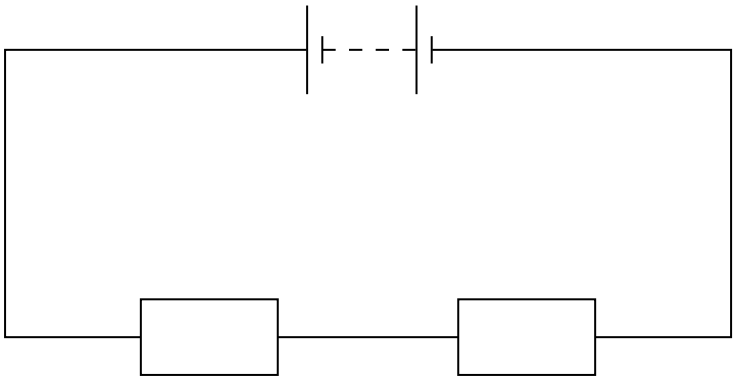

Fig. 6.1

The battery has electromotive force (e.m.f.) E and zero internal resistance.

(a) State the energy transformation that occurs in

(i) the battery,

.....

..... [1]

(ii) the resistors.

.....

..... [1]

(b) The current in the circuit is I.

State the rate of energy transformation in

(i) the battery,

..... [1]

(ii) the resistor A.

..... [1]

(c) The resistors are made from metal wires. Data for the resistors are given in Fig. 6.2.

resistor	A	B
resistivity of metal	ρ	$\rho/2$
length of wire	l	l
diameter of wire	d	$2d$

Fig. 6.2

information from Fig. 6.2 to determine the ratio

$$\frac{\text{power dissipated in A}}{\text{power dissipated in B}}.$$

ratio = ... [3]

(d) The resistors A and B are connected in parallel across the same battery of e.m.f. *E*. Determine the ratio

$$\frac{\text{power dissipated in A}}{\text{power dissipated in B}}.$$

ratio = ... [2]

7 **(a)** Describe the two main results of the α-particle scattering experiment.

result 1: .....

.....

result 2: .....

.....

[3]

(b) Relate each of the results in **(a)** with the conclusions that were made about the nature of atoms.

result 1: .....

.....

result 2: .....

.....

[3]