1 **(a)** The spacing between two atoms in a crystal is 3.8×10^{-10} m. State this distance in pm.

spacing = ... pm [1]

(b) Calculate the time of one day in Ms.

time = ... Ms [1]

(c) The distance from the Earth to the Sun is 0.15 Tm. Calculate the time in minutes for light to travel from the Sun to the Earth.

time = ... min [2]

(d) Underline all the vector quantities in the list below.

distance energy momentum weight work [1]

(e) The velocity vector diagram for an aircraft heading due north is shown to scale in Fig. 1.1. There is a wind blowing from the north-west.

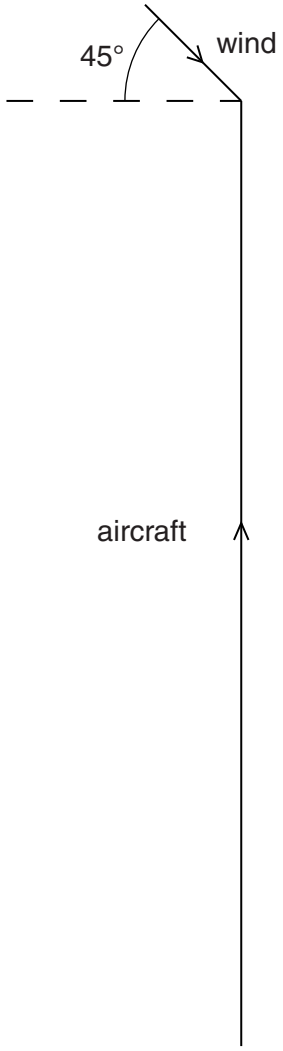

Fig. 1.1

The speed of the wind is 36 m s^{-1} and the speed of the aircraft is 250 m s^{-1}.

(i) Draw an arrow on Fig. 1.1 to show the direction of the resultant velocity of the aircraft. [1]

(ii) Determine the magnitude of the resultant velocity of the aircraft.

resultant velocity = ... m s^{-1} [2]

2 Two planks of wood AB and BC are inclined at an angle of 15° to the horizontal. The two wooden planks are joined at point B, as shown in Fig. 2.1.

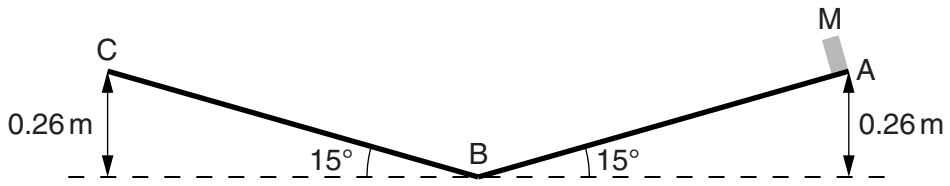

Fig. 2.1

A small block of metal M is released from rest at point A. It slides down the slope to B and up the opposite side to C. Points A and C are 0.26 m above B. Assume frictional forces are negligible.

(a) (i) Describe and explain the acceleration of M as it travels from A to B and from B to C.

.....

.....

.....

..... [3]

(ii) Calculate the time taken for M to travel from A to B.

time = ... s [3]

(iii) Calculate the speed of M at B.

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

(b) The plank BC is adjusted so that the angle it makes with the horizontal is 30°. M is released from rest at point A and slides down the slope to B. It then slides a distance along the plank from B towards C.

the law of conservation of energy to calculate this distance. Explain your working.

distance = ... m [2]

3 **(a)** Define *power*.

.....

..... [1]

(b) A cyclist travels along a horizontal road. The variation with time t of speed v is shown in Fig. 3.1.

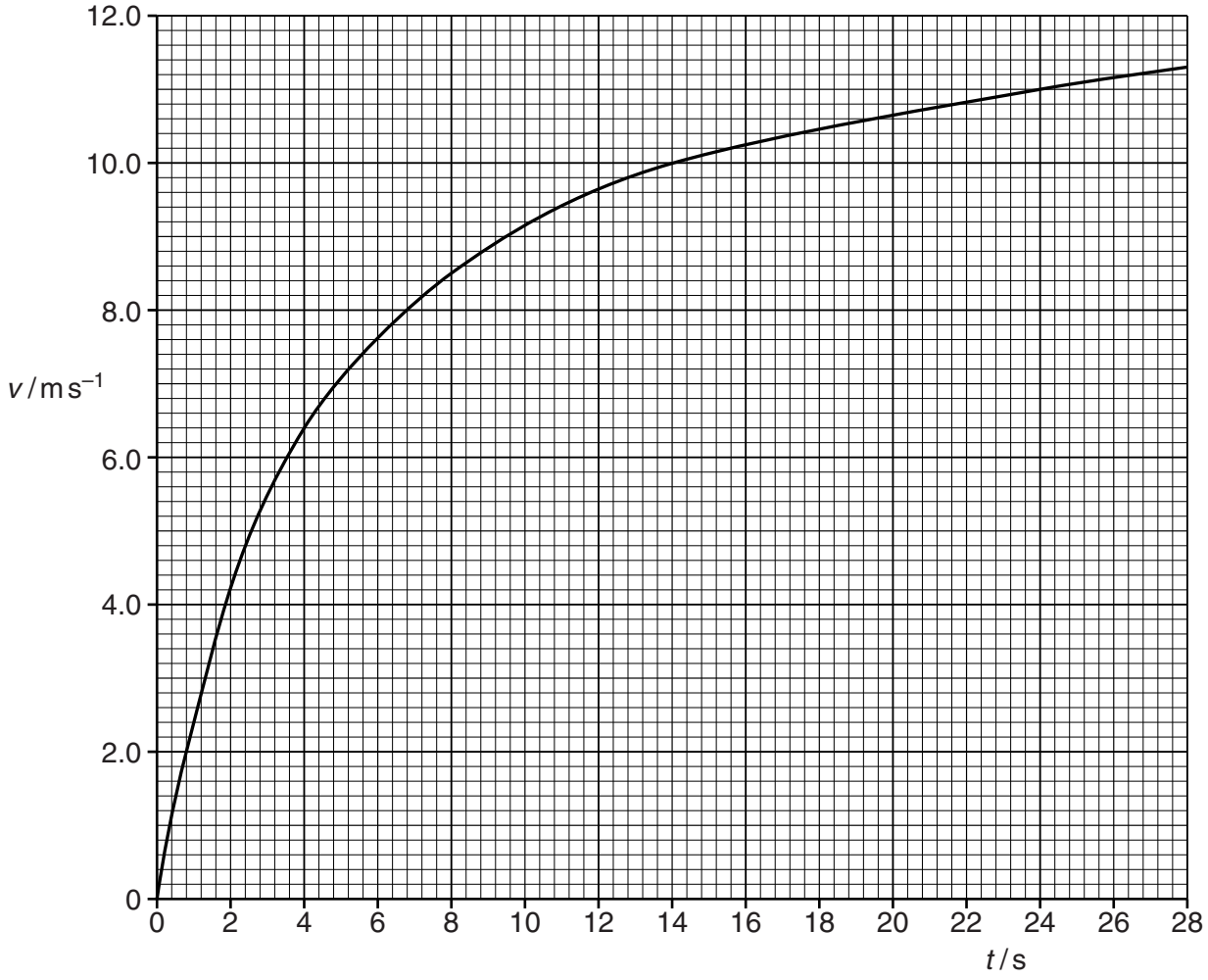

Fig. 3.1

The cyclist maintains a constant power and after some time reaches a constant speed of $12\,m\,s^{-1}$.

(i) Describe and explain the motion of the cyclist.

.....

.....

.....

.....

..... [3]

(ii) When the cyclist is moving at a constant speed of $12\,m\,s^{-1}$ the resistive force is 48 N. Show that the power of the cyclist is about 600 W. Explain your working.

[2]

(iii) Fig. 3.1 to show that the acceleration of the cyclist when his speed is $8.0\,m\,s^{-1}$ is about $0.5\,m\,s^{-2}$.

[2]

(iv) The total mass of the cyclist and bicycle is 80 kg. Calculate the resistive force R acting on the cyclist when his speed is $8.0\,m\,s^{-1}$. the value for the acceleration given in **(iii)**.

R = ... N [3]

(v) the information given in **(ii)** and your answer to **(iv)** to show that, in this situation, the resistive force R is proportional to the speed v of the cyclist.

[1]

4 A circuit used to measure the power transfer from a battery is shown in Fig. 4.1. The power is transferred to a variable resistor of resistance *R*.

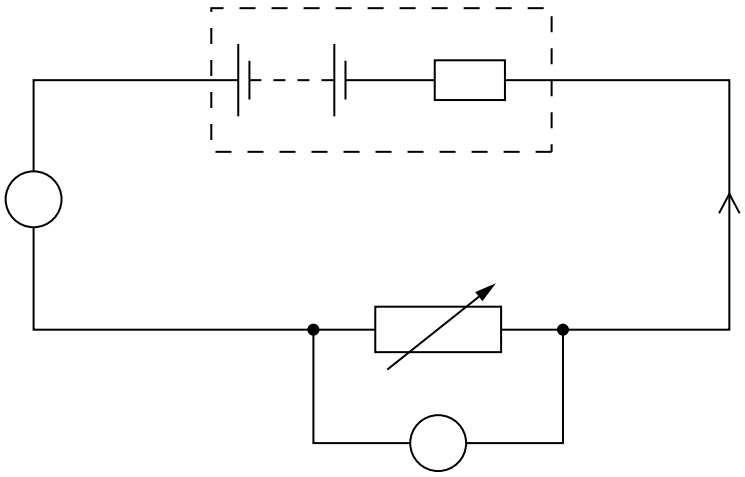

Fig. 4.1

The battery has an electromotive force (e.m.f.) *E* and an internal resistance *r*. There is a potential difference (p.d.) *V* across *R*. The current in the circuit is *I*.

(a) By reference to the circuit shown in Fig. 4.1, distinguish between the definitions of e.m.f. and p.d.

.....

.....

.....

..... [3]

(b) Using Kirchhoff's second law, determine an expression for the current *I* in the circuit.

[1]

(c) The variation with current I of the p.d. V across R is shown in Fig. 4.2.

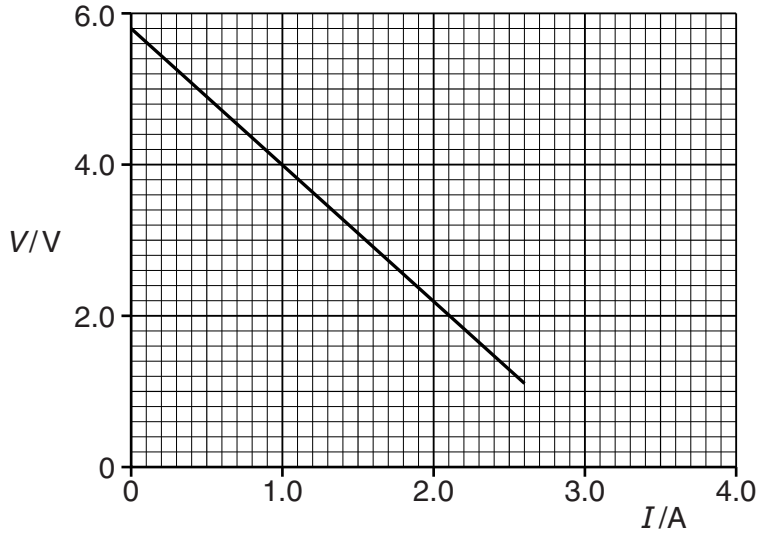

Fig. 4.2

Fig. 4.2 to determine

(i) the e.m.f. E,

E = ... V [1]

(ii) the internal resistance r.

r = ... Ω [2]

(d) (i) Using data from Fig. 4.2, calculate the power transferred to R for a current of 1.6 A.

power = ... W [2]

(ii) your answers from **(c)(i)** and **(d)(i)** to calculate the efficiency of the battery for a current of 1.6 A.

efficiency = ... % [2]

5 **(a)** State one property of electromagnetic waves that is **not** common to other transverse waves.

..... [1]

(b) The seven regions of the electromagnetic spectrum are represented by blocks labelled A to G in Fig. 5.1.

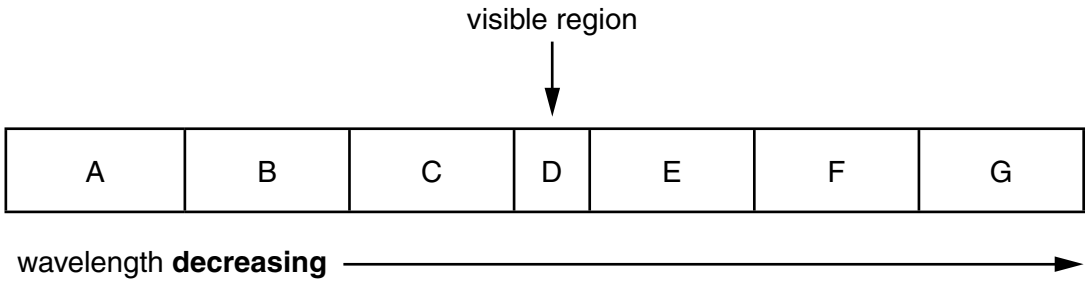

Fig. 5.1

A typical wavelength for the visible region D is 500 nm.

(i) Name the principal radiations and give a typical wavelength for each of the regions B, E and F.

B: name: ..... wavelength: ..... m

E: name: ..... wavelength: ..... m

F: name: ..... wavelength: ..... m
[3]

(ii) Calculate the frequency corresponding to a wavelength of 500 nm.

frequency = ... Hz [2]

(c) All the waves in the spectrum shown in Fig. 5.1 can be polarised. Explain the meaning of the term *polarised*.

.....

.....

.....

..... [2]

6 **(a)** β-radiation is emitted during the spontaneous radioactive decay of an unstable nucleus.

(i) State the nature of a β-particle.

..... [1]

(ii) State two properties of β-radiation.

1. .....

2. .....
[2]

(iii) Explain the meaning of *spontaneous radioactive decay*.

.....

..... [1]

(b) The following equation represents the decay of a nucleus of hydrogen-3 by the emission of a β-particle.

Complete the equation.

$$^{3}_{1}\mathrm{H} \rightarrow \overset{\ldots\ldots}{\underset{\ldots\ldots}{\ }}\mathrm{He} + \overset{\ldots\ldots}{\underset{\ldots\ldots}{\ }}\beta \qquad [2]$$

(c) The β-particle is emitted with an energy of 5.7×10^{3} eV.

Calculate the speed of the β-particle.

speed = ... $\mathrm{m\,s^{-1}}$ [3]

(d) A different isotope of hydrogen is hydrogen-2 (deuterium). Describe the similarities and differences between the atoms of hydrogen-2 and hydrogen-3.

.....

.....