1 **(a)** Fig. 10.1 shows the speed-time graph for the journey of a bus along a road for 80 seconds.

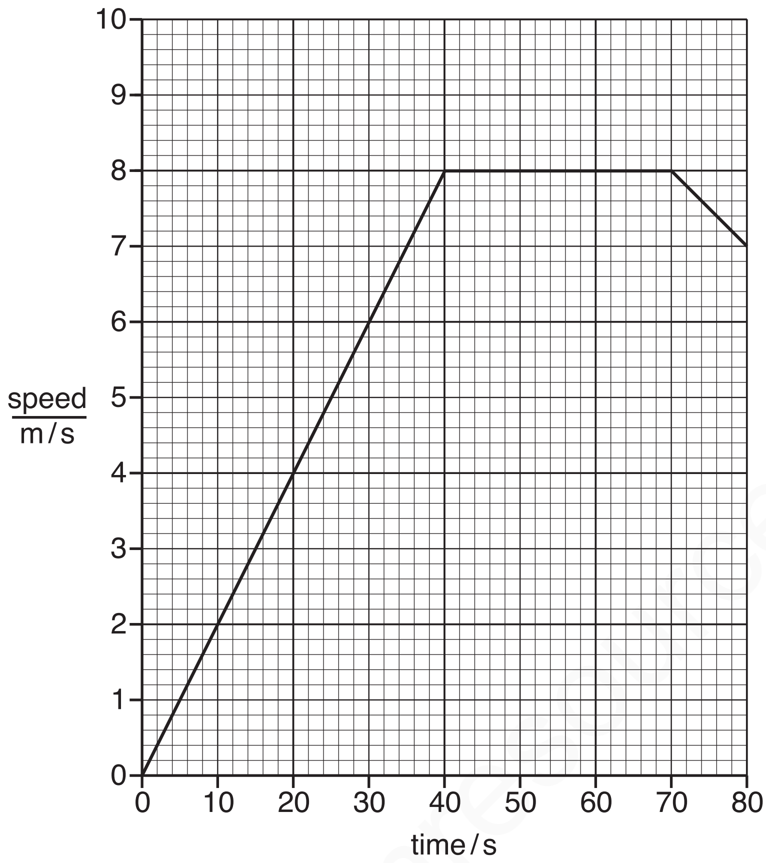

Fig. 10.1

(i) Calculate the distance travelled by the bus in 80 seconds.

Show your working.

distance = ...m [3]

(ii) The mass of the bus is 8000 kg. Calculate the maximum kinetic energy of the bus during the journey.

State the formula you use and show your working.

formula

working

kinetic energy = ...J [3]

(b) The bus has four wheels. Each wheel has a tyre inflated with air.

After a long journey, the tyres are hot and the air pressure in the tyres has increased.

(i) Describe how the air molecules in a tyre exert a pressure on the wall of the tyre.

....

....

....[2]

(ii) Explain, in terms of molecules, why the pressure of the air in the tyres increases when the temperature increases.

....

....

....[2]

(c) The bus has two headlights, $\mathbf{L_1}$ and $\mathbf{L_2}$.

The lamp inside headlight $\mathbf{L_1}$ is connected in parallel with the lamp inside headlight $\mathbf{L_2}$ across a 12 V battery.

Fig. 10.2 shows the circuit diagram for this arrangement.

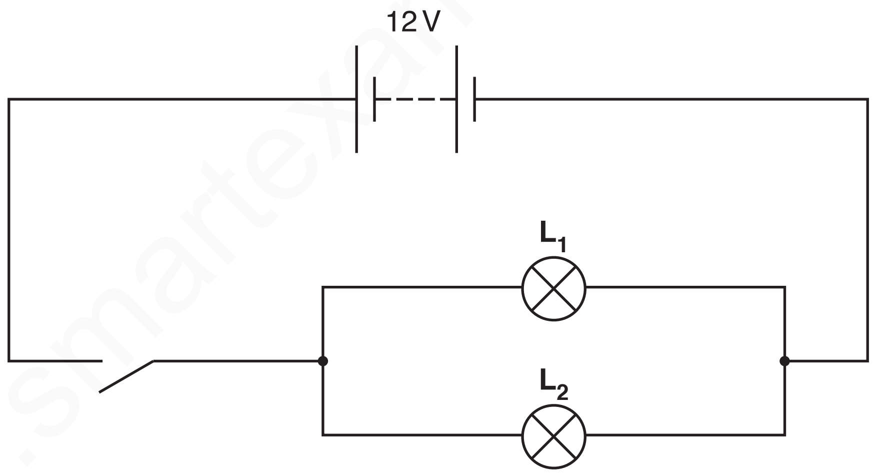

Fig. 10.2

(i) A current of 3.0 A flows through **each** lamp for 80 seconds.

Calculate the total charge that flows through the **two** lamps.

State the formula you use, show your working and state the unit of your answer.

formula

working

charge = ... unit .... [3]

(ii) The resistance of each lamp is 4.0 Ω.

Calculate the combined resistance of the two lamps connected in parallel.

Show your working.

resistance = ... Ω [2]

(d) Some of the bodywork on the bus is made from iron. Other parts are made from steel.

Both iron and steel are magnetic.

Describe **one** difference between the magnetic properties of iron and the magnetic properties of steel.

....

....[1]

MARKING SCHEME

(a)(i)	evidence of area under graph ; = 160 + 240 + 75 ; 475 (m) ;	**3**
(a)(ii)	max speed = 8 m / s ; KE = ½ m v^2 OR ½ × 8000 × 8 × 8 ; = 256 000 (J) ;	**3**
(b)(i)	particles collide with tyre / walls / it ; exert a force (on the tyre wall) ;	**2**
(b)(ii)	particles are moving faster / more (kinetic) energy ; greater rate of collision / more energetic collisions ; more force exerted (on tyre walls) ;	**max 2**
(c)(i)	Q=It OR 3 × 80 OR 240 ; 2 × 240 OR 480 ; C ;	**3**
(c)(ii)	correct formula / substitution / explanation ; 2.0 (Ω) ;	**2**
(d)	iron magnetises quickly / steel magnetises slowly / iron loses magnetism quickly / steel loses magnetism slowly ;	**1**

2 Fig. 3.1 shows a boat pulling a water skier across a lake.

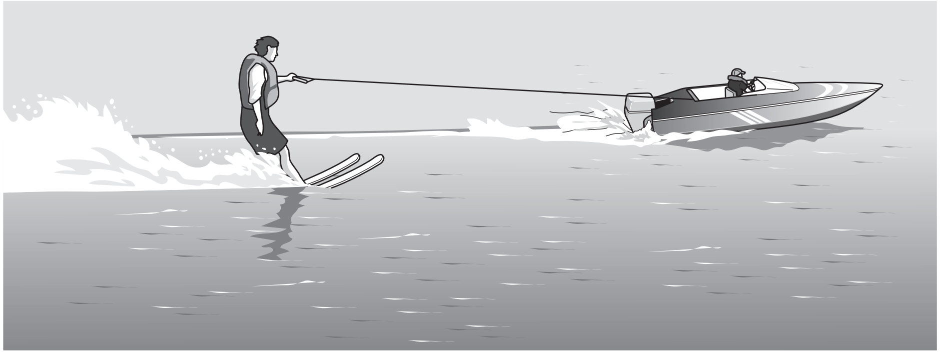

Fig. 3.1

(a) The boat accelerates at a constant rate.

The speed of the water skier increases from 5.0 m/s to 15.0 m/s in 8.0 seconds.

(i) On the grid in Fig. 3.2, draw the speed-time graph to show this motion.

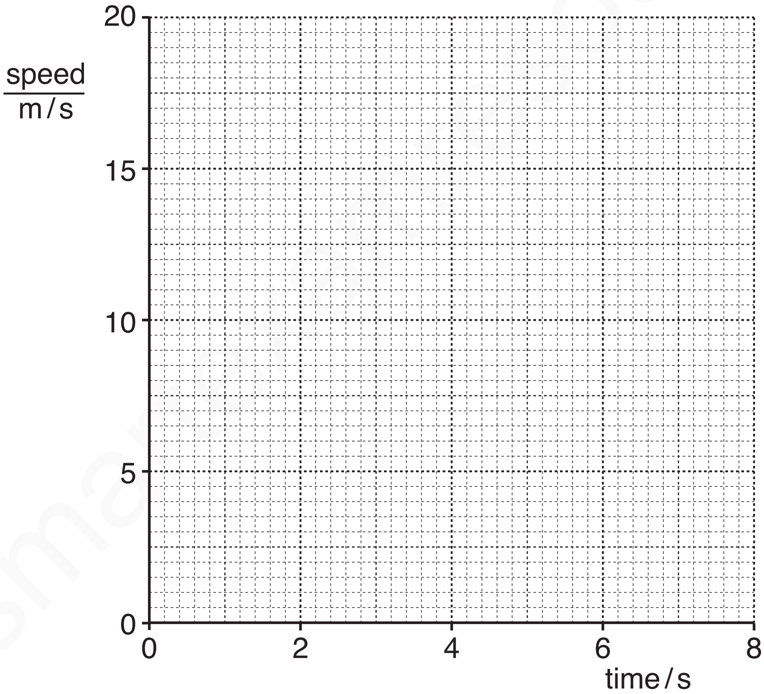

Fig. 3.2

[1]

(ii) Show that the acceleration of the water skier is 1.25 m/s^2.

[1]

(iii) The water skier has a mass of 60 kg.

Calculate the resultant force acting on the water skier as he accelerates.

State the formula you use and show your working.

formula

working

force = ... N [2]

(iv) Calculate the kinetic energy of the water skier when he is moving at 15.0 m/s.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

(b) The water skier produces water waves on the lake.

Fig. 3.3 shows some water waves.

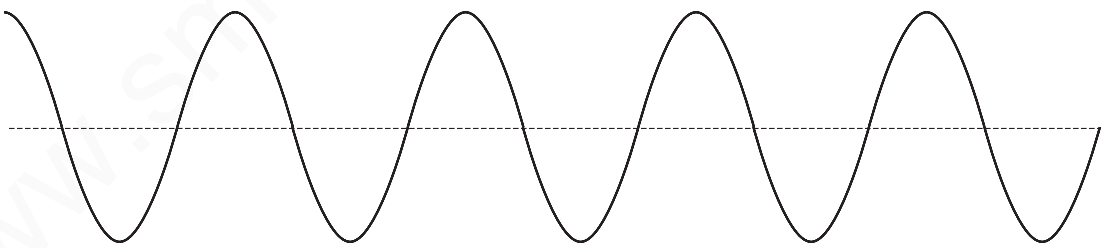

Fig. 3.3

On Fig. 3.3, draw a double headed arrow (⟷) to show the amplitude of the wave. [1]

(c) Fig. 3.4a shows the arrangement of particles in a sound wave.

Fig. 3.4b shows the arrangement of particles on the surface of a water wave.

The direction of movement of the two waves is also shown.

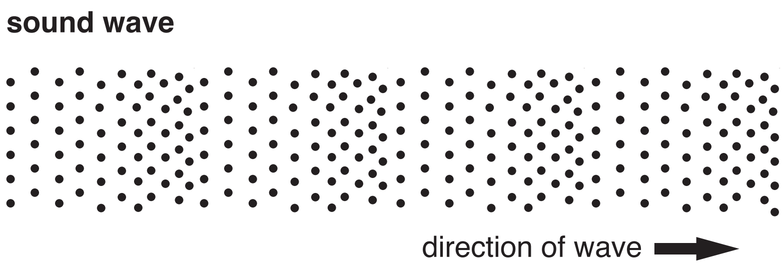

Fig. 3.4a

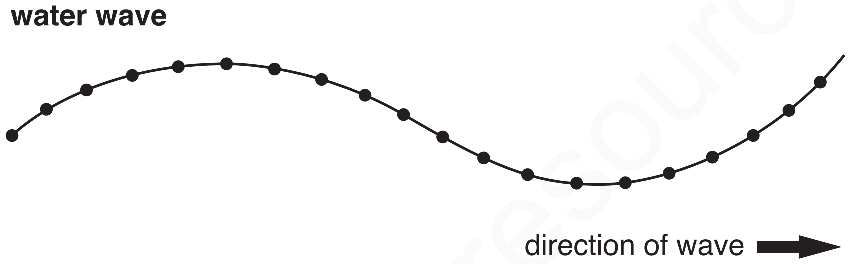

Fig. 3.4b

(i) On Fig. 3.4a, draw a double headed arrow (⟷) to show the direction of movement of particles in a sound wave. [1]

(ii) On Fig. 3.4b, draw a double headed arrow (⟷) to show the direction of movement of particles in a water wave. [1]

(iii) Sound waves pass through the air as a series of compressions and rarefactions.

State, in terms of compressions, what is meant by the frequency of a sound wave.

....

....[1]

MARKING SCHEME

(a)(i)	diagonal line starting at 0,5 and stopping at 8,15 ;	1
(a)(ii)	acceleration = change in speed / time or 10 / 8 = 1.25 ;	1
(a)(iii)	force = mass × acceleration or 60 × 1.25 ; = 75 (N) ;	2
(a)(iv)	kinetic energy = ½ mv^2 or ½ × 60 × 15 × 15 ; = 6750 (J) / 6800 (J) ;	2
(b)	arrow drawn from middle to top or bottom of the wave ;	1
(c)(i)	double headed arrow from left to right ;	1
(c)(ii)	water wave arrow up and down ;	1
(c)(iii)	number of compressions produced by the source per unit time / number of waves that pass a certain point per unit time ;	1

3 **(a)** Fig. 3.1 shows the speed-time graph for part of a journey made by a train.

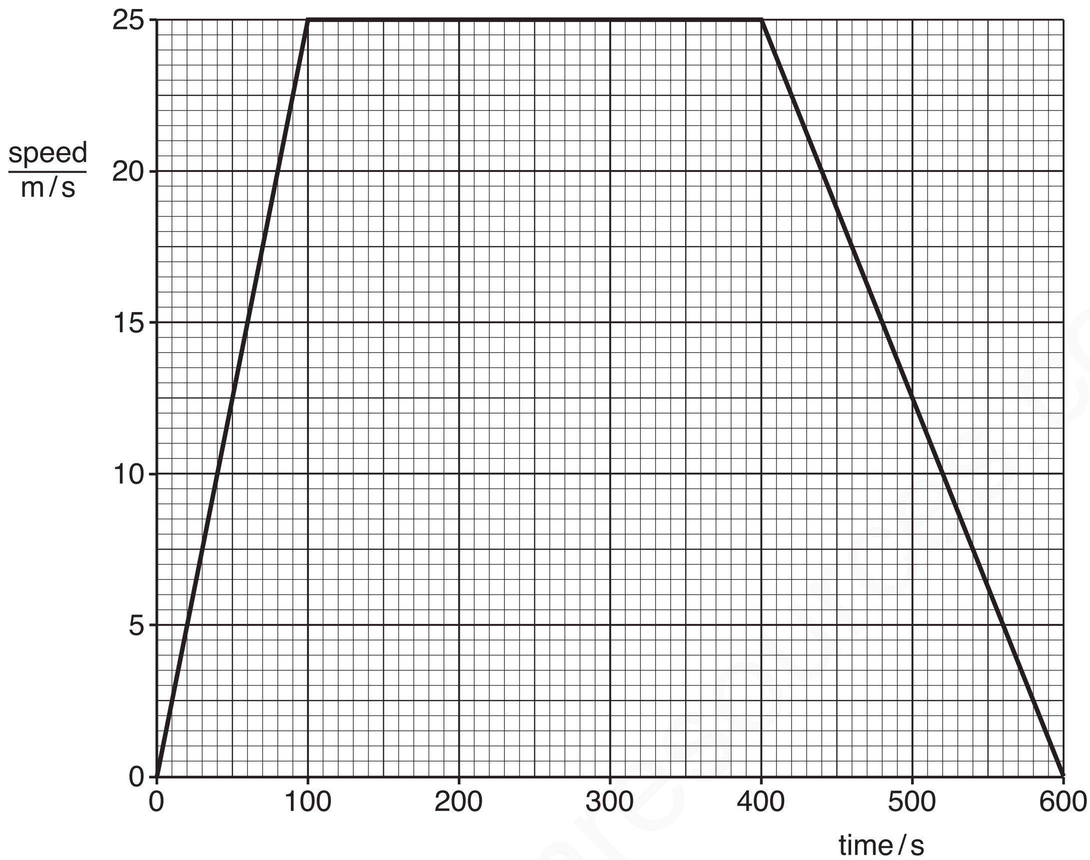

Fig. 3.1

(i) Show that the acceleration of the train at 60 s is 0.25 m/s^2.

State the formula that you use and show your working.

formula

working

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

(ii) The train has a mass of 7.5×10^5 kg.

Calculate the resultant force causing an acceleration of $0.25\,m/s^2$.

State the formula you use and show your working.

formula

working

force = ... N [2]

(b) The electric motor in the train operates at 2000 V. The electrical supply to the train is 25 000 V. A transformer is used to reduce the voltage.

Complete the sentences about a transformer using words from the list.

Each word may be used once, more than once or not at all.

copper **current** **iron** **plastic**

primary **secondary** **voltage**

An alternating .... passes through the primary coil. This produces a magnetic field that continuously changes direction. The soft .... core increases the strength of the magnetic field. The changing magnetic field passes through the secondary coil, inducing a .... across the ends of the coil. In order to reduce the 25 000 V supply to 2000 V, the transformer in the train has more turns on the .... coil than on the .... coil. [3]

MARKING SCHEME:

(a)(i)	acceleration = change in speed / time ; 15 / 60 (= 0.25 (m / s^2)) ;	**2**
(a)(ii)	force = mass × acceleration or $7.5 \times 10^5 \times 0.25$; = 1.9×10^5 (N) ;	**2**
(b)	current iron voltage primary secondary 1 or 2 correct ; 3 or 4 correct ; 5 correct ;	**3**

4 **(a)** In a cartoon, a mouse is being chased by a cat.

The mouse accelerates constantly from rest for 1 second and reaches a speed of 3 m/s and then moves at a constant speed of 3 m/s for 8 seconds.

(i) On the grid in Fig. 6.1 draw the speed-time graph to show the motion of the mouse.

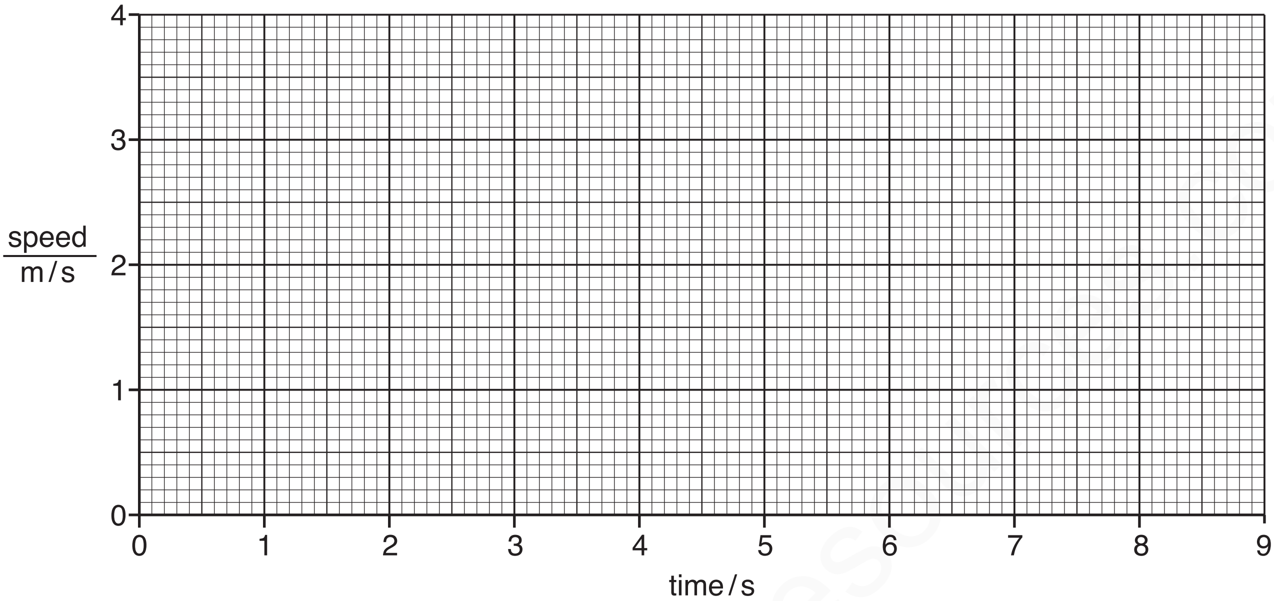

Fig. 6.1

[2]

(ii) The cat accelerates constantly from rest for 9 seconds and reaches a speed of 2 m/s.

Calculate the acceleration of the **cat**.

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

(b) Fig. 6.2 shows the mouse sitting on a cube of cheese, which is on a wooden beam pivoted in the middle.

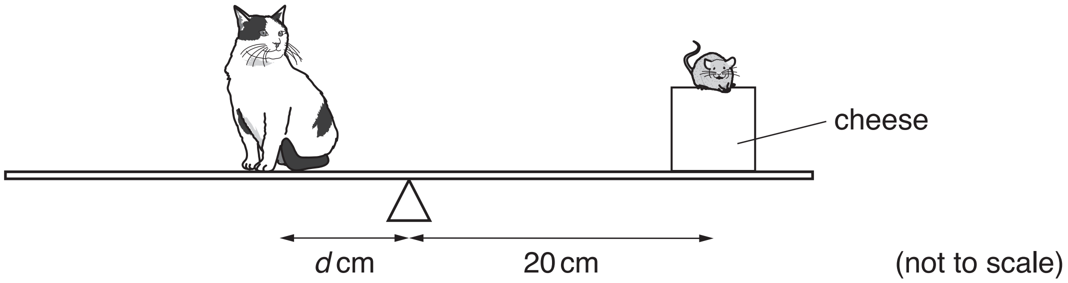

Fig. 6.2

The cat sits on the other end of the beam and balances it.

The weight of the cat is 50 N and the combined weight of the mouse and cheese is 21 N.

Calculate the distance *d* when the beam is balanced.

distance *d* = ... cm [2]

(c) Each side of the cube of cheese is 12 cm.

The weight of the cube of cheese is 20.5 N.

Calculate the density of the cube of cheese in g / cm^3.

gravitational field strength = 10 N / kg

density = ... g / cm^3 [4]

(d) Water evaporates from the cat's bowl.

Liquid water turns into water vapour when it evaporates. Water also turns into water vapour when water boils.

State two differences between the processes of evaporation and boiling.

1 ....

....

2 ....

....
[2]

[Total: 12]

MARKING SCHEME:

(a)(i)	acceleration section ; constant speed section ;	**2**
(a)(ii)	acceleration = change in speed / time **OR** 2 / 9 ; = 0.2 (m / s^2) ;	**2**
(b)	$f_1d_1 = f_2d_2$ **OR** 50 □ d = 21 □ 20 ; d = 8.4 (cm) ;	**2**
(c)	volume = 1728 (cm^3) / use of 12^3 ; mass = 20.5 / 10 **OR** 2.05 kg ; 2.05 □ 1000 **OR** 2050 g ; (density =) 1.2 (g / cm^3) ;	**4**
(d)	evaporation can occur at any temperature / boiling only happens at the boiling point ; evaporation happens at the surface / boiling occurs throughout the liquid ; during boiling all / most molecules have enough energy to leave / evaporation lets only the molecules with most kinetic energy out ; evaporation can occur using the internal energy of the system / boiling a(n external) source of heat ; evaporation produces cooling / boiling does not produce cooling ; evaporation is a slow process / boiling is a rapid process ; **max 2**	**2**

5 **(a)** A farmer drives his tractor at a constant speed.

Fig. 6.1 shows four forces **P**, **Q**, **R** and **S** acting on the tractor.

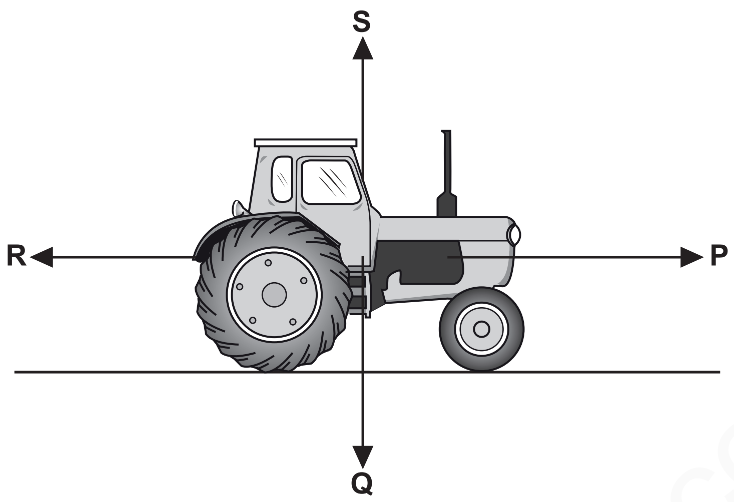

Fig. 6.1

(i) State the letter corresponding to the gravitational force acting on the tractor.

.... [1]

(ii) Force **P** is 1500 N.

State the value of force **R**.

Explain your answer.

force **R** = ... N

explanation ....

.... [2]

(b) The tractor accelerates.

The force causing this acceleration is 4200 N.

The weight of the tractor is 35 000 N.

The gravitational field strength *g* is 10 N / kg.

Calculate the acceleration of the tractor.

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

(c) The tractor has very wide tyres as shown in Fig. 6.2.

Fig. 6.2

The tractor sinks into the soil if the pressure acting on the ground is too large.

Explain why having wider tyres reduces the pressure of the tractor on the ground.

....

....

.... [2]

(d) The farmer lifts a bucket of water from a well.

The bucket of water has a weight of 120 N and is lifted through a vertical distance of 18 m.

Calculate the work done.

work done = ... J [2]

[Total: 10]

MARKING SCHEME

(a)(i)	**Q** ;	**1**
(a)(ii)	1500 (N) ; constant speed / forces are balanced / resultant is zero ;	**2**
(b)	mass = 3500 kg ; force / mass or 4200 / 3500 ; acceleration = 1.2 (m / s^2) ;	**3**
(c)	larger (surface) area ; (so pressure is less as) P = F / A ;	**2**
(d)	(work done =) force × distance or 120 × 18 ; = 2160 (J) ;	**2**

6 **(a)** A student cycles to school.

Fig. 9.1 shows a speed–time graph for the journey.

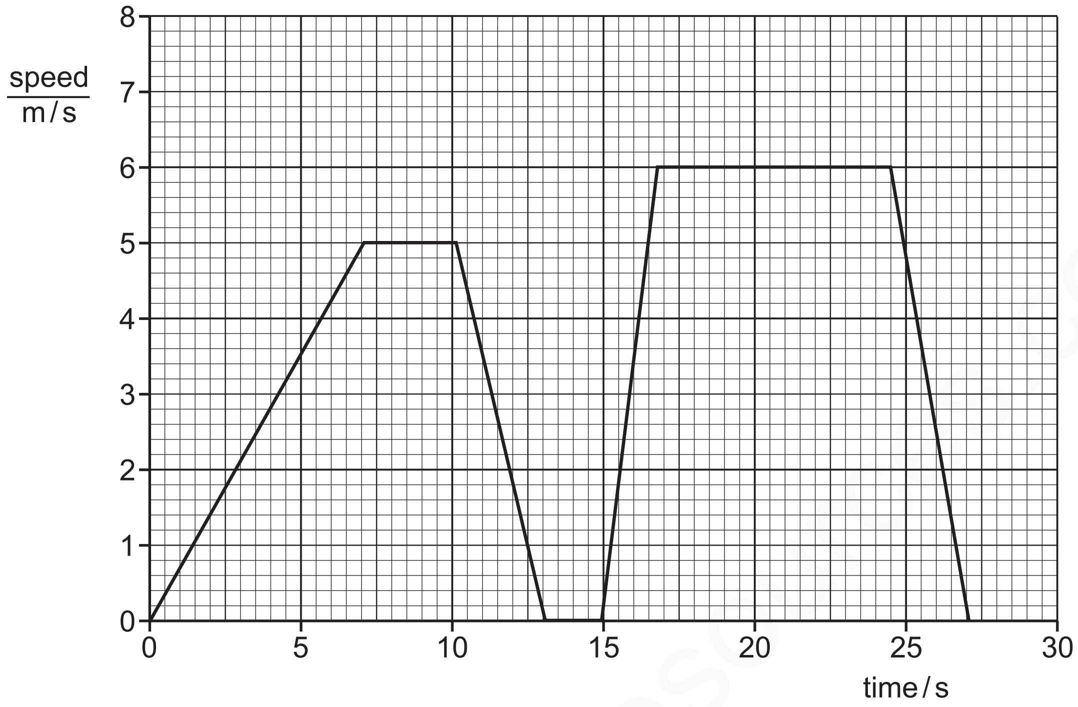

Fig. 9.1

(i) Draw an **X** on Fig. 9.1 to identify the part of the journey where there is maximum acceleration.

[1]

(ii) Calculate the acceleration of the student and bicycle at time = 5 s.

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

(b) At school, the student is asked how she would accurately measure the width of one of the brake cables on her bicycle.

Name a measuring device suitable for measuring very small distances accurately.

.... [1]

(c) The student watches her teacher set up an experiment to detect the β-radiation emitted by a radioactive source, strontium-90 (Sr).

When strontium-90 decays it produces an isotope of yttrium (Y).

(i) Use the correct nuclide notation to complete the symbol equation for this decay process.

$$^{90}_{\dots\dots}\text{Sr} \longrightarrow {}^{\dots\dots}_{\dots\dots}\text{Y} + {}^{\dots\dots}_{\dots\dots}\beta$$

[3]

(ii) State **one** difference between the behaviour of β-particles and γ-rays in an electric field.

....

.... [1]

[Total: 8]

MARKING SCHEME

(a)(i)	**X** between t > 15 s and t < 16.8 s ;	**1**
(a)(ii)	change in speed or 5.0 or gradient calculation ; time taken 7.0 0.7 (m / s^2) ;	**2**
(b)	micrometer screw gauge ;	**1**
(c)(i)	${}^{90}_{38}Sr \rightarrow {}^{90}_{39}Y + {}^{0}_{-1}\beta$ strontium notation correct ; yttrium notation correct ; beta notation correct ;	**3**
(c)(ii)	β-particles deflected / gamma rays are not deflected ;	**1**