1 **(a)** Fig. 12.1 shows the speed–time graph for part of a train journey.

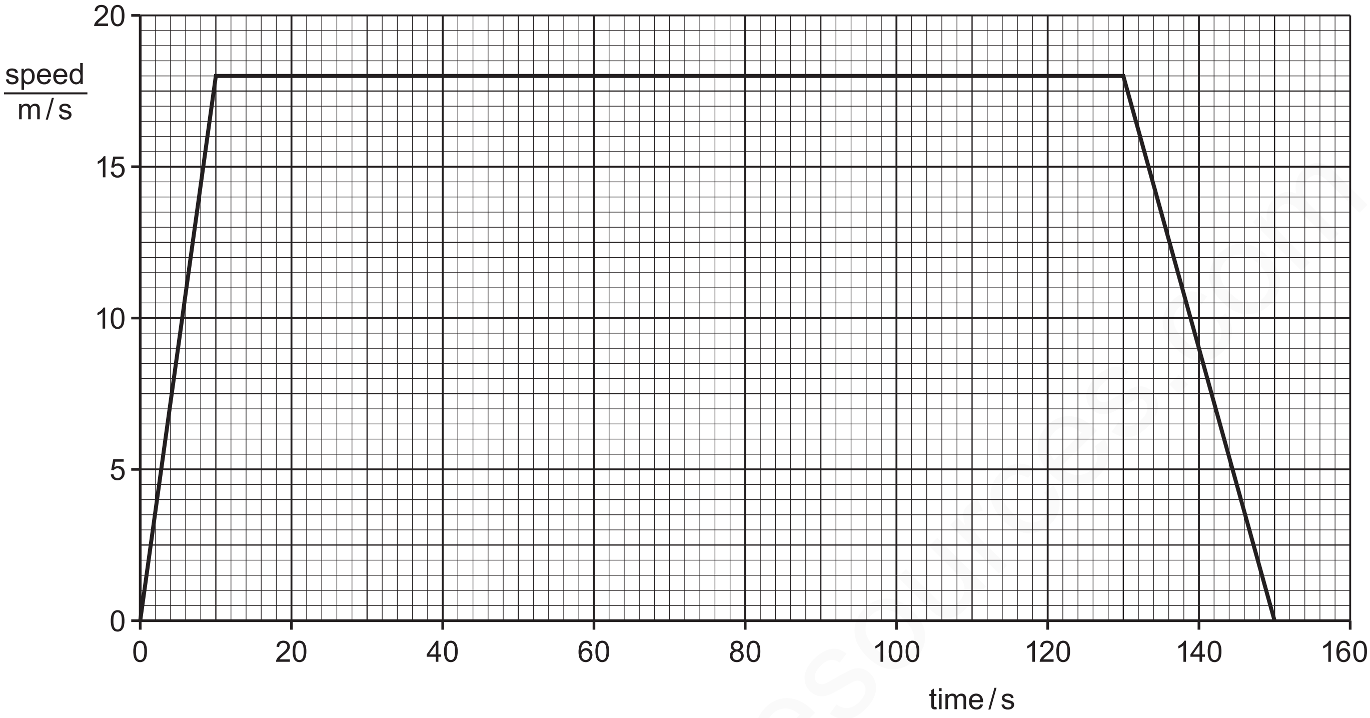


Fig. 12.1

Calculate the acceleration of the train at 5 s.

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

(b) The train has two large headlamps connected in parallel. The lamps have a power rating of 360 W and are operated with a potential difference of 80 V.

(i) Show that the resistance of each lamp is 18 Ω.

[3]

(ii) Calculate the combined resistance of the two lamps connected together in parallel.

resistance = ... Ω [2]

(c) The electricity for the lamps is produced by a generator.

Fig. 12.2 shows a simple generator.

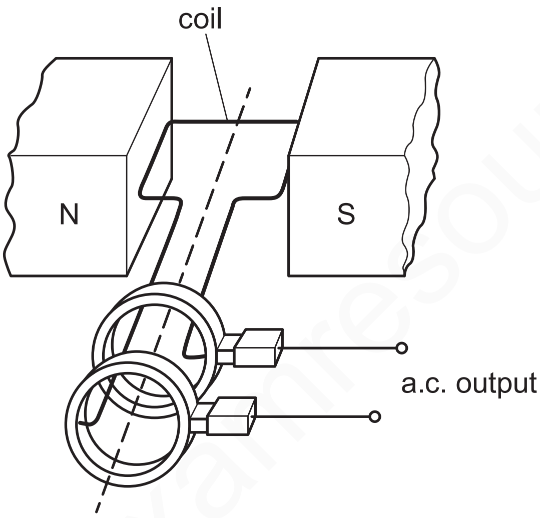


Fig. 12.2

(i) Describe how rotating the coil at constant speed induces an alternating voltage.

....

....

....

.... [2]

(ii) On the grid in Fig. 12.3, sketch a graph of voltage output against time for the generator when the coil rotates at constant speed.

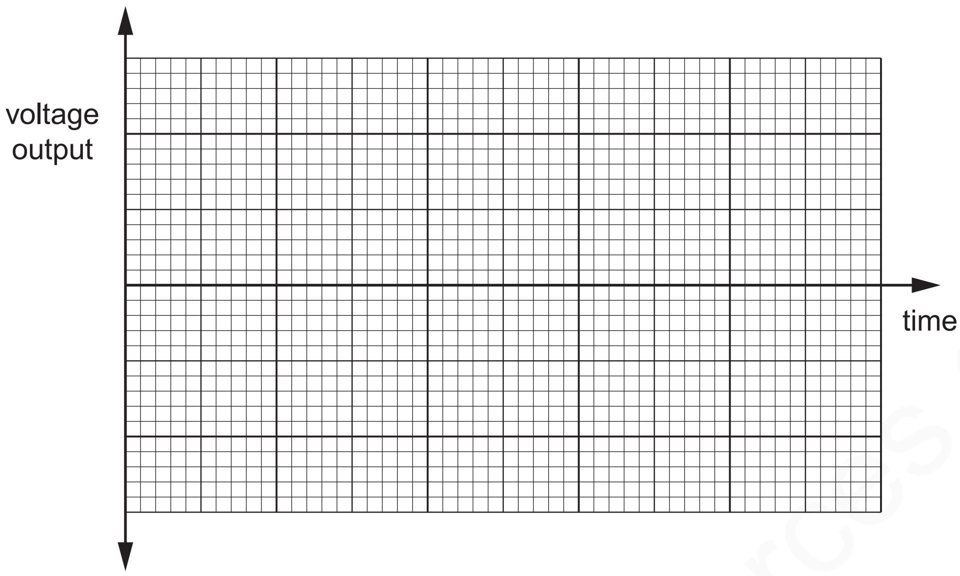


Fig. 12.3

[2]

(iii) The coil is rotated faster.

Suggest two effects this will have on the alternating voltage output.

1 ....

2 ....
[2]

(iv) The permanent magnets in the generator shown in Fig. 12.2 are made from steel rather than iron.

Suggest why the magnets are made from steel rather than iron.

....

.... [1]

[Total: 14]

MARKING SCHEME

(a)	formula or correct substitution (e.g. 18/10); 1.8 (m/s^2);	**2**
(b)(i)	I = P/V or 360/80; current = 4.5 A; resistance = 80/4.5 ;	**3**
(b)(ii)	$1/R_T = 1/R_1 + 1/R_2$ or $R_T = R_1 R_2 / R_1 + R_2$ or correct substitution; 9.0 (Ω);	**2**
(c)(i)	(rotating) coil cuts magnetic field / experiences a changing magnetic field; emf / current reverses every half turn;	**2**
(c)(ii)	approximate sine curve; constant frequency and amplitude;	**2**
(c)(iii)	amplitude / voltage increases; frequency increases;	**2**

2 **(a)** A cyclist accelerates along a straight road from a speed of 4 m/s to maximum speed.

The combined mass of the cyclist and bicycle is 80 kg.

Fig. 12.1 is the speed-time graph for the bicycle and cyclist.

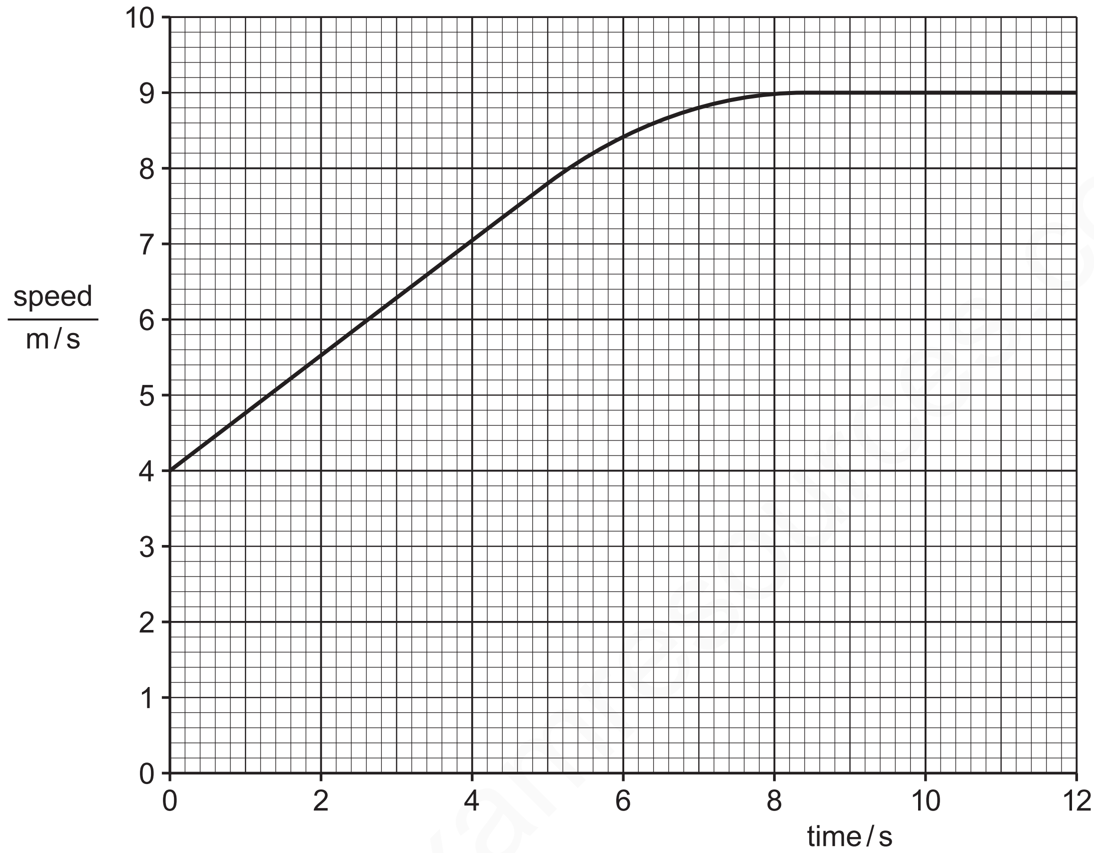


Fig. 12.1

(i) Use Fig. 12.1 to calculate the acceleration at 2 s.

Show your working.

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

(ii) Calculate the resultant force acting on the cyclist and bicycle during this acceleration.

force = ... N [2]

(iii) Calculate the maximum kinetic energy of the cyclist and bicycle during the 12 second period in Fig. 12.1.

kinetic energy = ... J [3]

(b) Fig. 12.2 shows a section through a plastic reflector on the bicycle. A ray of light from a car is incident on the flat surface of the reflector.

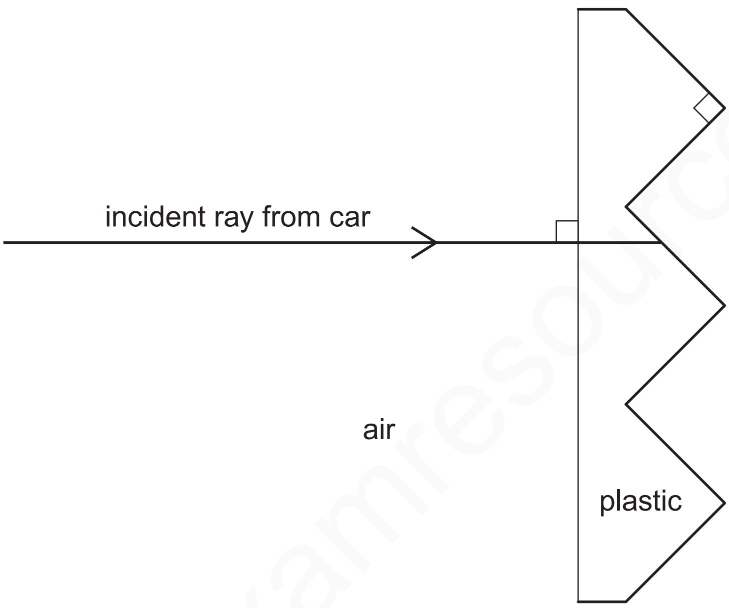


Fig. 12.2

The incident ray is totally internally reflected.

Continue the incident ray on Fig. 12.2 to show the path of the ray of light until it leaves the reflector. [2]

(c) Fig. 12.3 shows a metal nut on the bicycle wheel.

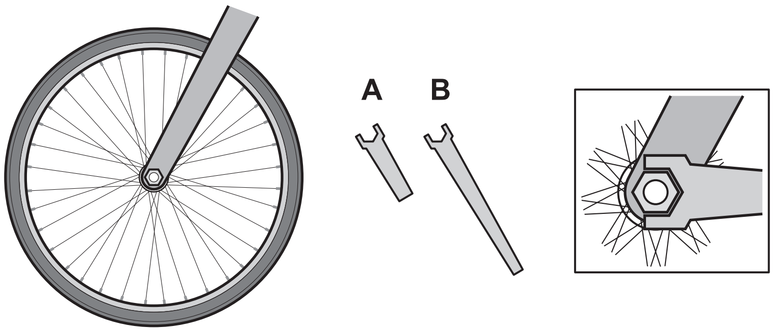


Fig. 12.3

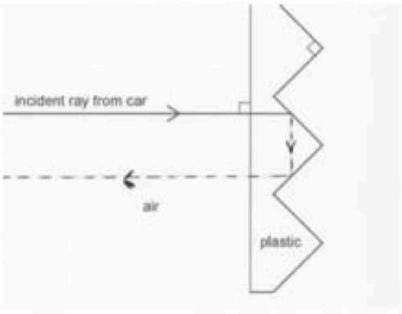
The nut must be turned by either spanner **A** or spanner **B**.

State why spanner **B** will turn the nut more easily than spanner **A**.

.... [1]

[Total: 10]

MARKING SCHEME

(a)(i)	change of speed or correct substitution (e.g. 1.55/2); 0.775 (m/s^2);	2
(a)(ii)	F = ma or 80×0.775; 62 (N);	2
(a)(iii)	max speed = 9 m/s; KE = $\frac{1}{2}mv^2$ or $\frac{1}{2} \times 80 \times 9 \times 9$; 3240 (J);	3
(b)	 reflection only shown at first reflection; after second reflection ray emerges parallel to incident ray;	2
12(c)	spanner **B** is longer / gives a bigger, moment / turning force ;	1

3 **(a)** Fig. 12.1 shows an aircraft being refuelled using a plastic pipe.

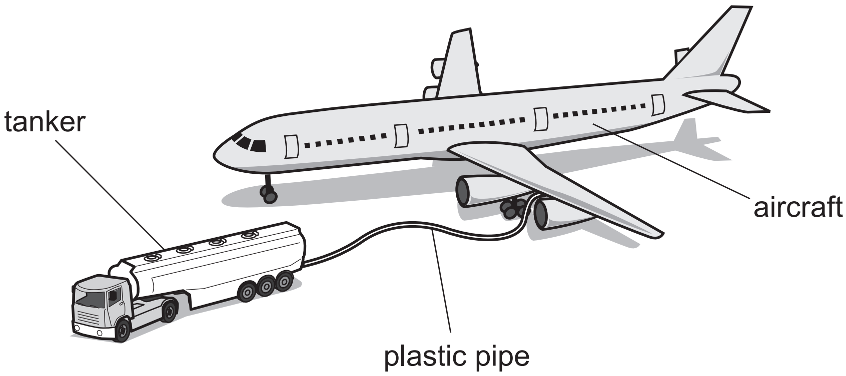


Fig. 12.1

As the fuel flows through the pipe, the fuel and pipe become electrically charged.

Explain why the fuel becomes negatively charged and the pipe becomes positively charged.

....

....

.... [2]

(b) Fig. 12.2 is the speed-time graph for the aircraft during take-off.

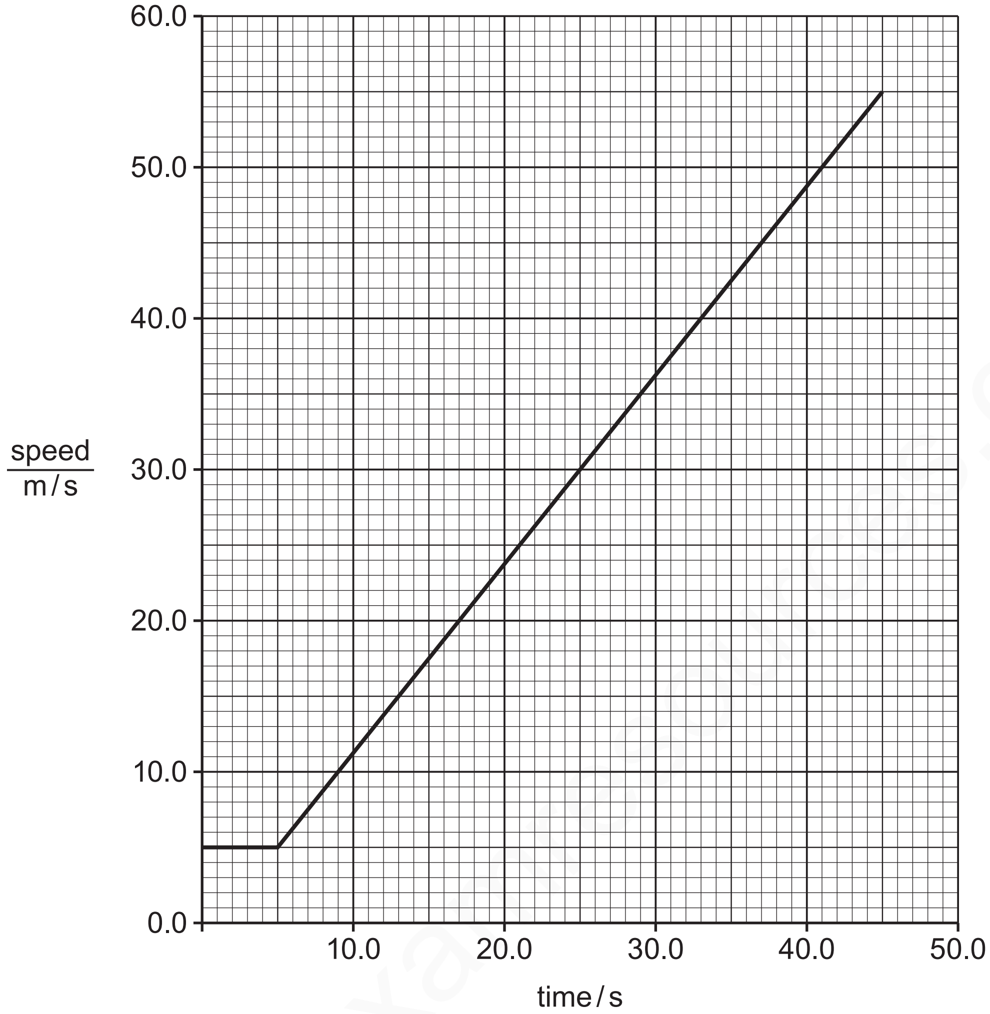


Fig. 12.2

(i) Calculate the acceleration at 25 seconds.

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

(ii) State how the graph shows that the acceleration of the aircraft is constant between 5.0 s and 45.0 s.

....

.... [1]

(c) **(i)** During the flight the pressure inside the aircraft cabin decreases but the temperature is kept constant.

Use ideas about gas molecules to describe the change in pressure in terms of the arrangement and motion of molecules.

....

....

....

.... [2]

(ii) The aircraft flies at a high altitude. Some water on the outside of the aircraft body turns to ice.

Describe in terms of molecular motion and arrangement how ice differs from liquid water.

....

....

.... [2]

[Total: 9]

MARKING SCHEME

(a)	transfer of electrons; from pipe to fuel;	**2**
(b)(i)	correct working (e.g. 50/40) ; 1.25 (m/s^2) ;	**2**
(b)(ii)	straight line;	**1**
(c)(i)	molecules further apart ; fewer molecules collide with, surfaces / walls, in unit time / lower frequency of collision of molecules with, surfaces / walls ;	**2**
(c)(ii)	molecular motion – molecules in liquid water can move throughout but molecules in ice vibrate about a fixed point ; molecular arrangement – molecules in liquid water in random arrangement / molecules in ice in regular arrangement ;	**2**

4 Fig. 11.1 shows an aircraft landing with constant deceleration along an airport runway.

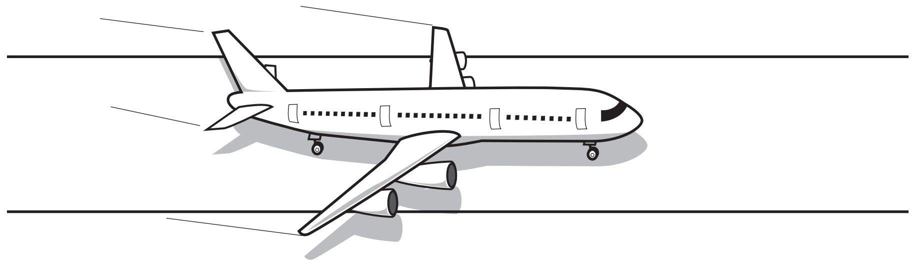
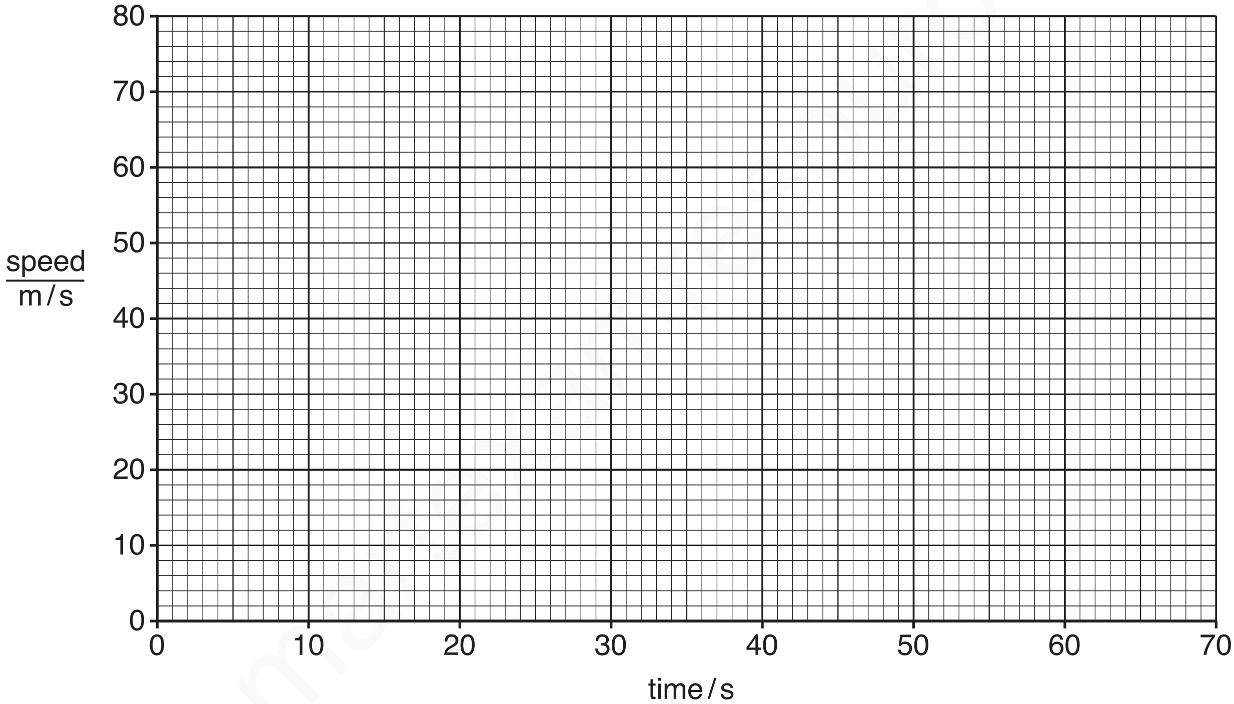


Fig. 11.1

The plane lands at 70 m / s and comes to a halt after 60 seconds.

(a) (i) On the grid provided, draw a speed-time graph to show the motion of the plane during this 60 second period.



[2]

(ii) Calculate the deceleration of the aircraft.

Show your working.

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

(iii) The aircraft has a mass of 350 000 kg.

Calculate the kinetic energy of the aircraft as it lands.

State the formula you use and show your working.

formula

working

kinetic energy = ... J [2]

(b) Microwaves travel at 3×10^8 m/s.

Radar uses microwaves with a frequency of 10 000 MHz to detect the aircraft when it is in flight.

A short pulse is sent from a transmitter, reflected by the aircraft and picked up by a receiver next to the transmitter.

The time it takes for the wave to make the journey to the aircraft and back is 3.3×10^{-5} seconds.

Calculate the distance from the radar transmitter to the aircraft.

State the formula you use and show your working.

formula

working

distance = ... m [3]

MARKING SCHEME

(a)(i)	diagonal line from 0, 70 ; to 60, 0 ;	**2**
(a)(ii)	acceleration = change in speed / time / 70 / 60 ; = 1.17(m / s^2) ;	**2**
(a)(iii)	KE = ½ mv^2 / ½ × 350000 × 70 × 70 ; = 857500000 (J) ;	**2**
(b)	distance = speed x time or working ; = (3 x 10^8 × 3.3 × 10^{-5}) / 2 = OR (3.3 × 10^{-5} / 2) × 3 × 10^8 ; distance = 4950 (m) ;	**3**

5 **(a)** Fig. 7.1 shows a speed-time graph for a car over a period of 50 seconds.

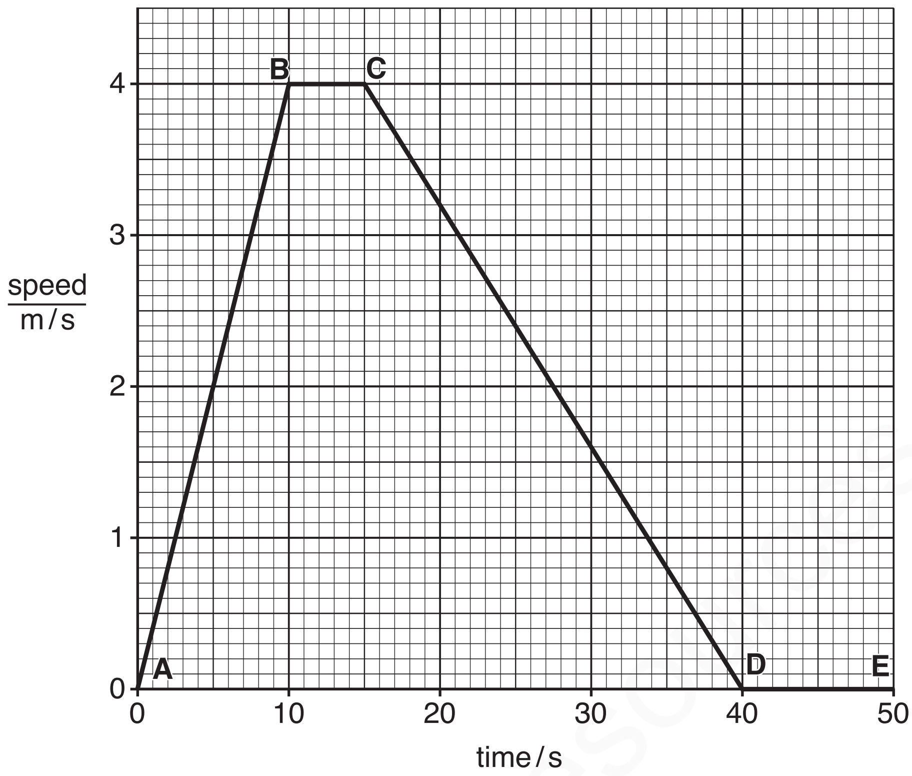


Fig. 7.1

(i) State the maximum speed reached by the car.

.... m/s [1]

(ii) Calculate the total distance travelled by the car.

Show your working.

distance = ... m [2]

(iii) Show that the acceleration of the car during the first ten seconds is $0.4\,m/s^2$.

[1]

(iv) The mass of the car is 950 kg. Calculate the force needed to produce an acceleration of 0.4 m/s^2.

State the formula you use and show your working.

formula

working

force = ... N [2]

(b) The temperature of the air in car tyres increases during a journey.

(i) Describe what happens to the motion of the air particles as the air warms up.

....

....[1]

(ii) When the temperature of the air in the tyres increases, the pressure in the tyres increases.

Explain in terms of the motion of the air particles why the pressure increases.

....

....

....[2]

(c) Relays are needed in many electrical circuits used in machines.

Fig. 7.2 shows a simple relay circuit.

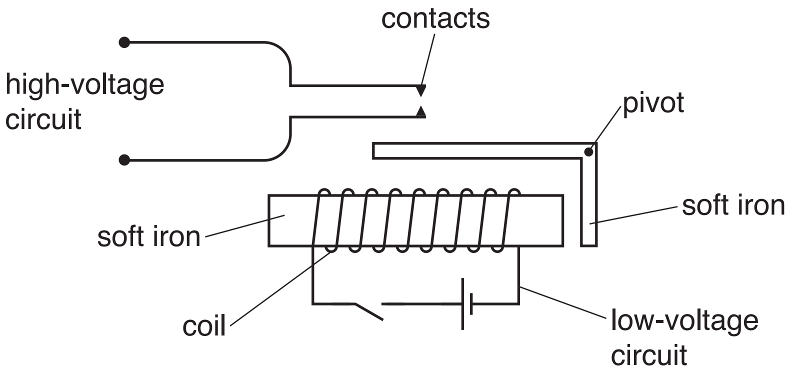


Fig. 7.2

(i) Describe how a small current flowing in a low-voltage circuit is able to turn on the high-voltage circuit.

....

....

....

....

.... [3]

(ii) Suggest how the use of a relay in a high-voltage circuit protects the person operating a machine.

....

....[1]

MARKING SCHEME:

(a)(i)	4 (m / s) ;	**1**
(a)(ii)	area under graph / working ; 20 + 20 + 50 = 90 (m) ;	**2**
(a)(iii)	working **;** e.g. correct substitution into formula such as 4 / 10 ;	**1**
(a)(iv)	force = mass × acceleration / 950 × 0.4 ; 380 (N) ;	**2**
(b)(i)	move faster ;	**1**
(b)(ii)	more frequent collisions / collide at greater speed, with tyre wall ; more force exerted on tyre walls ;	**2**
(c)(i)	current in low voltage circuit creates magnetic field (around solenoid) ; soft iron attracted (to magnet / solenoid) ; contacts in high voltage circuit close ;	**3**
(c)(ii)	so that humans, are not exposed to the high voltage circuit / operate low voltage switching circuit / owtte ;	**1**