1 The variation with time t of the displacement s for a car is shown in Fig. 1.1.

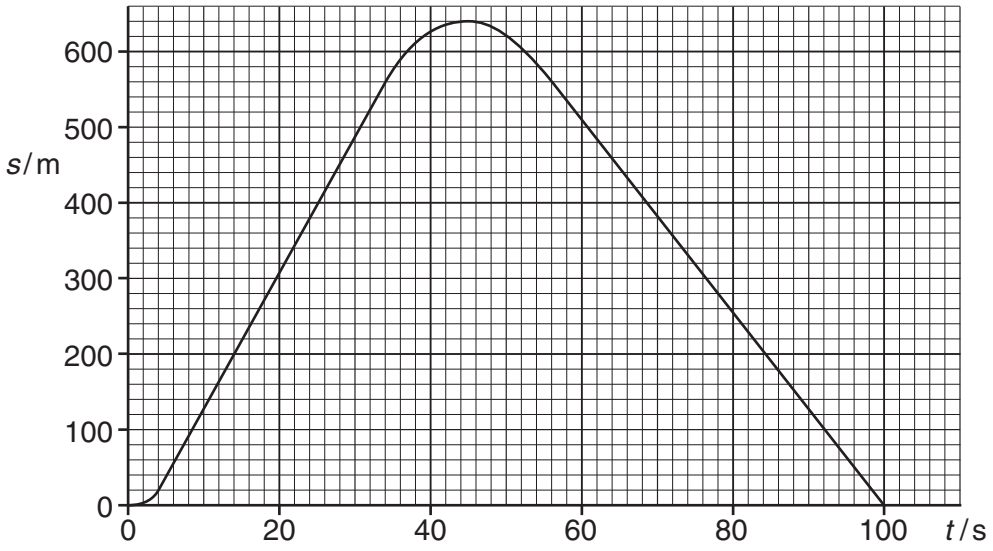

Fig. 1.1

(a) Determine the magnitude of the average velocity between the times 5.0 s and 35.0 s.

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

(b) On Fig. 1.2, sketch the variation with time t of the velocity v for the car.

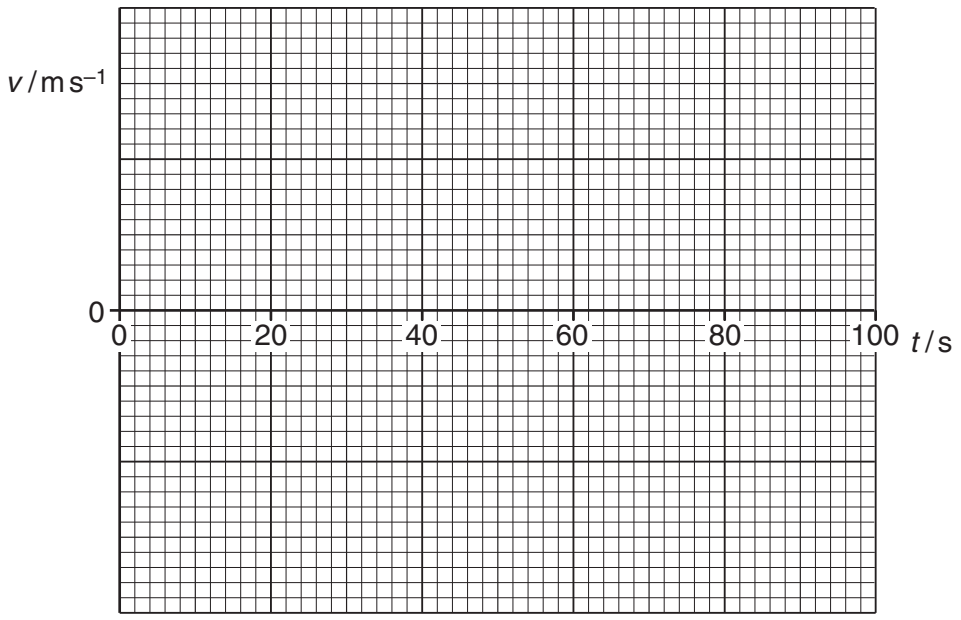

Fig. 1.2

[4]

2 **(a)** Define

(i) *force*,

.....

.....[1]

(ii) *work done*.

.....

.....[1]

(b) A force F acts on a mass m along a straight line for a distance s. The acceleration of the mass is a and the speed changes from an initial speed u to a final speed v.

(i) State the work W done by F.

[1]

(ii) your answer in **(i)** and an equation of motion to show that kinetic energy of a mass can be given by the expression

$$\text{kinetic energy} = \tfrac{1}{2} \times \text{mass} \times (\text{speed})^2.$$

[3]

(c) A resultant force of 3800 N causes a car of mass of 1500 kg to accelerate from an initial speed of $15\,\text{m}\,\text{s}^{-1}$ to a final speed of $30\,\text{m}\,\text{s}^{-1}$.

(i) Calculate the distance moved by the car during this acceleration.

distance = ... m [2]

(ii) The same force is used to change the speed of the car from $30\,\text{m}\,\text{s}^{-1}$ to $45\,\text{m}\,\text{s}^{-1}$. Explain why the distance moved is not the same as that calculated in **(i)**.

.....

.....

.....[1]

3 **(a)** Define

(i) *stress*,

.....

.....[1]

(ii) *strain*.

.....

.....[1]

(b) Explain the term *elastic limit*.

.....

.....[1]

(c) Explain the term *ultimate tensile stress*.

.....

.....

.....[2]

(d) **(i)** A **ductile** material in the form of a wire is stretched up to its breaking point. On Fig. 3.1, sketch the variation with extension x of the stretching force F.

Fig. 3.1

[2]

(ii) On Fig. 3.2, sketch the variation with x of F for a **brittle** material up to its breaking point.

Fig. 3.2

[1]

(e) (i) Explain the features of the graphs in **(d)** that show the characteristics of ductile and brittle materials.

.....

.....

.....

.....

.....[2]

(ii) The force F is removed from the materials in **(d)** just before the breaking point is reached. Describe the subsequent change in the extension for

1. the ductile material,

.....

.....[1]

2. the brittle material.

.....

.....[1]

4 **(a)** Define *electric field strength*.

.....

.....[1]

(b) Two horizontal metal plates are 20 mm apart in a vacuum. A potential difference of 1.5 kV is applied across the plates, as shown in Fig. 4.1.

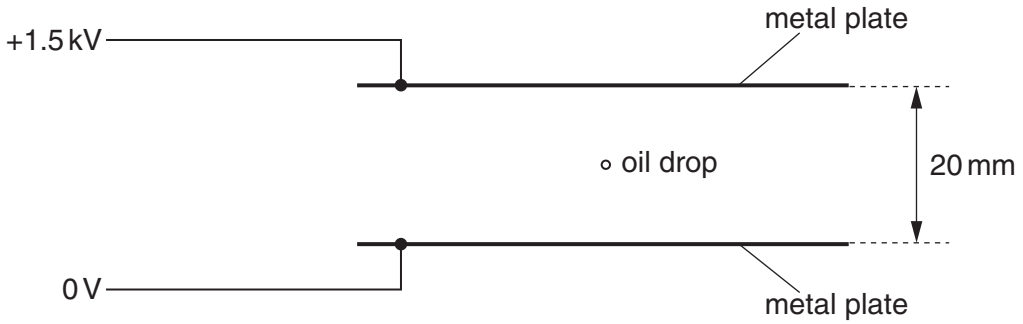

Fig. 4.1

A charged oil drop of mass 5.0×10^{-15} kg is held stationary by the electric field.

(i) On Fig. 4.1, draw lines to represent the electric field between the plates. [2]

(ii) Calculate the electric field strength between the plates.

electric field strength = ... $V\,m^{-1}$ [1]

(iii) Calculate the charge on the drop.

charge = ... C [4]

(iv) The potential of the upper plate is increased. Describe and explain the subsequent motion of the drop.

.....

.....

.....[2]

5 A potentiometer circuit that is used as a means of comparing potential differences is shown in Fig. 5.1.

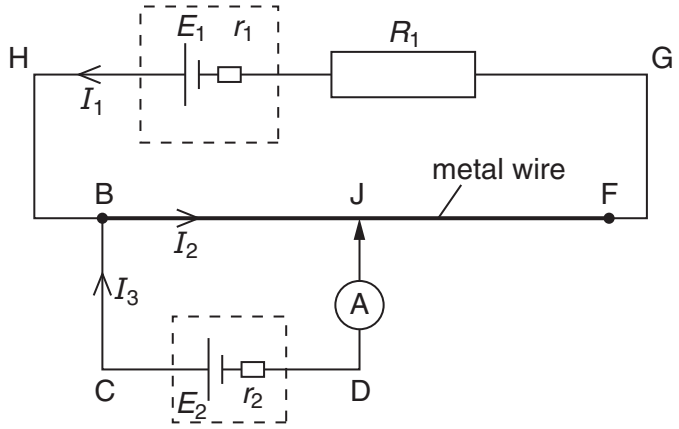

Fig. 5.1

A cell of e.m.f. E_1 and internal resistance r_1 is connected in series with a resistor of resistance R_1 and a uniform metal wire of total resistance R_2.
A second cell of e.m.f. E_2 and internal resistance r_2 is connected in series with a sensitive ammeter and is then connected across the wire at BJ. The connection at J is halfway along the wire. The current directions are shown on Fig. 5.1.

(a) Kirchhoff's laws to obtain the relation

(i) between the currents I_1, I_2 and I_3,

.....[1]

(ii) between E_1, R_1, R_2, r_1, I_1 and I_2 in loop HBJFGH,

.....[1]

(iii) between E_1, E_2, r_1, r_2, R_1, R_2, I_1 and I_3 in the loop HBCDJFGH.

.....[2]

(b) The connection at J is moved along the wire. Explain why the reading on the ammeter changes.

.....

.....

.....

.....[2]

6 **(a)** State the *principle of superposition*.

.....

.....

.....[2]

(b) An arrangement that can be used to determine the speed of sound in air is shown in Fig. 6.1.

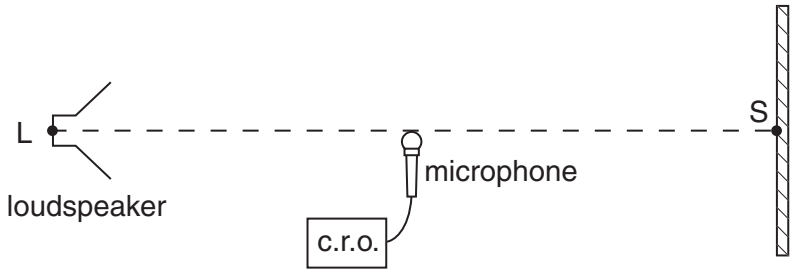

Fig. 6.1

Sound waves of constant frequency are emitted from the loudspeaker L and are reflected from a point S on a hard surface.
The loudspeaker is moved away from S until a stationary wave is produced.

Explain how sound waves from L give rise to a stationary wave between L and S.

.....

.....

.....[2]

(c) A microphone connected to a cathode ray oscilloscope (c.r.o.) is positioned between L and S as shown in Fig. 6.1. The trace obtained on the c.r.o. is shown in Fig. 6.2.

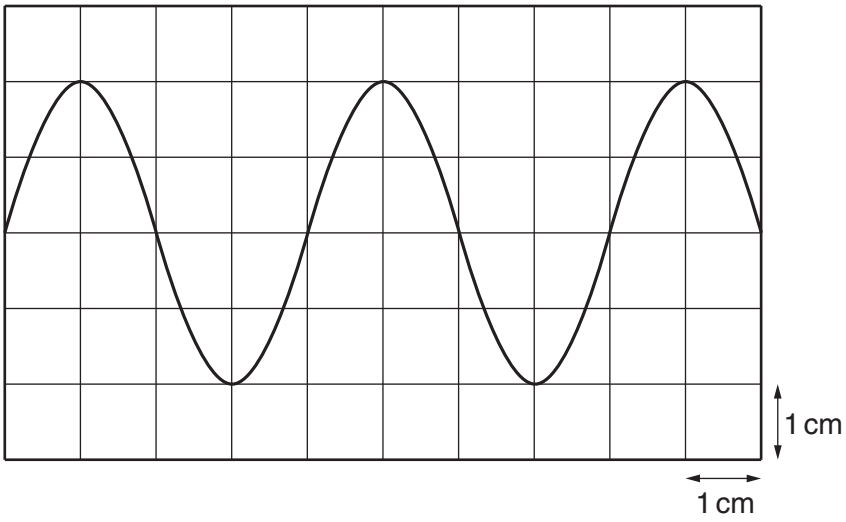

Fig. 6.2

The time-base setting on the c.r.o. is 0.10 ms cm^{-1}.

7 **(a)** State the experimental observations that show radioactive decay is

(i) spontaneous,

.....

.....[1]

(ii) random.

.....

.....[1]

(b) On Fig. 7.1, complete the charge and mass of α-particles, β-particles and γ-radiation. Give example speeds of α-particles and γ-radiation emitted by a laboratory source.

	α-particle	β-particle	γ-radiation
charge			0
mass	4u		
speed		up to 0.99*c*	

Fig. 7.1

[3]

(c) Explain the process by which α-particles lose energy when they pass through air.

.....

.....

.....[2]