MOTION-SET-3-QP-MS

1 Fig. 3.1 shows two speed / time graphs for a car.

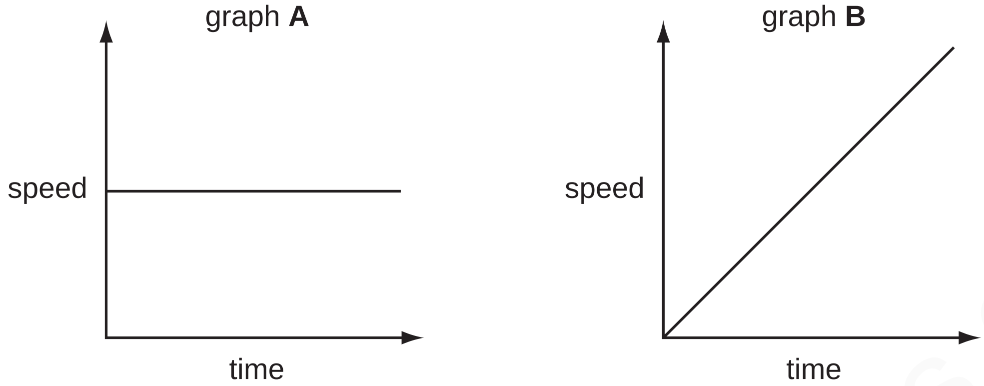

Fig. 3.1

(a) Describe the motion of the car in

graph **A**, ...

graph **B**. .... [1]

(b) The car travels at 20 m / s for 90 seconds. The total force driving the car forward is 1000 N.

Calculate the work done by this force during this 90 second journey.

State the formulae that you use and show your working.

formulae used

working

.... [3]

(c) The manufacturer of the car gave the following information.

- mass of car 950 kg
- the car will accelerate from 0 to 33 m / s in 11 seconds

(i) Calculate the acceleration of the car during the 11 seconds.

Show your working.

.... [2]

(ii) Calculate the force needed to produce this acceleration.

State the formula that you use and show your working.

formula used

working

.... [2]

(iii) The manufacturer claims the car can reach a maximum speed of 170 km / hr.

Explain, in terms of forces acting on the car, why there is a maximum speed (terminal velocity) that a car can reach.

....

....

.... [2]

MARKING SCHEME

(a) **A** – constant / steady, speed / velocity ;
B – acceleration ; [1]

(b) (distance = 20 × 90 =) 1800 (m) ;
(work done =) force × distance ;
= 1000 × 1800 = 1 800 000 J ; [3]

(c) **(i)** (acceleration =) change in speed ÷ time = 33/11 ;
= 3 m / s^2 ; [2]

(ii) (force =) mass × acceleration ;
= 950 × 3 = 2850 N ; [2]

(iii) the faster a car goes the greater the air resistance / frictional force ;
(eventually) air resistance balances (maximum) driving force ; [2]

[Total: 10]

2 Fig. 5.1 shows a solar-powered vehicle.

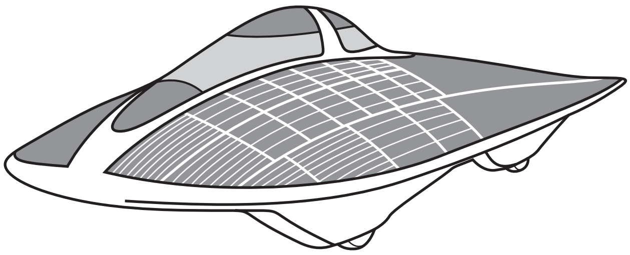

Fig. 5.1

(a) Fig. 5.2 shows a speed / time graph for the vehicle for the first hour of a journey.

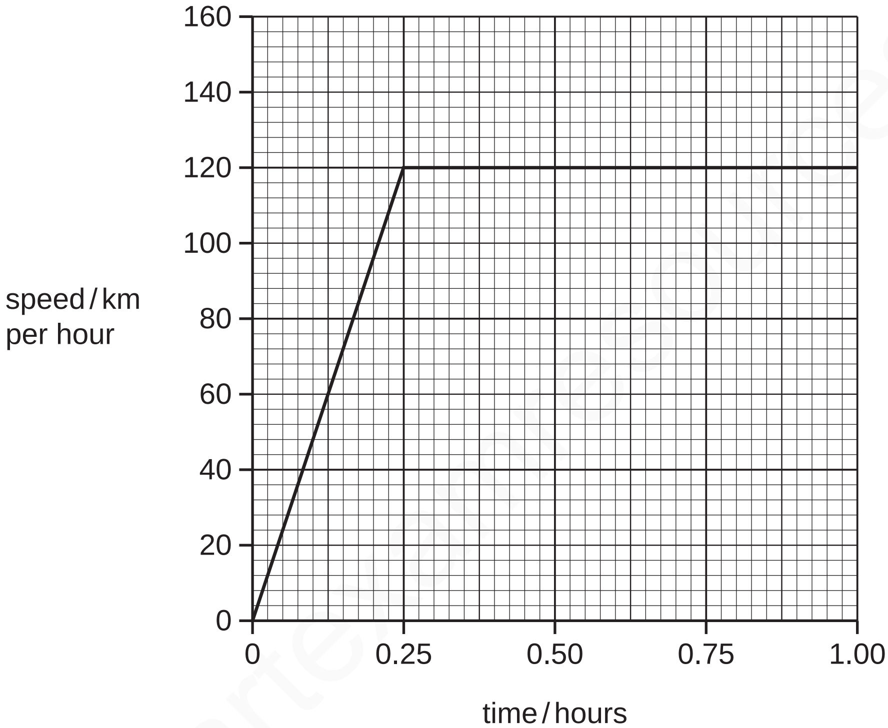

Fig. 5.2

(i) Calculate the distance travelled during the first hour.

Show your working and state the unit of your answer.

.... unit .... [2]

(ii) Calculate the acceleration of the vehicle during the first quarter of an hour.

State your answer in m/s^2.

Show your working.

.... m/s^2 [3]

MARKING SCHEME

(a) **(i)** area under graph / working / 120 × 0.75 + ½ × 120 × 0.25 ;
= 105 km ; [2]

(ii) (acceleration =) gradient or 120/0.25 ;
= 480 (km / h^2) ;
= 0.037 m / s^2 ; [3]

(b) **(i)** 10% ; [1]

(ii) 1,000,000 × 0.10 × 0.70 ;
= 70,000 J ; [2]

3 Fig. 9.1 shows a solar-powered golf cart used to carry golfers around a golf course.

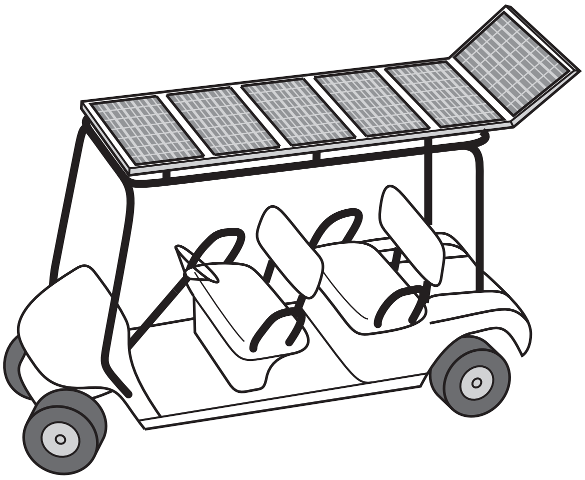

Fig. 9.1

(a) As the cart moves around the course, the motion of the cart is measured.

Fig. 9.2 shows a distance / time graph for a small part of the journey lasting 60 seconds.

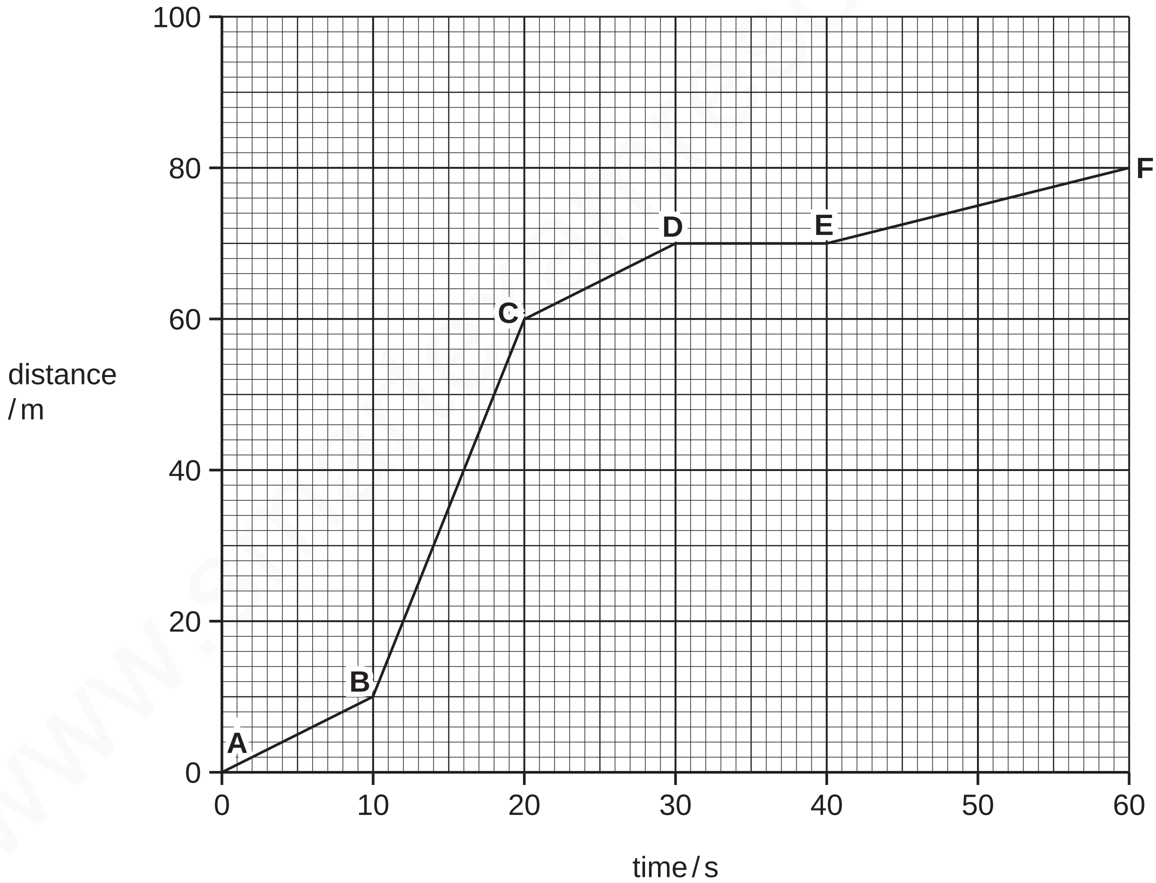

Fig. 9.2

(i) Show that the speed of the cart between **B** and **C** is 5 m / s.

Show your working in the space.

[1]

MARKING SCHEME

(a) **(i)** 50/10 (= 5 m / s) ;
20–10
(working could be on graph) [1]

4 **(a)** A polar bear of mass 400 kg is swimming in the sea.

Fig. 4.1 shows the speed-time graph for the polar bear over a time interval of 300 s.

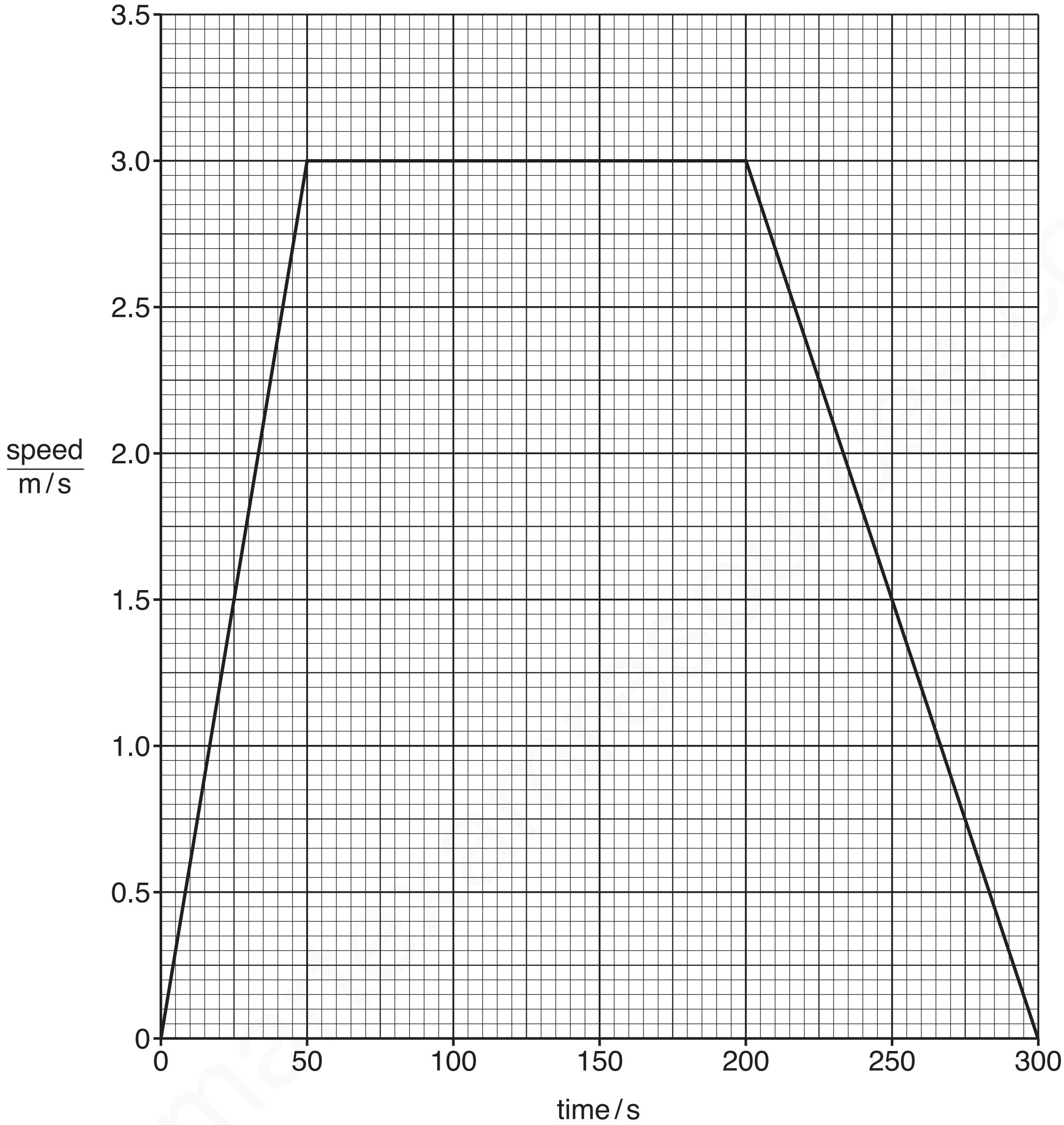

Fig. 4.1

(i) Calculate the distance travelled by the polar bear over the 300 s.

Show your working.

distance = ... m [2]

(ii) Calculate the acceleration of the polar bear at 25 seconds.

Show your working.

.... m/s^2 [2]

(iii) Calculate the maximum kinetic energy of the polar bear.

State the formula you use and show your working.

formula

working

kinetic energy = ……………………… J [3]

(b) The polar bear has a weight of 4000 N .

The polar bear stands with all four feet in contact with the ice. Each foot of the polar bear has an area of 0.035 m^2.

Calculate the pressure exerted by the polar bear on the ice.

State the formula you use and show your working.

formula

working

pressure = ... N/m^2 [2]

(c) Recent research suggests that the audible frequency range for polar bears is between 50 Hz and 35 000 Hz.

(i) Ultrasound waves have a very high frequency that cannot be heard by humans. Devices which emit ultrasound waves have been tested to see if they can keep polar bears away from people.

Suggest a suitable frequency for the waves emitted by such a device.

.... Hz [1]

(ii) A polar bear hears a sound.

Fig. 4.2 represents the sound wave travelling through the air as a series of compressions **(C)** and rarefactions **(R)**.

Fig. 4.2

Describe **two** differences between a region of compression and a region of rarefaction.

1 ....

....

2 ....

....
[2]

(d) Scientists use thermal imaging cameras to detect polar bears travelling on the ice.

Thermal imaging cameras use infra-red radiation. Infra-red radiation is part of the electromagnetic spectrum.

Name **one** radiation in the electromagnetic spectrum that has a lower frequency than infra-red radiation.

....[1]

MARKING SCHEME

(a)(i)	area under graph / working / 75 + 150 + 450 ; 675 (m) ;	**2**
(a)(ii)	working or 3 / 50 ; 0.06 (m / s^2) ;	**2**
(a)(iii)	max speed = 3 m / s ; KE = ½ mv^2 / ½ × 400 × 9 ; 1800(J) ;	**3**
(b)	pressure = force / area / 4000 / 4 × 0.035 ; 28 600 (N / m^2) ;	**2**
(c)(i)	allow between 20 000 Hz and 35 000Hz ;	**1**
(c)(ii)	compressions are regions where the particles in air are close together / rarefactions are regions where the particles in air are spread out ; compressions are regions with air at higher pressure than normal / rarefactions are regions with air at lower pressure than normal ;	**2**
(d)	radio waves or microwaves ;	**1**

5 **(a)** A car travels along a road at 8 m/s.

Describe the difference between the terms *speed* and *velocity*.

....

....

.... [1]

(b) Some puddles of water have formed on the road.

Explain, in terms of water molecules, how the rate of evaporation of water from a puddle is affected by the strength of the wind blowing across the puddle.

....

....

....

.... [2]

(c) The car battery has an electromotive force (e.m.f.) of 12 V.

State what is meant by *electromotive force*.

....

....

.... [2]

(d) Fig. 3.1 shows part of the lighting circuit for the car. Two lamps, $\mathbf{L_1}$ and $\mathbf{L_2}$, each have a resistance of 16 Ω.

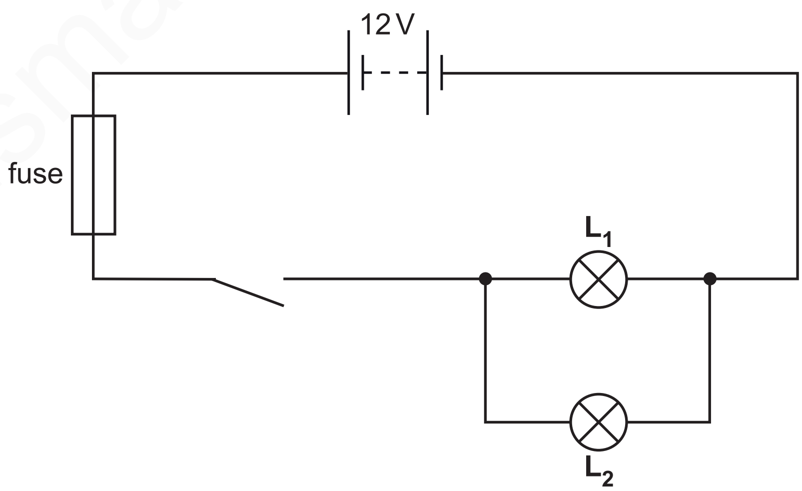

Fig. 3.1

(i) When the switch is closed the current in the fuse is 1.5A.

Determine the current in $\mathbf{L_1}$.

current = ... A [1]

(ii) State **one** reason why the lamps are connected as shown in Fig. 3.1 and **not** in series.

Explain your answer.

....

....

.... [2]

(e) Modern cars use optical fibres to transfer information using visible light rays.

Fig. 3.2 shows a ray of light entering an optical fibre.

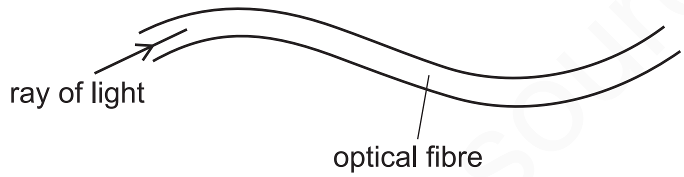

Fig. 3.2

(i) Explain why the ray of light is able to stay inside the optical fibre. You may draw on Fig. 3.2 if it helps your answer.

....

....

....

.... [2]

(ii) Visible light rays are transverse waves.

Draw labelled diagrams to show the difference between a transverse wave and a longitudinal wave.

[2]

[Total: 12]

MARKING SCHEME

(a)	speed has magnitude only / velocity has magnitude and direction / velocity has direction / speed does not have direction ;	1
(b)	increase in wind strength increases rate of evaporation / ORA ; (stronger wind) allows more molecules to escape / evaporate into the air above the puddle / ORA ;	2
(c)	the energy / work done (supplied by a source) ; per (unit) charge ;	2
(d)(i)	0.75 (A) ;	1
(d)(ii)	if one lamp fails the other will still work ; if one lamp fails still a complete circuit ; OR ref. to full brightness / brighter lamps ; because they each receive the full voltage ;	2
(e)(i)	ref. to total internal reflection / owtte / shown on diagram ; angle of incidence greater than the critical angle ;	2
(e)(ii)	correct diagrams for transverse and longitudinal waves ; vibrations perpendicular to direction of travel for transverse and parallel for longitudinal ;	2

6 **(a)** A flea is a small insect.

A student uses a magnifying glass to observe a flea.

The magnifying glass produces a virtual image.

Describe the difference between a real image and a virtual image.

....

.... [1]

(b) **(i)** The flea jumps upwards from rest. The speed of the flea increases to 1.2 m/s in 0.001 s.

State the difference between the terms *speed* and *velocity*.

....

....

.... [1]

(ii) Calculate the acceleration of the flea.

acceleration = ... m/s^2 [2]

(iii) The flea has a mass of 0.0005 g.

Calculate the force causing this acceleration.

force = ... N [3]

[Total: 7]

MARKING SCHEME

(a)	a **real image** is formed where light rays, converge / are focussed ; a virtual image is formed from where light rays appear to have diverged from ; a **real image** can be formed on a screen ; a **virtual image** cannot be formed on a screen ; **max 1**	**1**
(b)(i)	speed has magnitude only / velocity has magnitude and direction / velocity has direction / speed does not have direction ;	**1**
(b)(ii)	$\frac{\text{change in speed}}{\text{time taken}}$ or $\frac{v-u}{t}$ or $\frac{\Delta v}{t}$ or $\frac{1.2}{0.001}$; 1200 (m / s^2) ;	**2**
(b)(iii)	conversion of grams to kilograms; (force =) mass × acceleration or 0.0000005 × 1200 ; = 0.0006 (N);	**3**

7 Fig. 9.1 shows a snowboarder moving down a ski slope.

Fig. 9.1

(a) Fig. 9.2 shows a speed-time graph for the snowboarder.

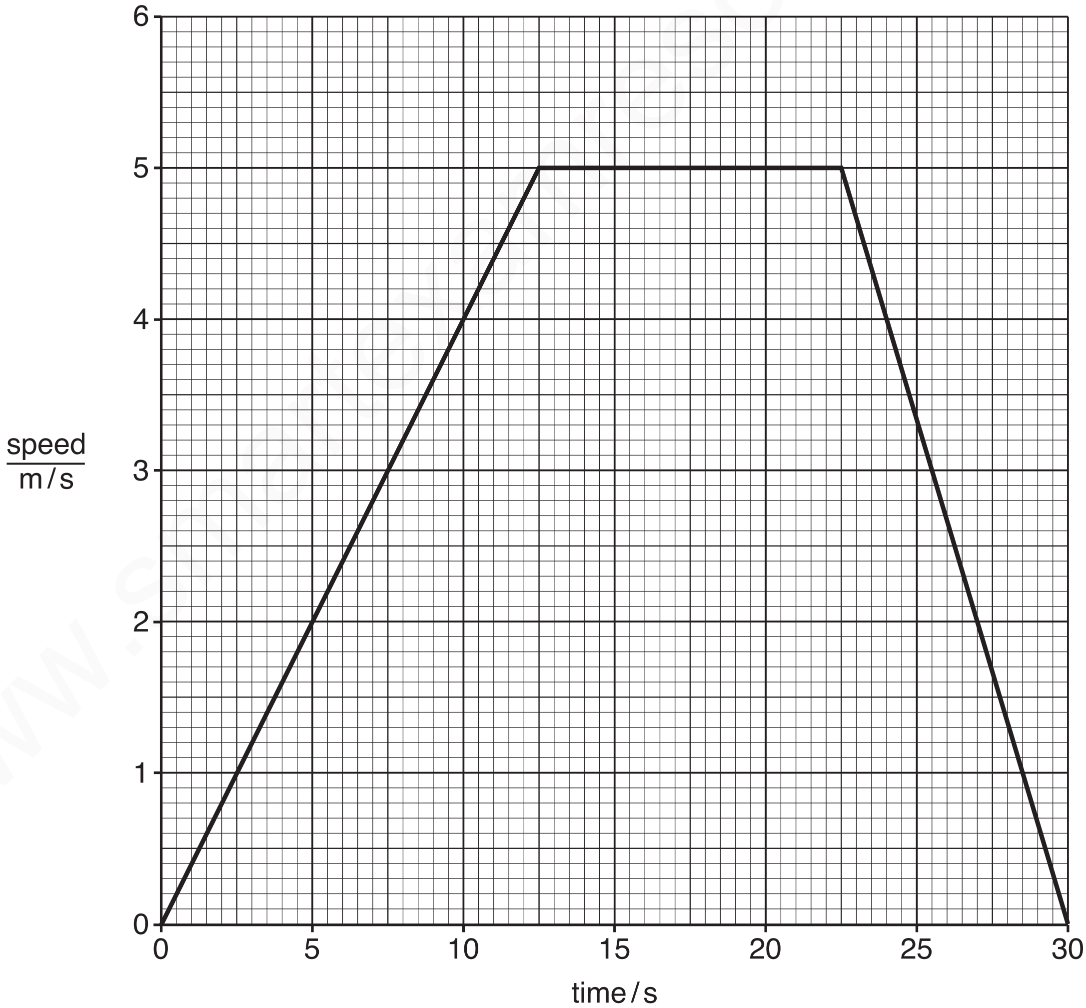

Fig. 9.2

The mass of the snowboarder is 75 kg.

(i) Calculate the maximum kinetic energy of the snowboarder.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [3]

(ii) Calculate the acceleration of the snowboarder in the first 10 seconds.

Show your working. State the unit of your answer.

acceleration = ... unit .... [3]

(iii) Calculate the force required to produce the acceleration of the snowboarder you calculated in **(a)(ii)**.

State the formula you use and show your working.

formula

working

force = ... N [2]

(b) The snowboarder is exposed to infra-red and ultraviolet radiation from the Sun.

Infra-red and ultraviolet radiation are both parts of the electromagnetic spectrum.

(i) Place the radiations infra-red and ultraviolet in their correct positions in the incomplete electromagnetic spectrum in Fig. 9.3.

γ-rays			visible light			radio waves

Fig. 9.3

[1]

(ii) State the speed at which ultraviolet waves travel from the Sun to the Earth in km/s.

Give a reason for your answer.

speed .... km/s

reason ....

....
[2]

(c) Some snow is steadily heated in a beaker.

The temperature of the snow is measured as it is heated.

Fig. 9.4 shows a graph of the results.

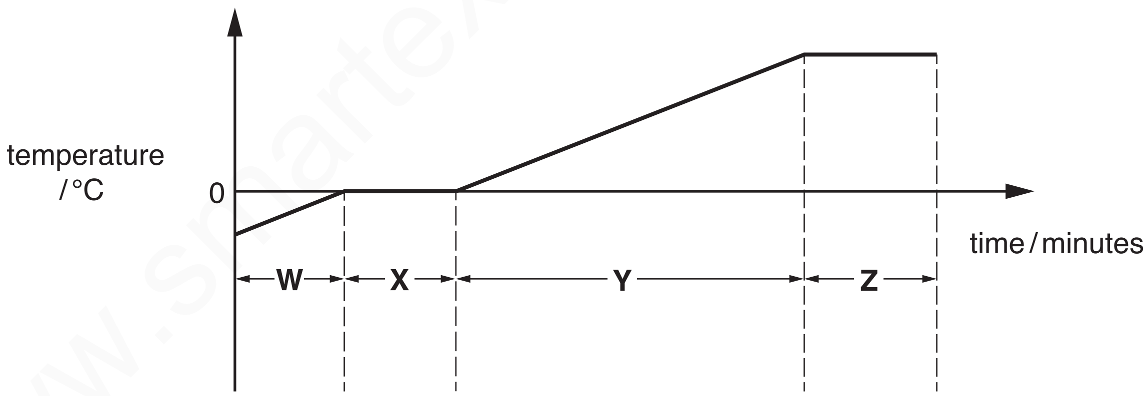

Fig. 9.4

Explain why the temperature of the snow does not increase in section **X**. Use the term *latent heat of fusion* in your answer.

....

....

....

.... [2]

MARKING SCHEME

(a)(i)	maximum speed = 5.0 m/s ; KE = ½ mv^2 OR ½ × 75 × 5 × 5 ; = 940 (J) ;	**3**
(a)(ii)	$\frac{\Delta v}{t}$ OR 4/10 OR 5/12.5 ; = 0.4 ; m/s^2 ;	**3**
(a)(iii)	F = ma OR = 75 × 0.4 ; = 30 (N) ;	**2**
(b)(i)	ultraviolet written in correct box AND infra-red written in correct box ;	**1**
(b)(ii)	300 000 (km/s) ; because all electromagnetic waves travel at this speed ;	**2**
(c)	latent heat of fusion required to melt snow ; to break bonds (between molecules)/to overcome attractive forces (between molecules) / to increase potential energy of the molecules ;	**2**