1 Distinguish between the *mass* of a body and its *weight*.

mass .....

.....

weight .....

.....[4]

2 A student determines the acceleration of free fall using the apparatus illustrated in Fig. 2.1.

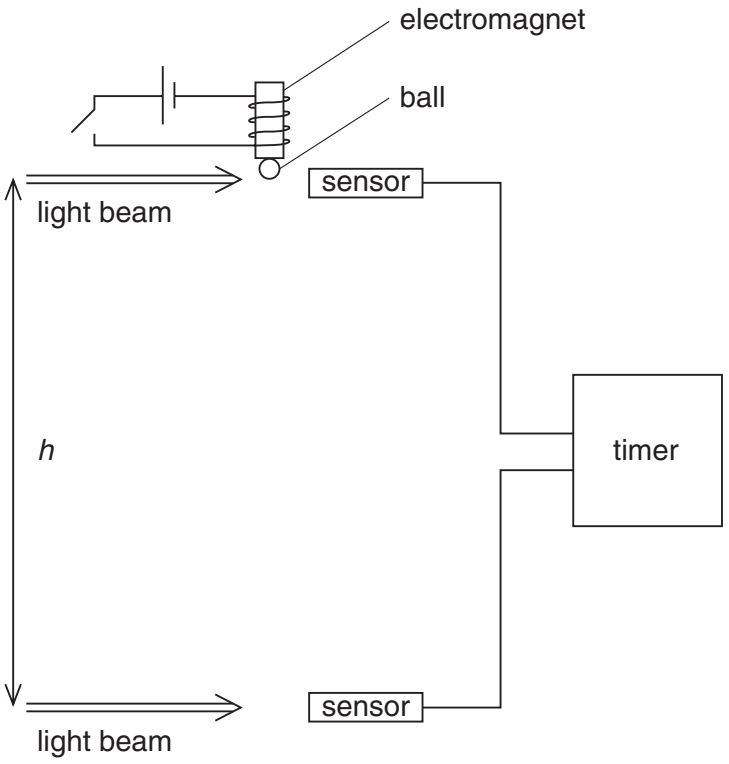

Fig. 2.1

A steel ball is held on an electromagnet. When the electromagnet is switched off, the ball immediately interrupts a beam of light and a timer is started. As the ball falls, it interrupts a second beam of light and the timer is stopped. The vertical distance h between the light beams and the time t recorded on the timer are noted. The procedure is repeated for different values of h. The student calculates values of t^2 and then plots the graph of Fig. 2.2.

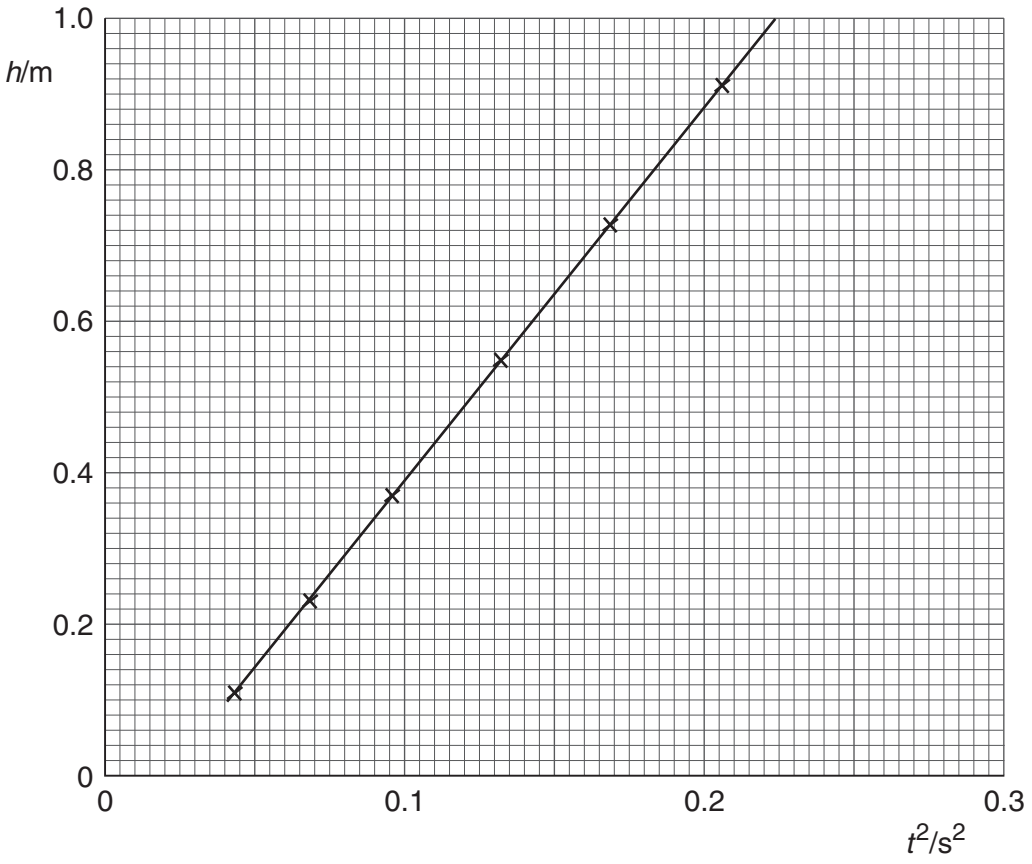

Fig. 2.2

(a) Use Fig. 2.2 to calculate a value for g, the acceleration of free fall of the ball. Explain your working.

g = ... $m\,s^{-2}$ [4]

(b) Identify one possible source of random error in the determination of g and suggest how this error may be reduced.

.....

.....

.....[2]

3 Make reasonable estimates of the following quantities.

(a) mass of an apple

mass = ... kg [1]

(b) number of joules of energy in 1 kilowatt-hour

number = ... [1]

(c) wavelength of red light in a vacuum

wavelength = ... m [1]

(d) pressure due to a depth of 10 m of water

pressure = ... Pa [1]

4 A student uses a micrometer screw gauge to measure the diameter of a wire. He fails to notice that, with the gauge fully closed, the reading is not zero.

(a) State and explain whether the omission introduces a random error or a systematic error into the readings of the diameter.

.....

.....[2]

(b) Explain why the readings are precise but not accurate.

.....

.....

.....[2]

5 **(a)** **(i)** Define *density*.

.....

.....

(ii) State the base units in which density is measured.

.....
[2]

(b) The speed v of sound in a gas is given by the expression

$$v = \sqrt{\left(\frac{\gamma p}{\rho}\right)},$$

where p is the pressure of the gas of density ρ. γ is a constant.

Given that p has the base units of $\mathrm{kg\,m^{-1}\,s^{-2}}$, show that the constant γ has no unit. [3]

6 A student uses a metre rule to measure the length of an elastic band before and after stretching it.

The lengths are recorded as

length of band before stretching, $L_0 = 50.0 \pm 0.1$ cm

length of band after stretching, $L_S = 51.6 \pm 0.1$ cm.

Determine

(a) the change in length $(L_S - L_0)$, quoting your answer with its uncertainty,

$(L_S - L_0)$ = ... cm [1]

(b) the fractional change in length, $\frac{(L_S - L_0)}{L_0}$,

fractional change = ... [1]

(c) the uncertainty in your answer in **(b)**.

uncertainty = ... [3]

7 **(a)** State the difference between a scalar quantity and a vector quantity.

scalar: .....

.....

vector: .....

..... [2]

(b) Two forces of magnitude 6.0 N and 8.0 N act at a point P. Both forces act away from point P and the angle between them is 40°.
Fig. 1.1 shows two lines at an angle of 40° to one another.

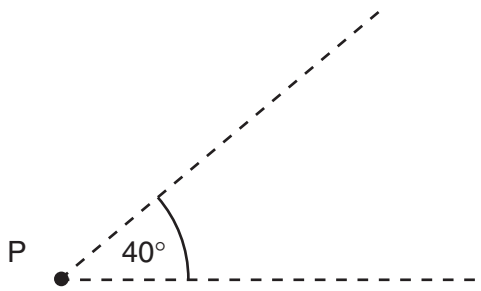

Fig. 1.1

On Fig. 1.1, draw a vector diagram to determine the magnitude of the resultant of the two forces.

magnitude of resultant = ... N [4]

8 A student takes readings to measure the mean diameter of a wire using a micrometer screw gauge.

(a) Make suggestions, one in each case, that the student may adopt in order to

(i) reduce a systematic error in the readings,

.....

.....

(ii) allow for a wire of varying diameter along its length,

.....

.....

(iii) allow for a non-circular cross-section of the wire.

.....

.....
[3]

(b) The mean diameter of the wire is found to be 0.50 ± 0.02 mm. Calculate the percentage uncertainty in

(i) the diameter,

uncertainty = ... %

(ii) the area of cross-section of the wire.

uncertainty = ... %
[2]

9 The spectrum of electromagnetic waves is divided into a number of regions such as radio waves, visible light and gamma radiation.

(a) State three distinct features of waves that are common to all regions of the electromagnetic spectrum.

1. .....

2. .....

3. ..... [3]

(b) A typical wavelength of visible light is 495 nm. Calculate the number of wavelengths of this light in a wave of length 1.00 m.

number = ... [2]

(c) State a typical wavelength for

(i) X-rays,

wavelength = ... m

(ii) infra-red radiation.

wavelength = ... m
[2]

For Examiner's Use

10 Make estimates of the following quantities.

(a) the speed of sound in air

speed = ... [1]

(b) the density of air at room temperature and pressure

density = ... [1]

(c) the mass of a protractor

mass = ... [1]

(d) the volume, in cm^3, of the head of an adult person

volume = ... cm^3 [1]

11 **(a)** **(i)** Define *pressure*.

.....

..... [1]

(ii) State the units of pressure in base units.

..... [1]

(b) The pressure p at a depth h in an incompressible fluid of density ρ is given by

$$p = \rho g h,$$

where g is the acceleration of free fall.
Use base units to check the homogeneity of this equation.

.....

.....

.....

..... [3]

12 **(a)** Derive the SI base unit of force.

SI base unit of force = ... [1]

(b) A spherical ball of radius r experiences a resistive force F due to the air as it moves through the air at speed v. The resistive force F is given by the expression

$$F = crv,$$

where c is a constant.

Derive the SI base unit of the constant c.

SI base unit of c = ... [1]

(c) The ball is dropped from rest through a height of 4.5 m.

(i) Assuming air resistance to be negligible, calculate the final speed of the ball.

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

(ii) The ball has mass 15 g and radius 1.2 cm.

The numerical value of the constant c in the equation in **(b)** is equal to 3.2×10^{-4} when measured using the SI system of units.

Show quantitatively whether the assumption made in **(i)** is justified.

[3]

13 The uncalibrated scale and the pointer of a meter are shown in Fig. 1.1.

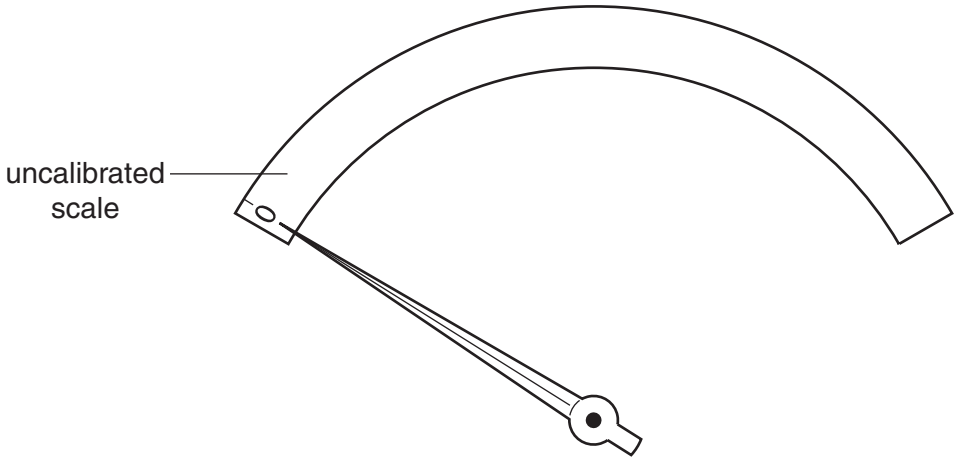

Fig. 1.1

The pointer is shown in the zero position.
The meter is to be used to indicate the volume of fuel in the tank of a car.
A known volume V of fuel is poured into the tank and the deflection θ of the pointer is noted.
Fig. 1.2 shows the variation with θ of V.

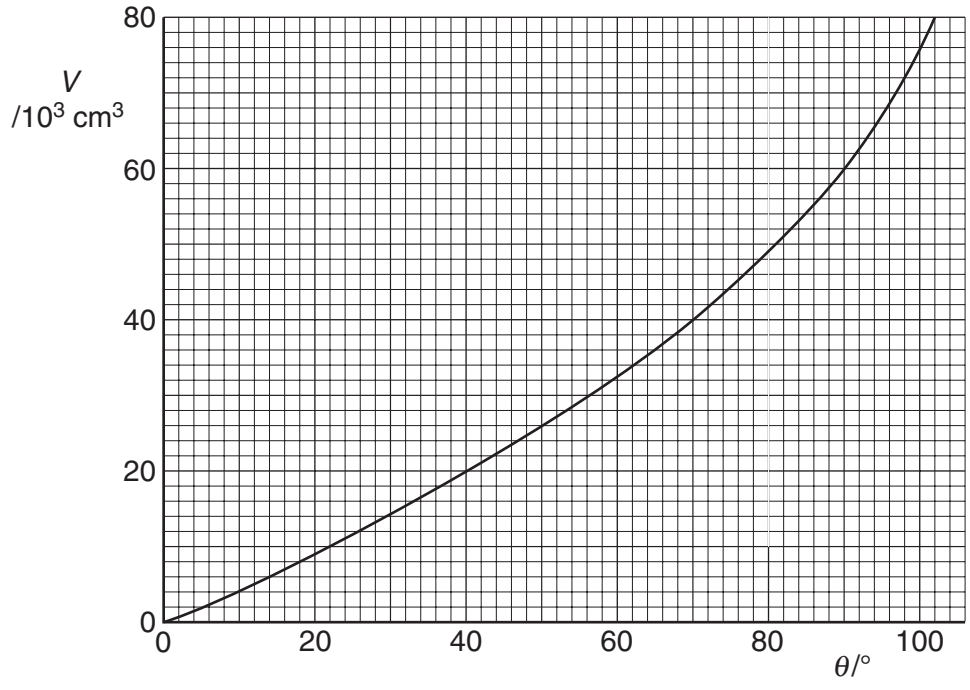

Fig. 1.2

(a) On Fig. 1.1,

(i) calibrate the scale at 20×10^3 cm^3 intervals, [2]

(ii) mark a possible position for a volume of 1.0×10^5 cm^3. [1]

(b) Suggest one advantage of this scale, as compared with a uniform scale, for measuring fuel volumes in the tank of the car.

.....

.....[1]

14 **(a)** Distinguish between systematic errors and random errors.

systematic errors .....

.....

random errors .....

..... [2]

(b) A cylinder of length L has a circular cross-section of radius R, as shown in Fig. 1.1.

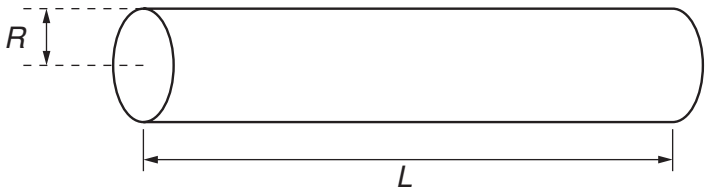

Fig. 1.1

The volume V of the cylinder is given by the expression

$$V = \pi R^2 L.$$

The volume and length of the cylinder are measured as

$V = 15.0 \pm 0.5\,\text{cm}^3$
$L = 20.0 \pm 0.1\,\text{cm}$.

Calculate the radius of the cylinder, with its uncertainty.

radius = ... ± ..... cm [5]

For Examiner's Use

15 Make reasonable estimates of the following quantities.

(a) the frequency of an audible sound wave

frequency = ... Hz [1]

(b) the wavelength, in nm, of ultraviolet radiation

wavelength = ... nm [1]

(c) the mass of a plastic 30 cm ruler

mass = ... g [1]

(d) the density of air at atmospheric pressure

density = ... kg m^{-3} [1]

16 **(a)** The current in a wire is I. Charge Q passes one point in the wire in time t. State

(i) the relation between I, Q and t,

..... [1]

(ii) which of the quantities I, Q and t are base quantities.

.....

..... [2]

(b) The current in the wire is due to electrons, each with charge q, that move with speed v along the wire. There are n of these electrons per unit volume.
For a wire having a cross-sectional area S, the current I is given by the equation

$$I = nSqv^k,$$

where k is a constant.

(i) State the units of I, n, S, q and v in terms of the base units.

I .....

n .....

S .....

q .....

v .....
[3]

(ii) By considering the homogeneity of the equation, determine the value of k.

k = ... [2]