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

....

....

.... [2]

(b) In the following list, underline **all** the scalar quantities.

acceleration force kinetic energy mass power weight [1]

(c) A stone is thrown with a horizontal velocity of 20 m s^{-1} from the top of a cliff 15 m high. The path of the stone is shown in Fig. 1.1.

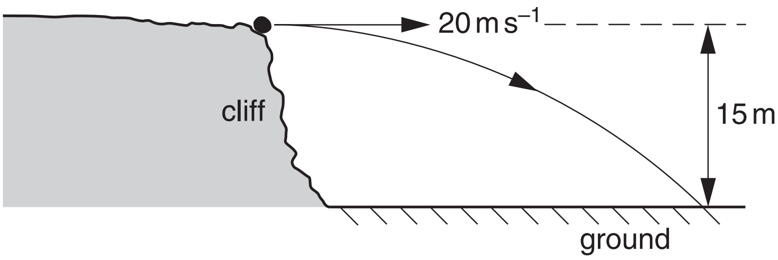

Fig. 1.1

Air resistance is negligible.

this stone,

(i) calculate the time to fall 15 m,

time = ... s [2]

(ii) calculate the magnitude of the resultant velocity after falling 15 m,

resultant velocity = ... m s^{-1} [3]

(iii) describe the difference between the displacement of the stone and the distance that it travels.

....

....

.... [2]

2 **(a)** A sphere of radius R is moving through a fluid with constant speed v. There is a frictional force F acting on the sphere, which is given by the expression

$$F = 6\pi DRv$$

where D depends on the fluid.

(i) Show that the SI base units of the quantity D are $\mathrm{kg\,m^{-1}\,s^{-1}}$.

[3]

(ii) A raindrop of radius 1.5 mm falls vertically in air at a velocity of $3.7\,\mathrm{m\,s^{-1}}$. The value of D for air is $6.6 \times 10^{-4}\,\mathrm{kg\,m^{-1}\,s^{-1}}$. The density of water is $1000\,\mathrm{kg\,m^{-3}}$.

Calculate

1. the magnitude of the frictional force F,

F = ... N [1]

2. the acceleration of the raindrop.

acceleration = ... $\mathrm{m\,s^{-2}}$ [3]

(b) The variation with time t of the speed v of the raindrop in **(a)** is shown in Fig. 2.1.

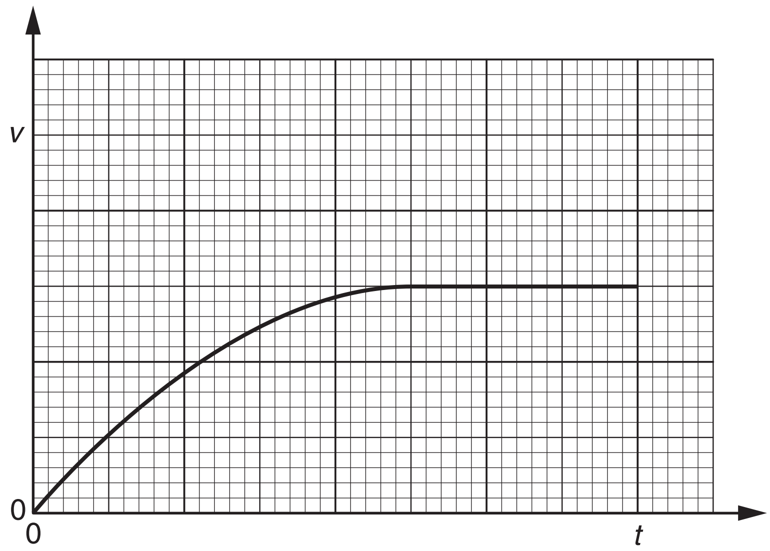

Fig. 2.1

(i) State the variation with time of the **acceleration** of the raindrop.

....

....

....

....

.... [3]

(ii) A second raindrop has a radius that is smaller than that given in **(a)**. On Fig. 2.1, sketch the variation of speed with time for this second raindrop. [2]

3 **(a)** **(i)** Explain what is meant by *work done*.

....

.... [1]

(ii) Define *power*.

....

.... [1]

(b) Fig. 3.1 shows part of a fairground ride with a carriage on rails.

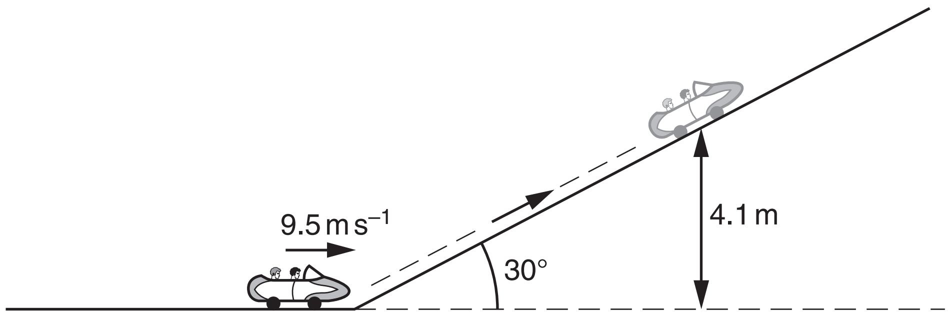

Fig. 3.1

The carriage and passengers have a total mass of 600 kg. The carriage is travelling at a speed of 9.5 m s^{-1} towards a slope inclined at 30° to the horizontal. The carriage comes to rest after travelling up the slope to a vertical height of 4.1 m.

(i) Calculate the kinetic energy, in kJ, of the carriage and passengers as they travel towards the slope.

kinetic energy = ... kJ [3]

(ii) Show that the gain in potential energy of the carriage and passengers is 24 kJ.

[2]

(iii) Calculate the work done against the resistive force as the carriage moves up the slope.

work done = ... kJ [1]

(iv) your answer in **(iii)** to calculate the resistive force acting against the carriage as it moves up the slope.

resistive force = ... N [2]

4 A student measures the Young modulus of a metal in the form of a wire.

(a) Describe, with the aid of a diagram, the apparatus that could be used.

....

....

....

.... [2]

(b) Describe the method used to obtain the required measurements.

....

....

....

....

....

....

....

....

....

.... [4]

(c) Describe how the measurements taken can be used to determine the Young modulus.

....

....

....

....

....

....

....

....

....

.... [4]

5 **(a)** a cell, explain the terms

(i) *electromotive force* (e.m.f.),

....

.... [1]

(ii) *internal resistance*.

....

.... [1]

(b) The circuit of Fig. 5.1 shows two batteries A and B and a resistor R connected in series.

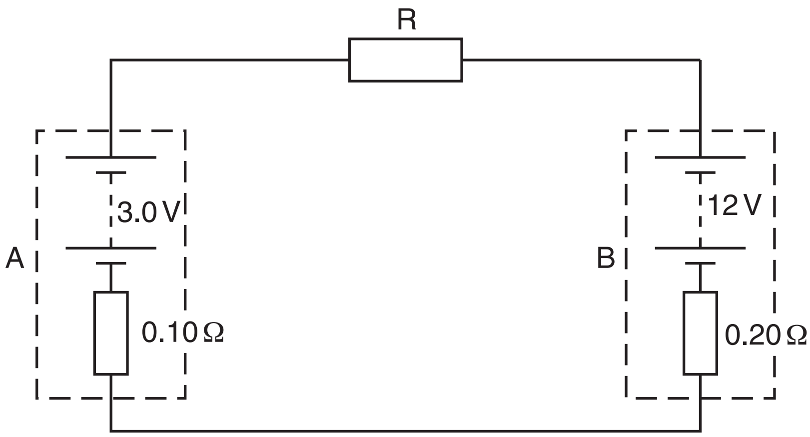

Fig. 5.1

Battery A has an e.m.f. of 3.0 V and an internal resistance of 0.10 Ω. Battery B has an e.m.f. of 12 V and an internal resistance of 0.20 Ω. Resistor R has a resistance of 3.3 Ω.

(i) Apply Kirchhoff's second law to calculate the current in the circuit.

current = ... A [2]

(ii) Calculate the power transformed by battery B.

power = ... W [2]

(iii) Calculate the total energy lost per second in resistor R and the internal resistances.

energy lost per second = ... $J s^{-1}$ [2]

(c) The circuit of Fig. 5.1 may be used to store energy in battery A. Suggest how your answers in **(b)** support this statement.

....

....

.... [1]

6 **(a)** Apparatus used to produce interference fringes is shown in Fig. 6.1. The apparatus is not drawn to scale.

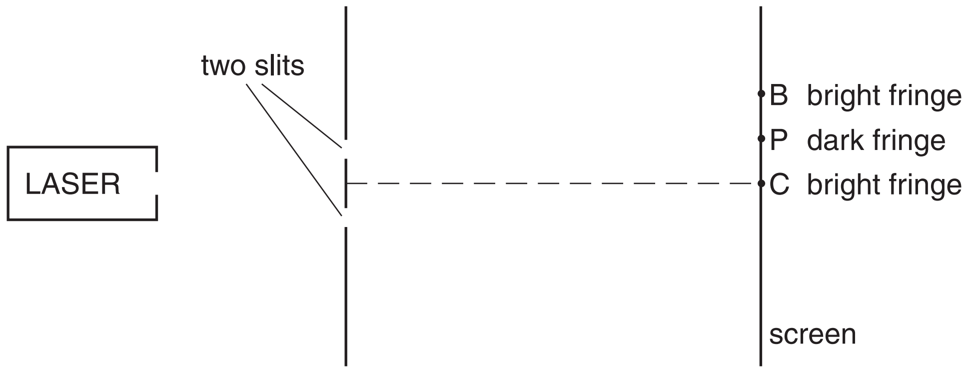

Fig. 6.1 (not to scale)

Laser light is incident on two slits. The laser provides light of a single wavelength. The light from the two slits produces a fringe pattern on the screen. A bright fringe is produced at C and the next bright fringe is at B. A dark fringe is produced at P.

(i) Explain why one laser and two slits are used, instead of two lasers, to produce a visible fringe pattern on the screen.

....

.... [1]

(ii) State the phase difference between the waves that meet at

1. B .... [1]

2. P .... [1]

(iii) **1.** State the *principle of superposition*.

....

....

.... [2]

2. the principle of superposition to explain the dark fringe at P.

....

.... [1]

(b) In Fig. 6.1 the distance from the two slits to the screen is 1.8 m. The distance CP is 2.3 mm and the distance between the slits is 0.25 mm.
Calculate the wavelength of the light provided by the laser.

wavelength = ... nm [3]