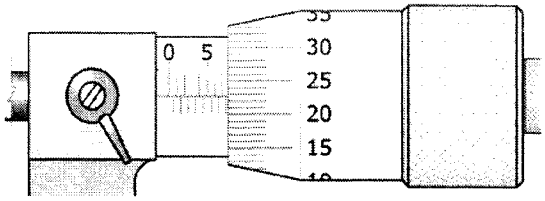
Answer all questions on the optical mark sheet.

1 The light year is defined as the distance light travels in 1 year. There are 365 days in 1 year.

Which of the following is the nearest estimate of 1 light year?

A 100 Gm **B** 1 000 Gm **C** 10 000 Gm **D** 10 000 000 Gm

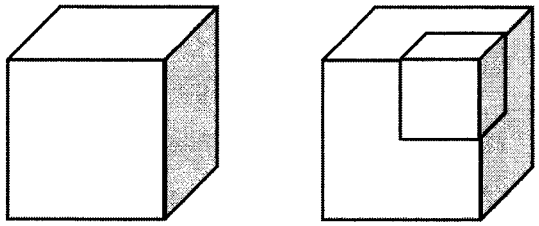
2 The diagram below shows the reading on a micrometer screw gauge.



What is the reading on the micrometer screw gauge?

A 7.22 mm **B** 7.72 mm **C** 7.22 cm **D** 7.72 cm

3 A cube of mass 5.0 kg with sides 0.20 m long has a cube of sides 0.10 m cut from its corner as shown.



What is the density of the remaining section of the cube?

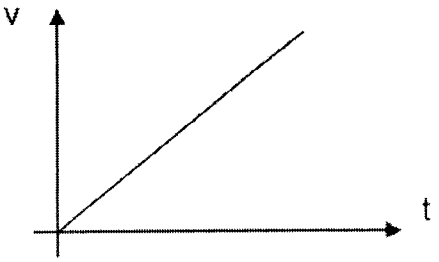
A 25 kg/m^3 **B** 547 kg/m^3 **C** 625 kg/m^3 **D** 714 kg/m^3

4 A bullet is fired towards a nearby tree trunk with a speed of 200 m/s. The bullet is found at a depth of 0.05 m in the tree trunk.

What is the time taken by the tree to stop the bullet in its trunk?

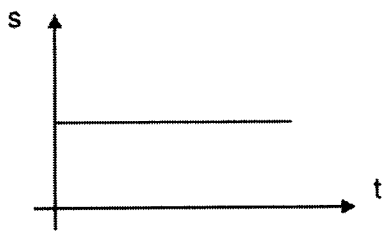
A 5×10^{-2} s **B** 5×10^{-3} s **C** 5×10^{-4} s **D** 5×10^{-5} s

5 The following graph shows the velocity-time graph of a body.

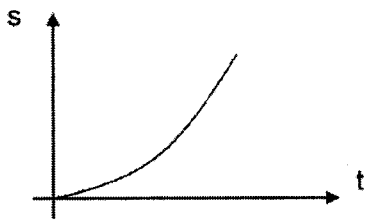


Which of the following graphs shows the correct displacement-time graph of the body?

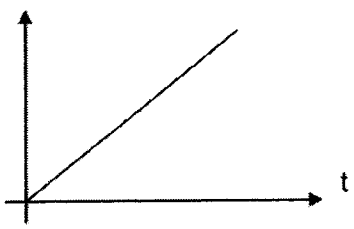
A



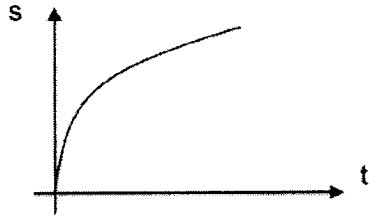
B



C



D



6 A ball rolling across a field will slow down and eventually stop because

A inertia will cause all objects to remain in a state of rest.

B there is no net force acting on the ball.

C there is a force that acts in the direction opposite its motion.

D the ball has no energy since there is no work done on the ball.

7 A 2000 kg car travelling at a constant velocity of 25 m/s encounters a total resistive force of 50 kN. You may assume that there are no other horizontal forces acting on the car.

Which of these relationships describes the driving force F provided by the engine?

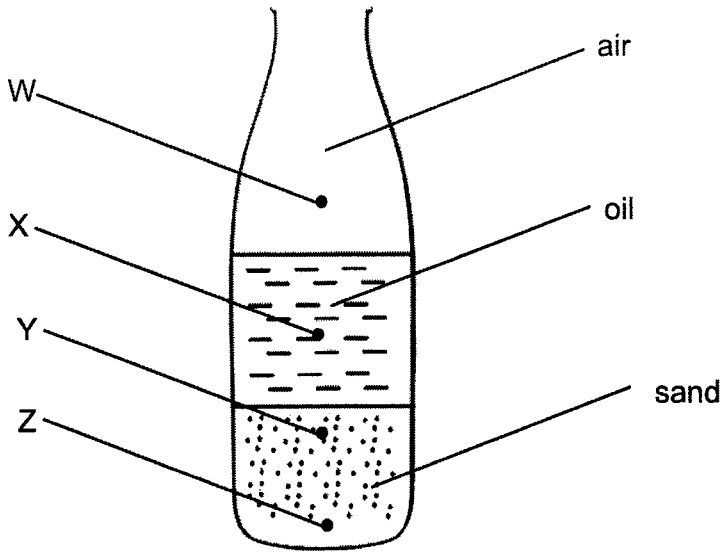
A $F = 0$ N **B** $F < 50$ kN **C** $F = 50$ kN **D** $F > 50$ kN

8 A pellet of mass 50 mg is fired vertically upwards and reaches a height of 1000 m.
The gravitational field strength *g* is 10 N/kg.

What is the total energy at the highest point?

A 0 J **B** 0.5 J **C** 500 J **D** 500 000 J

9 The diagram shows a bottle containing air, oil and sand.



More sand is added to the bottle. This affects the position of the centre of gravity of the bottle and its contents.

How might the centre of gravity move?

A from X towards W

B from W towards X

C from Y towards X

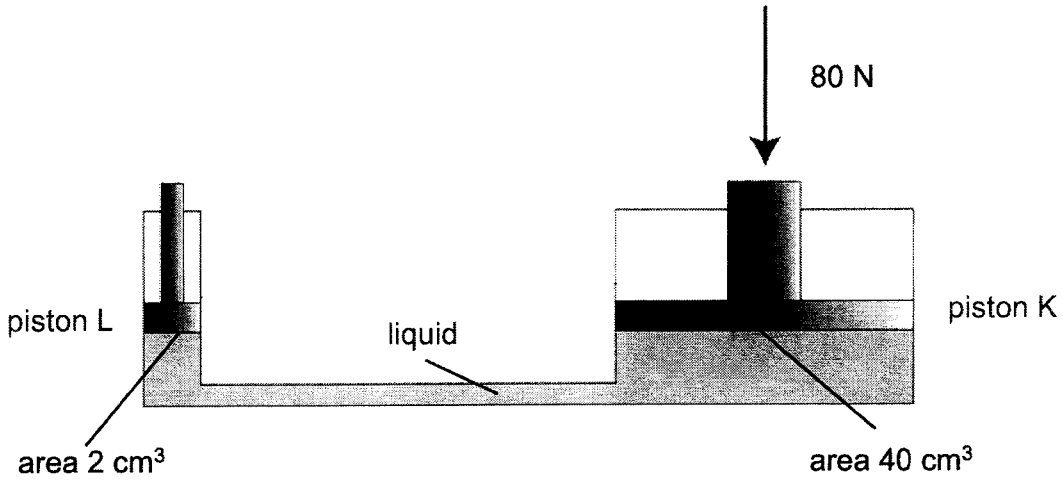
D from Y towards Z

10 A rectangular box of dimensions 4.0 m by 2.0 m by 3.0 m weighs 50 N.

What is the minimum pressure it can exert on the surface it rests on?

A 2.1 Pa **B** 4.2 Pa **C** 6.3 Pa **D** 8.3 Pa

11 The diagram shows the cross-section of a hydraulic jack. Piston K is supporting a weight of 80 N. The liquid in the hydraulic jack is not compressible.



Which of the following statements is correct?

A The force at piston L is 1600 N.

B Piston K will move a longer distance than piston L.

C The pressure at piston K and piston L is the same.

D The pressure at piston K is lower than at piston L.

12 A man lies on a bed of needles. The number of needles is doubled.

What row describes the change on force on the man and the pressure at the contact?

	force on man	pressure at contact
A	doubled	remains the same
B	remains the same	halved
C	doubled	doubled
D	remains the same	remains the same

13 Illuminated smoke particles, suspended in air, are viewed through a microscope. They appear to move randomly.

Which of the following best describes the conversion or transfer of energy that takes place?

A kinetic energy of air molecules → kinetic energy of smoke particles

B potential energy of air molecules → kinetic energy of smoke particles

C heat energy from source → kinetic energy of smoke particles

D light energy from source → kinetic energy of smoke particles

14 Which of the following statements is true when the temperature of a solid is raised?

A The mass of the solid increases as the volume increases

B The molecules expand and the solid occupies a greater volume.

C The molecules in the solid start to slide past each other at a greater speed.

D Heat travels to all parts of the solid in the form of kinetic energy of the molecules.

15 A gas in the process of condensation.

Which of the following statements best describes what happen to the gas?

A It will take in heat in order to break the intermolecular forces.

B It will give off heat because intermolecular forces are forming.

C It will give off heat because its molecules are losing kinetic energy.

D It will not give off or take in any heat because there is no change in temperature.

16 Blowing across the surface of a bowl of hot soup will cause it to cool.

Which of the following statements best explains this observation?

A Convection cannot occur without blowing.

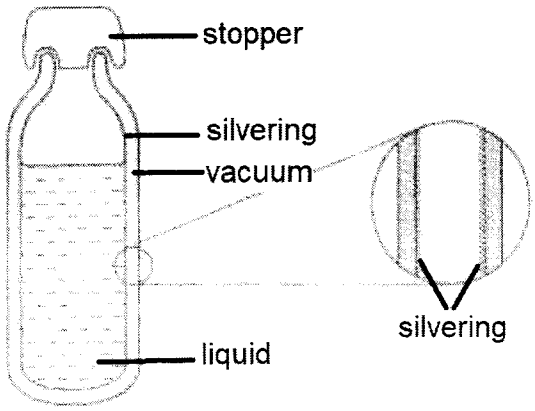
B Blowing across the surface allows more evaporation to take place.

C Blowing across the surface increases the surface area for radiation.

D Still air is a poor conductor of heat but moving air is good conductor of heat.

[Turn Over

17 The diagram shows a vacuum flask and an enlarged view of a section through the flask wall.



Which of the following best explains why the silvering is needed in reducing heat loss of the liquid in the flask?

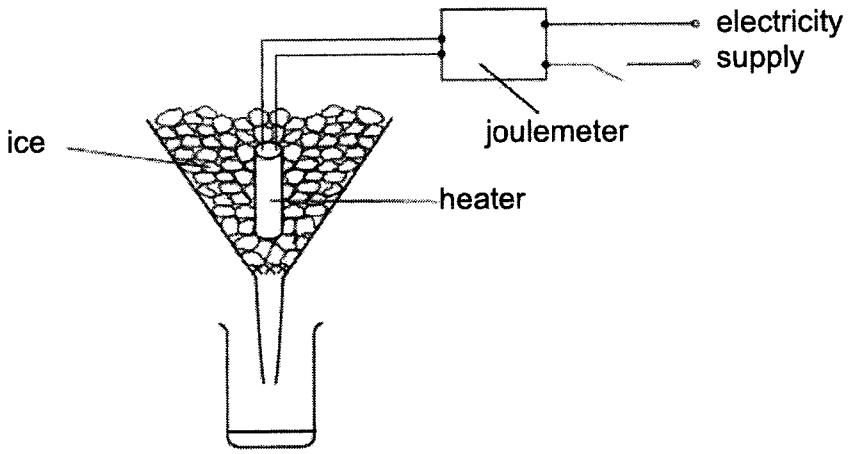
A silver surfaces are poor absorbers of radiation

B silver surfaces are good absorbers of radiation

C silver surfaces are poor emitters of radiation

D silver surfaces are good emitters of radiation

18 In the experiment shown below, the amount of electrical energy used to melt some ice is measured using a joulemeter.



What is needed to find the specific latent heat of fusion?

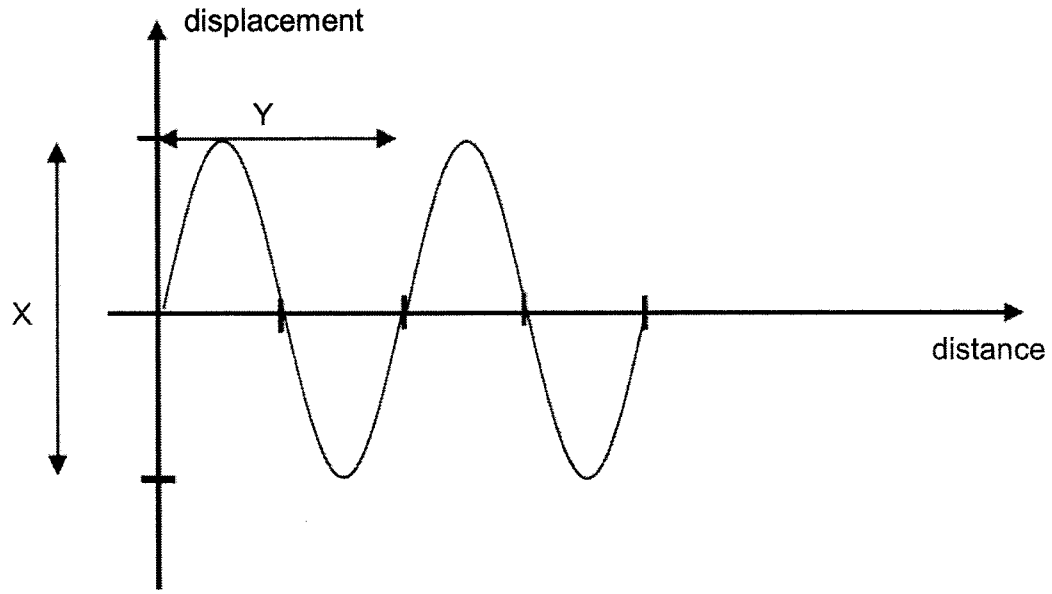
A the final temperature of water

B the temperature change of ice

C the voltage of the electricity supply

D the mass of water produced by the melting ice

19 The diagram shows a graph of wave motion.



What information can you deduce from the graph?

A The amplitude of the wave is X.

B The amplitude of the wave is X/2.

C The period of the wave is Y.

D The period of the wave is Y/2.

20 A wave moves across the surface of the water in a ripple tank. In 1.0 minute, a wavefront moves 12 wavelengths.

What is the frequency of the wave?

A 0.20 Hz **B** 2.5 Hz **C** 5.0 Hz **D** 12 Hz

21 The critical angle of a medium is 45°.

What is the refractive index of the medium?

A 0.71 **B** 1.00 **C** 1.33 **D** 1.41

22 An object is placed 12 cm from a lens of focal length 8 cm.

Which of the following best describes the property of the image?

A real, inverted, diminished

B real, inverted, magnified

C real, upright, magnified

D virtual, upright, diminished

23 The refractive index of water is 1.33.

What is the speed of light in water?

A 7.5×10^7 m/s **B** 2.25×10^8 m/s **C** 3.00×10^8 m/s **D** 4.00×10^8 m/s

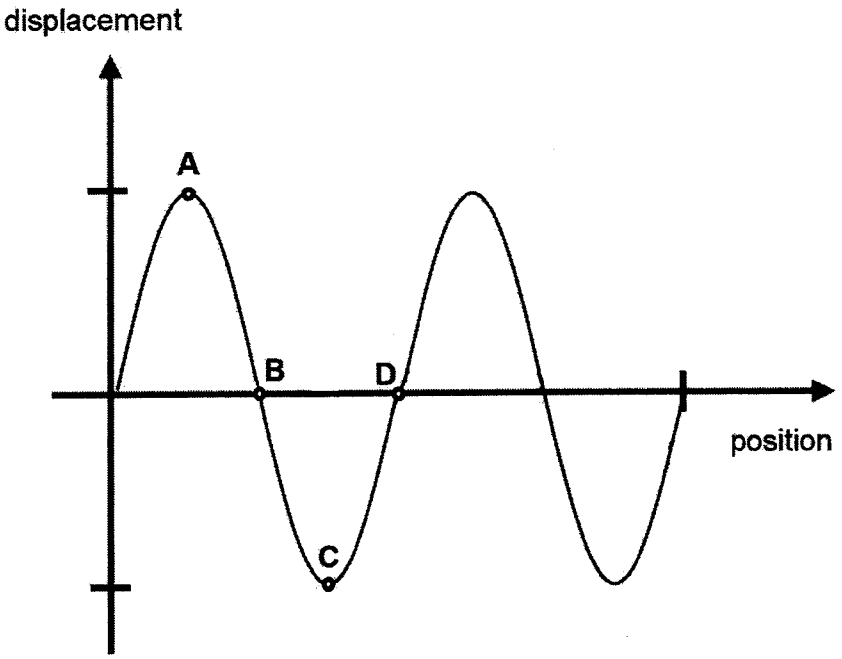
24 A boy shouts on a mountain and hears the echo from the nearest neighbouring mountain after 2.0 s. The speed of sound in air is 300 m/s.

How far is the neighbouring mountain from the boy?

A 75 m **B** 150 m **C** 300 m **D** 600 m

25 The diagram shows a graph which describes a longitudinal wave, with right defined as the positive direction.

Which is a center of compression?



26 Which of the following observation/s shows that an unknown material X is a magnet?

I A current carrying wire is wound around X deflected a compass needle.

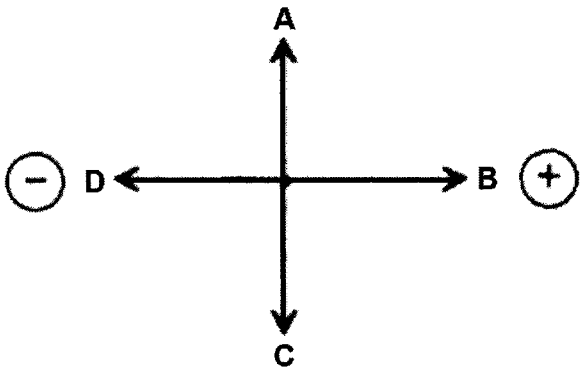
II A North pole of a permanent magnet will attract X.

III A South pole of a permanent magnet will repel X.

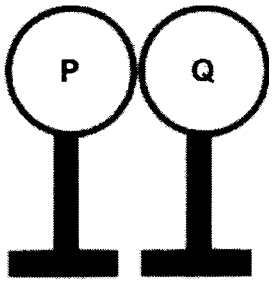
A I and III only **B** II and III only **C** I and II only **D** III only

27 The diagram shows two charges placed near to each other.

In which direction will the electric field act?



28 The diagram shows two insulated metal spheres P and Q touching each other. The following steps are carried out in succession on both spheres.



Step 1: Bring a positively charged rod near to sphere P on the left.

Step 2: Earth sphere Q momentarily.

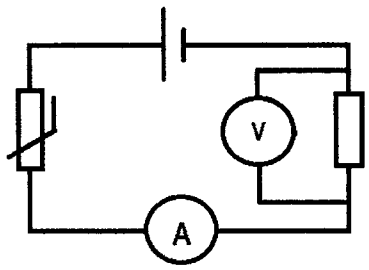
Step 3: Separate sphere P and Q.

Step 4: Remove the positively charged rod.

What are the final charges on sphere P and Q?

	charge on sphere P	charge on sphere Q
A	positive	positive
B	positive	neutral
C	negative	neutral
D	negative	negative

29 A resistor and a thermistor are connected in series with a cell, as shown.



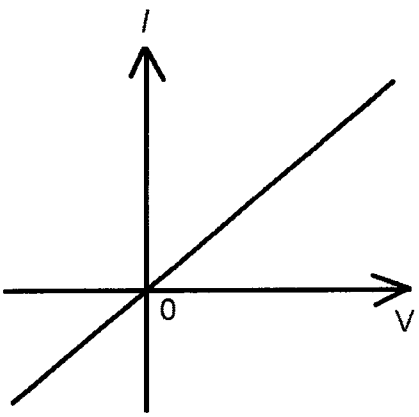
The thermistor is exposed to high temperature, the readings on both ammeter and voltmeter change.

How do they change?

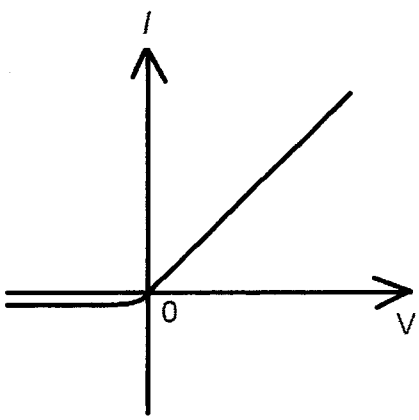
	reading on ammeter	reading on voltmeter
A	decreases	decreases
B	decreases	increases
C	increases	decreases
D	increases	increases

30 Which graph shows the *I* / *V* characteristics for a semiconductor diode?

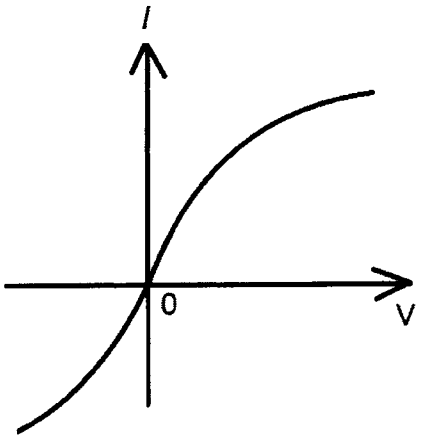
A



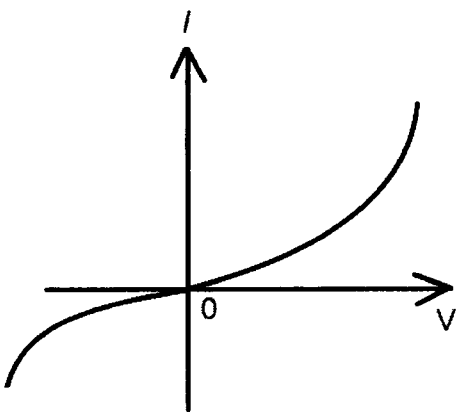
B



C



D



31 A wire has resistance R. Another wire has a length that is half as long with twice the diameter of the original wire. Both wires are made of the same material.

What is the resistance of the new wire?

A (R / 8) **B** (R / 4) **C** R **D** 2R

32 A battery moves a charge of 60 C around a circuit in a time of 15 s.

What is the current in the circuit?

A 900 A **B** 240 A **C** 4.0 A **D** 0.25 A

[Turn Over

33 A heater is marked 240 V, 1.2 kW.

Which fuse rating is suitable for the heater?

A 5 A **B** 7 A **C** 12 A **D** 20 A

34 The cost of a unit (kWh) of electricity is 24 cents.

What is the cost, to the nearest cent, to turn on a 0.5 kW computer for 30 minutes?

A $ 0.06 **B** $ 3.60 **C** $ 21.60 **D** $ 60.00

35 A current of 4 A flows in the live wire of a socket when the appliance is functioning normally.

Which of the following statements is true?

A A current of 4 A flows in the neutral wire.

B A current of 4 A flows in the earth wire.

C A current of less than 4 A flows in the neutral wire.

D A current of less than 4 A flows in the earth wire.

36 The electric light switch for a bathroom is sometimes fitted on wall outside the bathroom.

Why is this safer than fitting the switch on the wall inside the bathroom?

A The heat from the light affects the switch.

B The switch is less likely to be damaged outside the bathroom.

C The warm air in the bathroom causes the switch to overheat.

D The person in the bathroom may be electrocuted if the user touches the switch with wet hands.

37 Which of the following statement best expains why a magnet will attract a piece of soft iron?

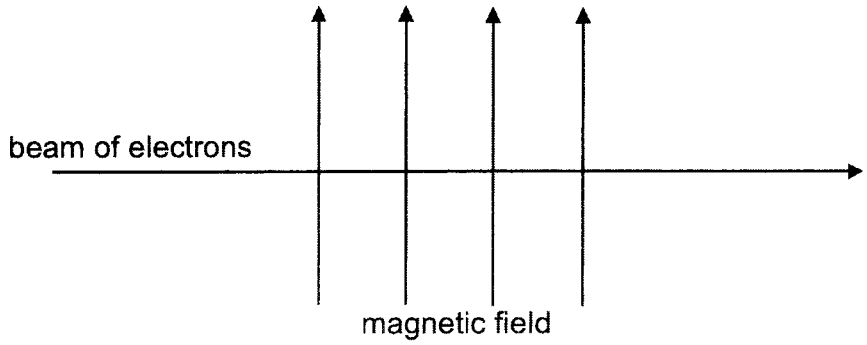
A The piece of soft iron becomes an induced magnet.

B The piece of soft iron becomes a temporary magnet.

C The piece of soft iron becomes a permanent magnet.

D An induced current will flow in the piece of soft iron.

38 The diagram shows the direction of a beam of electrons passing through a magnetic field.



In which direction will the beam of electrons deflect?

A into the page

B out of the page

C up towards the top of the page

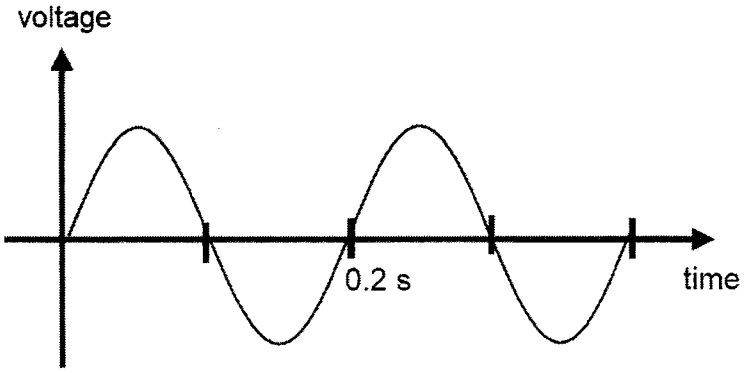
D down towards the bottom of the page

39 An a.c. input of 240 V is connected to the primary coil of an ideal transformer. The output current is 6 A.

Which of the following is a possible combination of the input current and output voltage?

	input current	output voltage
A	12 A	120 V
B	480 A	24 V
C	1 A	40 V
D	0 A	0 V

40 An ac generator produces an output voltage as shown in the diagram.



Which of the following best describes the changes if the generator is turned twice as fast?

	output voltage	period
A	doubles	doubles
B	halves	doubles
C	doubles	halves
D	unchanged	doubles

END OF PAPER

For examiner's use

SECTION A [50 marks]

Answer **all** questions in this section.

1 A car describes a linear motion represented by the graph shown in Fig.1.1.

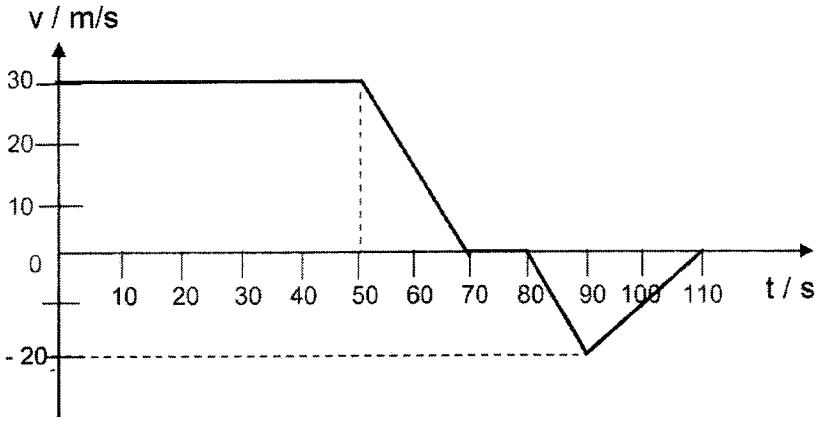


Fig. 1.1

(a) **(i)** Describe the motion of the car from t = 50 s to 90 s.

.....

.....

.....

..... [2]

(ii) Calculate the deceleration of the car from t = 50 to 70 s.

deceleration = ... [2]

(b) Calculate the total displacement of the car for the whole journey.

total displacement = ... [2]

[Turn Over

For examiner's use

(c) On Fig. 1.2, sketch the displacement-time graph for the car's motion from t = 0 s to t = 80 s. Indicate all relevant values on the graph.

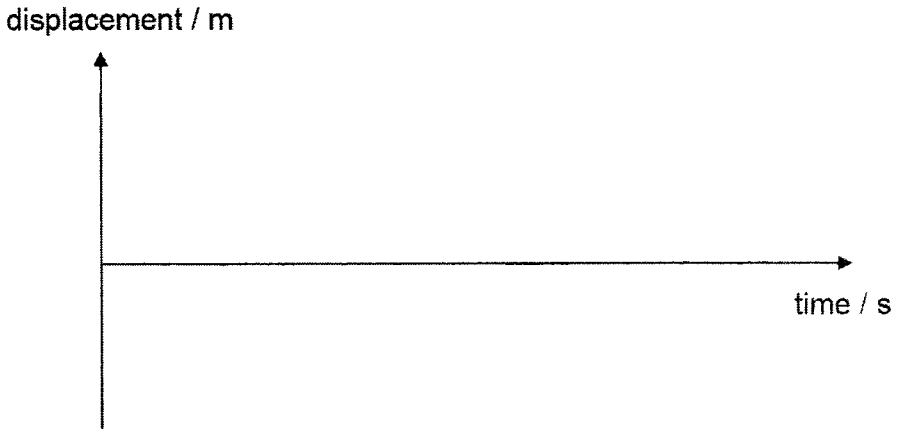


Fig. 1.2 [2]

2 A uniform rod PQ of length 80.0 cm and weight 2.0 N is placed on the pivot as shown in Fig. 2.1 below. A spring balance is attached to the other end of the rod. A load of 8.0 N is placed 20.0 cm from the spring balance.

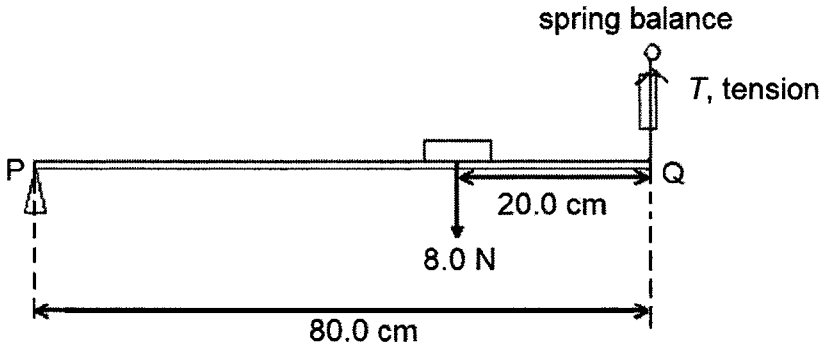


Fig. 2.1

(a) **(i)** Calculate *T*, the tension on the spring balance in order for the rod to balance horizontally.

tension, T = ... [2]

[Turn Over

For examiner's use

(ii) Calculate the magnitude of the reaction force on the pivot and state the direction of the force.

direction : .....

magnitude of force = ... [2]

(b) The 8.0 N weight is pushed horizontally towards point P. The rod remains horizontal throughout.

State and explain the change in the magnitude of T.

.....

.....

.....

..... [2]

3 Fig. 3.1 shows a 0.50 kg ball sliding down a rough incline from position A which is 7.5 m above the ground with an initial speed of v_o m/s. Friction along the incline produces 10.7 J of heat energy. The ball leaves the incline at position B moving vertically upward and reaches a height of 13.0 m above the floor at position C.

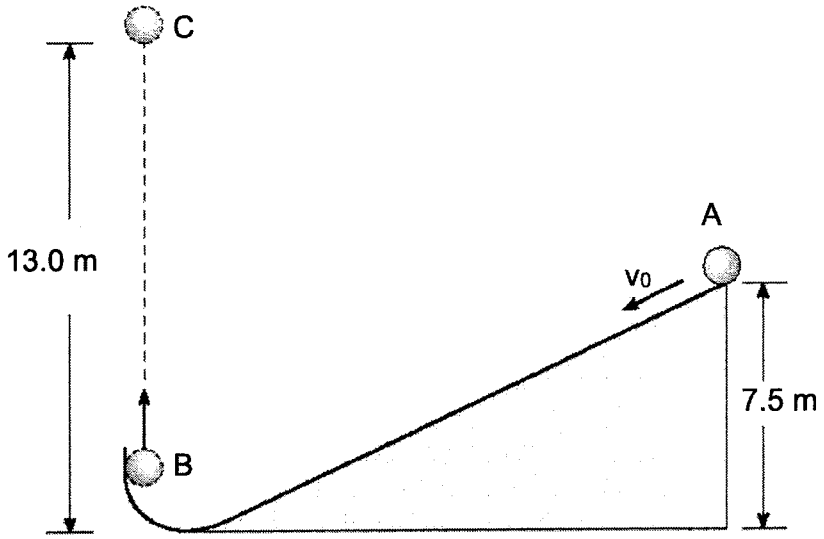


Fig. 3.1

[Turn Over

For examiner's use

(a) State the principle of conservation of energy.

.....

..... [1]

(b) **(i)** Calculate the gravitational potential energy of the ball at position C.

gravitational potential energy = ... [2]

(ii) Calculate the initial speed v_0, at position A.

v_0 = ... [2]

(c) State one assumption for your calculations in **(b)(ii)**.

.....

..... [1]

4 Fig.4.1 shows the top view of a fish tank. A light ray from the fish exits from the water into air as shown.

The diagram is drawn to scale.

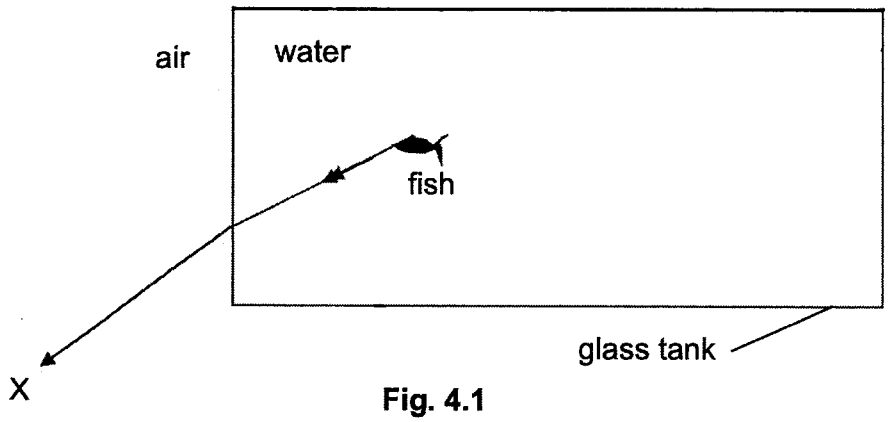


Fig. 4.1

[Turn Over

For examiner's use

(a) **(i)** On Fig.4.1 measure the angle of incidence, i and the angle of refraction, r.

i = ...

r = ... [1]

(ii) Calculate the refractive index of the water in the tank.

refractive index = ... [2]

(b) Explain why it is possible to see two images of the fish at position X.

.....

..... [1]

5 Explain, in terms of the air molecules, how the air inside a car tyre exerts a pressure on the walls of the tyre.

.....

.....

.....

..... [2]

For examiner's use

6 Fig. 6.1 shows a charged light perspex ball placed near a positively charged metal dome in a Van de Graaf generator. The ball swings away from the positively charged metal dome and remains stationary at X.

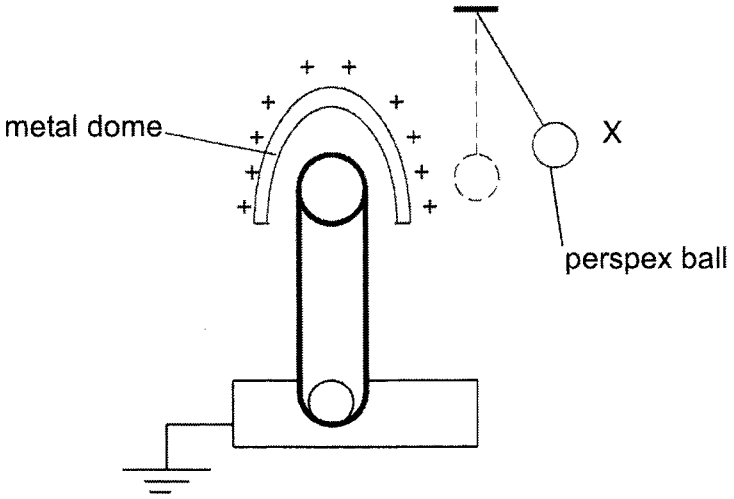


Fig. 6.1

(a) Explain why the perspex ball moves away from the metal dome.

.....

.....

.....

..... [2]

For examiner's use

(b) The perspex ball has a weight of 0.05 N.

Fig. 6.2 shows the instant where the ball is stationary at X. There is a horizontal electric force of 0.15 N acting to the right, tension T along the string and the weight of the ball.

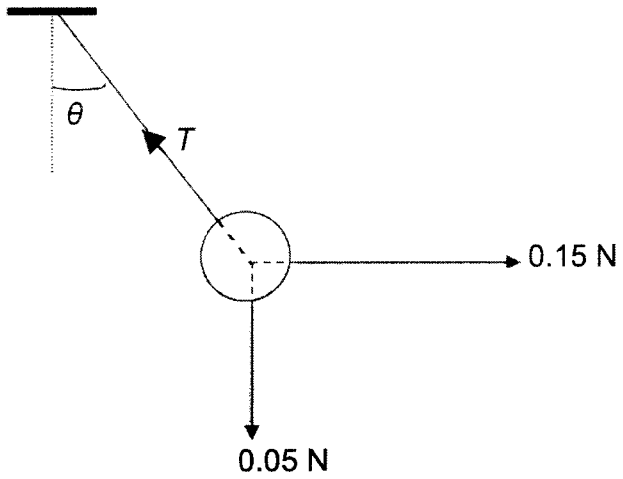


Fig. 6.2

By using a scale drawing, determine the tension T and the angle θ that the string makes with the vertical.

The gravitational field strength g is 10 N / kg.

T = ...

θ = ... [4]

[Turn Over

For examiner's use

7 **(a)** Fig. 7.1 shows an electric circuit powered by a 12.0 V battery of negligible internal resistance.

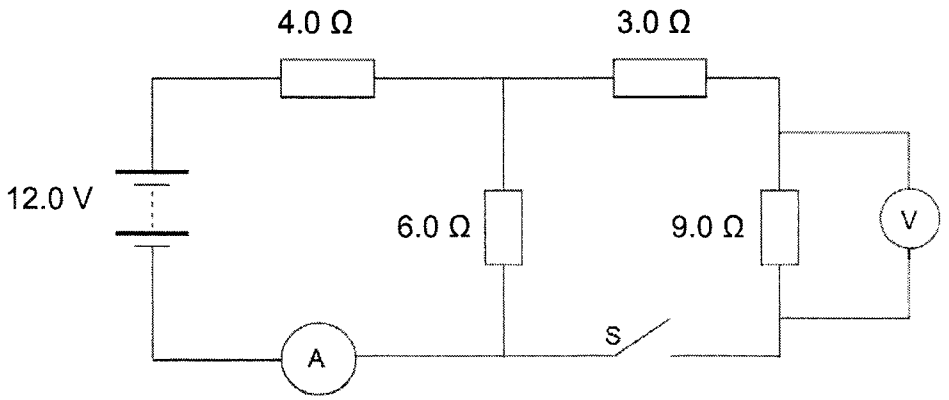


Fig. 7.1

When switch S is closed, calculate

(i) the total resistance of the circuit,

total resistance = ... [2]

(ii) the current flowing through the ammeter.

current = ... [2]

(b) Switch S is then opened.
State the effect on the reading of the ammeter when the switch is opened.

.....

..... [1]

[Turn Over

For examiner's use

(c) Fig. 7.2 shows the same power source connected to a potential divider consisting of an LDR and a resistor instead.
An LDR (light-emitting diode) is an input transducer whose resistance can change according to the amount of light falling on it.

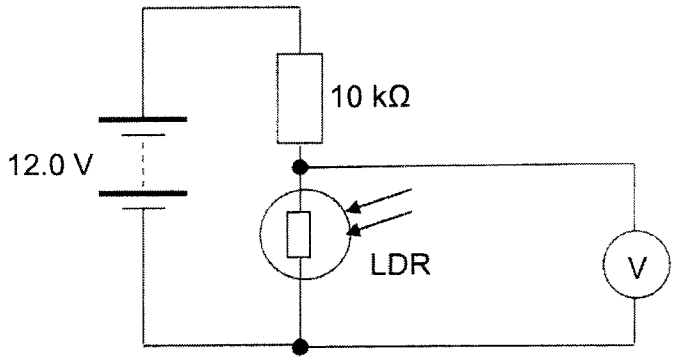


Fig. 7.2

(i) Explain the term 'input transducer'.

.....

..... [1]

(ii) Calculate the resistance of the LDR when the voltmeter reads 2.0 V.

resistance = ... [2]

[Turn Over

For examiner's use

8 A student makes a simple d.c motor as shown in Fig. 8.1 using some common materials connected to a 6.0 V battery.

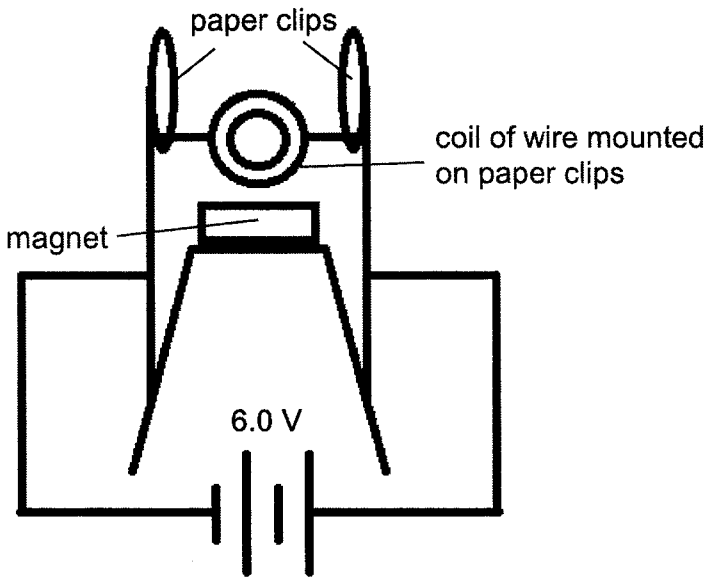


Fig. 8.1

The ends of the coil are placed on large paper clips inserted into the cup. When the power source is turned on, the coil is given a slight push and the coil begins to spin.

(a) **(i)** Explain why the coil is given a slight push.

.....

..... [1]

(ii) Explain why the coil starts to rotate.

.....

.....

.....

.....

..... [2]

(b) If a stronger power source is used, state its effect on the rotation of the coil.

.....

..... [1]

[Turn Over

For examiner's use

9 Fig. 9.1 shows the structure of a transformer which is used in the transmission of electrical power through the cables.

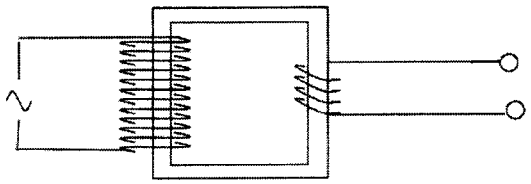


Fig. 9.1

coil	number of turns
J	50
K	100
L	1 000
M	1 500

Table 9.2

An engineer is assigned to build a step-down transformer for stepping down the voltage from 3.3 kV to 220 V in the substation of a housing estate. He has the choice of using four types of coils with different number of turns as shown in Table 9.2 above.

(a) Based on Table 9.2, select the most suitable pair of coils for making the primary coil and secondary coil of the transformer.

Explain your choice.

.....

.....

.....

..... [2]

(b) Assume that the transformer is 75 % efficient and the power output is 15 kW, calculate the current flowing in the primary coil.

resistance = ... [2]

(c) State and explain one feature that can improve the efficiency of this transformer.

.....

.....

.....

..... [2]

[Turn Over

For examiner's use

SECTION B [30 marks]

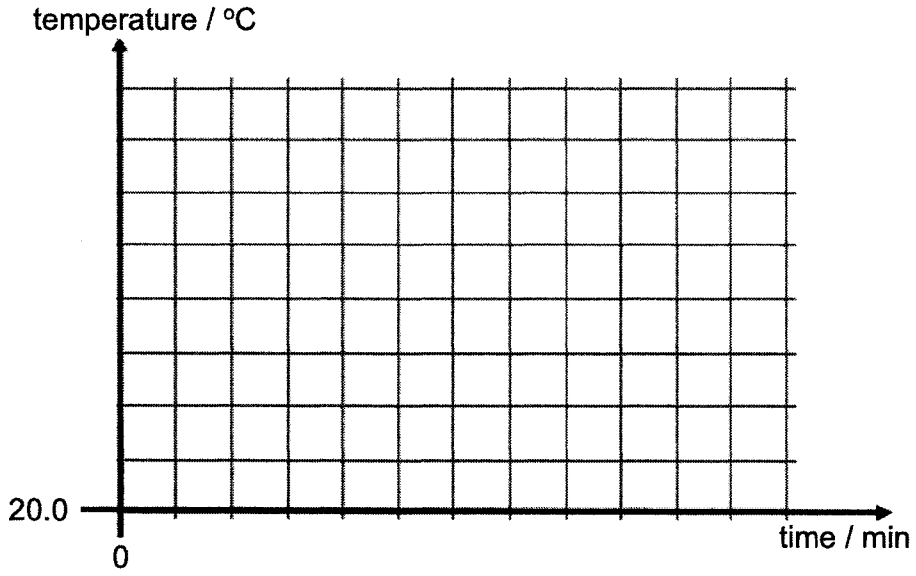
Answer **all** questions from this section.
Answer only one of the two alternative questions in **Question 12.**

10 (a) A heater was used to melt a pure substance X from its solid state until it reaches the gaseous state. Substance X was heated uniformly throughout the entire process. Fig. 10.1 shows the temperature of X taken in intervals of 2 minutes.
You may assume that the heat supplied was constant and no heat was lost during the heating process.

time / min	temperature / ° C
0	25.0
2	35.0
4	45.0
6	45.0
8	45.0
10	60.0
12	75.0
14	90.0
16	90.0
18	90.0
20	90.0

Fig. 10.1

(i) On Fig. 10.2, draw the heating curve of pure substance X in the grid lines provided.



[1]

Fig. 10.2

[Turn Over

For examiner's use

(ii) Using the data from Fig. 10.1, determine the melting point and boiling point of substance X.

mass of substance X = 2 kg
power of heater used = 1 000 W

melting point = ...

boiling point = ... [1]

(iii) Calculate the specific heat capacity of the solid X.

specific heat capacity = ... J / kg°C [3]

(b) Fig. 10.3 below shows the cooling curve graphs of two pure liquids, Y and Z, of the same mass.

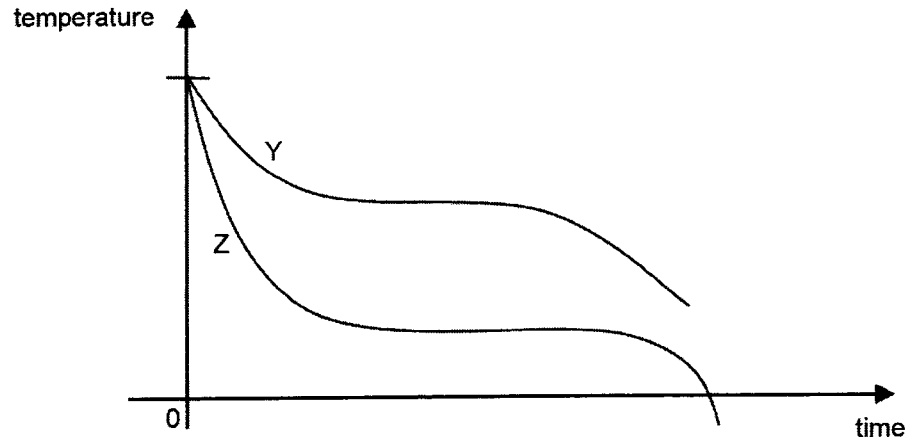


Fig. 10.3

(i) State why both liquids are losing thermal energy throughout the experiment.

..... [1]

[Turn Over

For examiner's use

(ii) Which substance (Y or Z) has a greater specific heat capacity in the liquid state?

Explain your answer clearly.

.....

.....

.....

..... [2]

(iii) Which substance (Y or Z) has a greater specific latent heat of fusion?

Explain your answer clearly.

.....

.....

.....

..... [2]

For examiner's use

11 Fig. 11.1 shows the hydraulic braking system for a car from the brake pedal to the braking discs of the wheel.

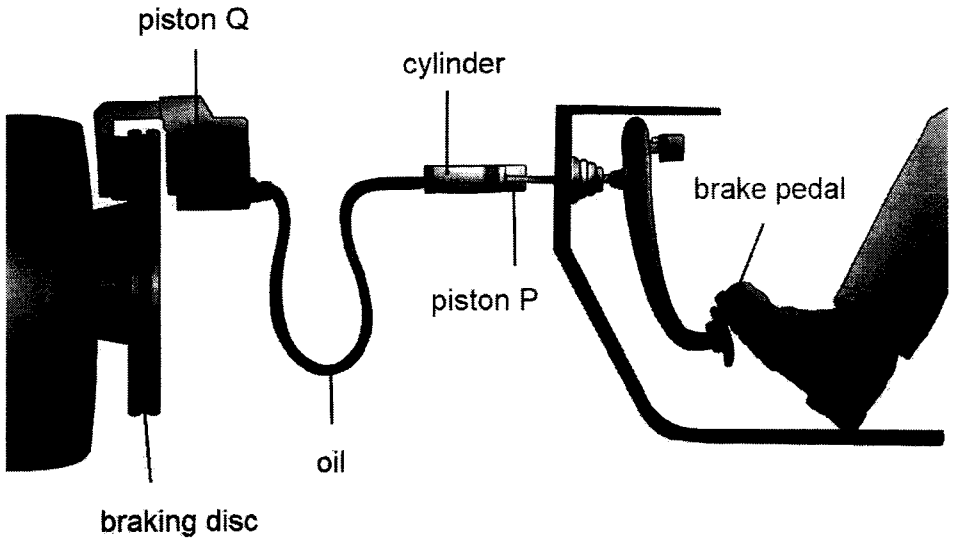


Fig. 11.1

A force is applied downwards on the brake pedal in order to slow down the wheels of the car.

(a) Using Fig. 11.1, explain clearly how a force applied on piston P can create a larger force to slow down the wheels of the car.

.....

.....

.....

..... [2]

(b) The surface area of piston P in contact with the brake fluid at the master cylinder is 5.0×10^{-4} m^2 and the area of piston Q of the slave cylinder is 7.5×10^{-3} m^2.

(i) Explain why the area of piston P is smaller than piston Q.

.....

..... [1]

[Turn Over

For examiner's use

(ii) Calculate the force exerted on Piston Q when a force of 120 N is exerted on the brake pedal.

force = ... [2]

(c) In order to ensure that the braking system functions properly, air cannot be trapped in the oil.

Explain clearly how trapped air in the oil can affect the performance of the hydraulic braking system.

.....

.....

.....

..... [2]

(d) When the road is wet, a sudden hard braking when the car is moving at a high speed can cause the wheels to stop rotating instantly and the car will skid.

(i) Explain why a fast moving car skids on the wet road when the brake is suddenly pressed very hard and the wheels stop rotating.

.....

.....

.....

..... [2]

For examiner's use

(ii) To reduce the possibility of a car skidding on a wet surface, the wheels of the car have specially designed threads as shown in Fig.11.2. Suggest how these threads are able to reduce the chances of the car skidding on a wet surface.

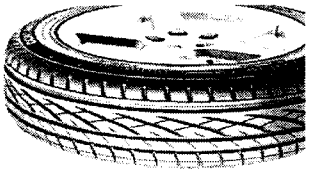


Fig. 11.2

.....

..... [1]

For examiner's use

EITHER

12 (a) Fig. 12.1 shows an object AB near a thin converging lens. The principal foci of the lens are at F and F'.

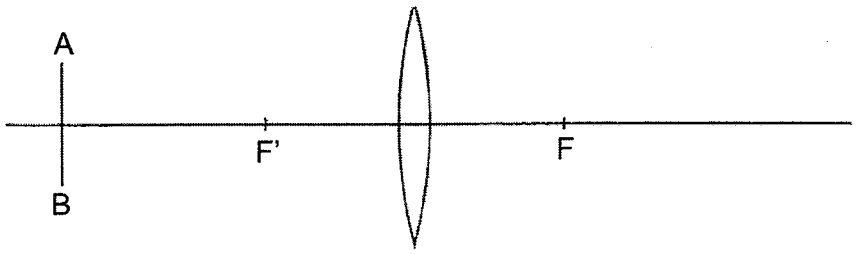


Fig. 12.1

(i) By means of an accurate drawing, draw rays to find the positions of the images of the points A and B. [2]

(ii) If object AB is gradually brought closer to the converging lens until a distance less than one focal length, describe clearly the changes to the image of AB.

.....

.....

.....

..... [2]

(b) Fig. 12.2 shows a scaled drawing of an object PQ and its image P'Q' after passing through a thin converging lens. P'Q' is a virtual image.

With the aid of drawing light rays on the diagram, find the focal length of the converging lens.

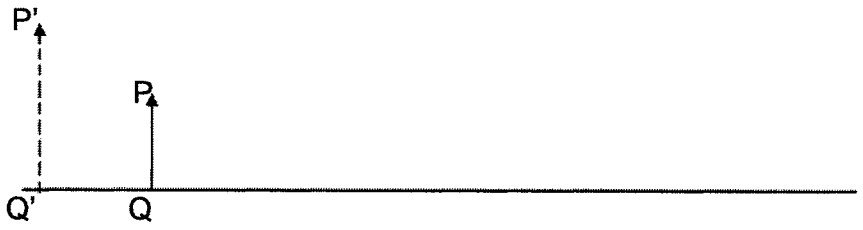


Fig. 12.2

[2]

focal length = ...

[Turn Over

For examiner's use

(c) Light rays passing into an eyeball undergo two refractions; once as they pass through the cornea and another as they pass through the lens of the eye. Fig.12.3 shows how light rays pass through the eyeball and the image of an object is formed in front of the retina for an individual with short-sightedness.

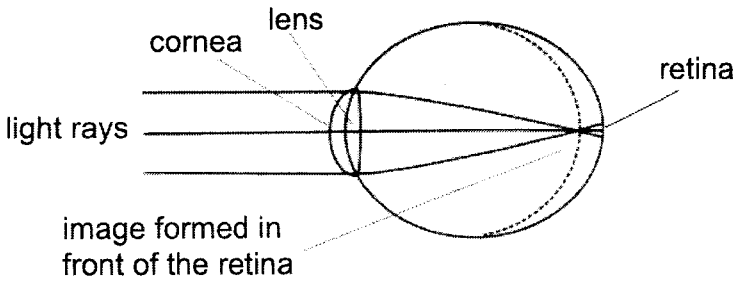


Fig. 12.3

(i) One way to correct short-sightedness is to use a pair of spectacles. Which type of spectacle lens (converging or diverging) would be suitable to correct short-sightedness?

Explain your answer clearly.

.....

.....

.....

..... [2]

(ii) Another method to correct short-sightedness is by performing a 'lasik surgery' which removes a small portion of tissue in the cornea to make the cornea less rounded.

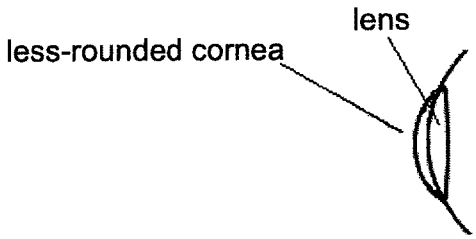


Fig. 12.4

Suggest how the less-rounded cornea in front of the eye's lens can help to correct short-sightedness.

.....

.....

.....

..... [2]

[Turn Over

For examiner's use

OR

12 (a) Fig. 12.4 shows a solenoid with an alternating current (a.c) supply coiled around a soft iron core. An aluminium ring is placed through the soft iron and rests on the solenoid. When the a.c supply is turned on, the ring 'floats' above the solenoid as shown in Fig. 12.5.

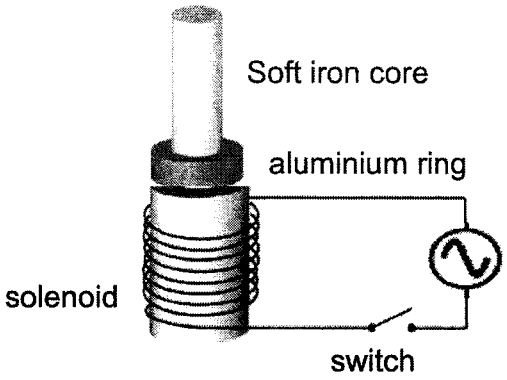


Fig. 12.4

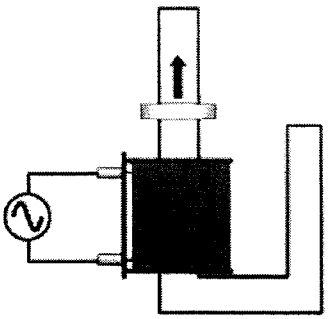


Fig. 12.5

(i) Explain clearly why the aluminium ring 'floats' when the a.c supply is turned on.

.....

.....

.....

.....

.....

..... [3]

(ii) If the a.c supply is now replaced by a d.c supply, state what will be observed after the supply is turned on.

.....

.....

.....

..... [1]

[Turn Over

For examiner's use

(iii) The solenoid has an a.c supply but the aluminium ring is replaced with a 'C'-shaped ring instead as shown in Fig. 12.6. When the supply is turned on, the C-shaped ring does not 'float' upwards but continued to remain at rest on the solenoid instead.

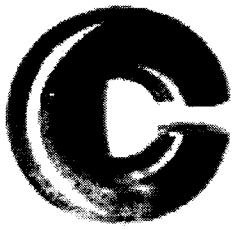


Fig. 12.6

Explain why this happens.

.....

.....

.....

..... [2]

(b) Fig.12.7 shows a simple a.c generator which has a frequency of 60 Hz and peak voltage 12 V.

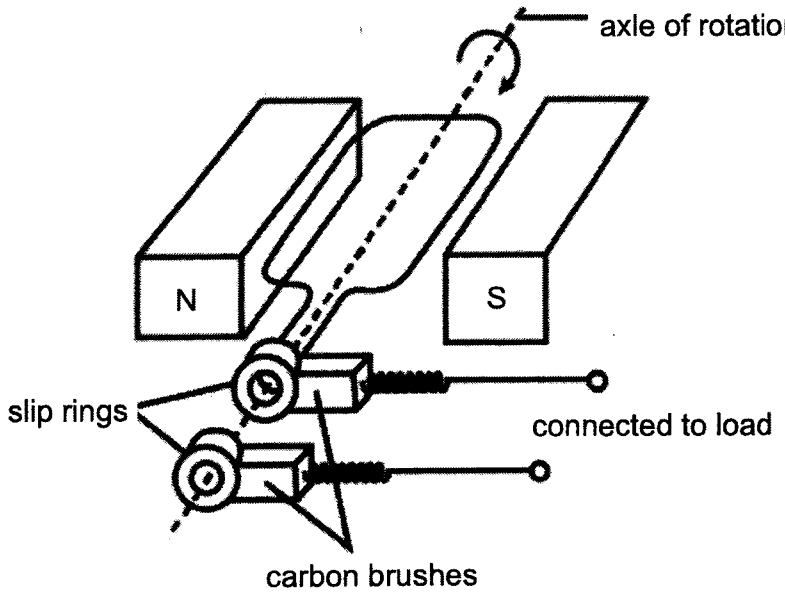
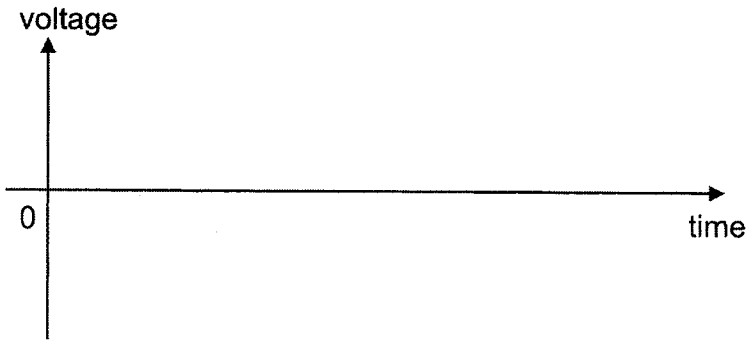


Fig. 12.7

[Turn Over

For examiner's use

(i) Sketch the graph of the voltage produced against time for two complete cycles below. The position of the coil at time = 0 s is as shown in Fig. 12.7.



[2]

(ii) If the speed of rotation of the coil is reduced, sketch the new graph of the voltage produced on the same axis above.

Label this new graph with **(ii)**.

[1]

(iii) Explain the difference in amplitude between the graphs for **b(i)** and **b(ii)**.

.....

.....

.....

.....

[1]

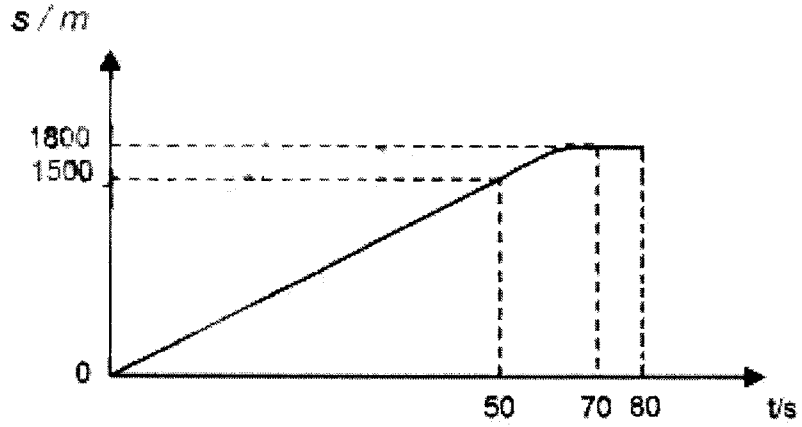
END OF PAPER

MARKING SCHEME 4E Pure Physics PRELIMS 2022

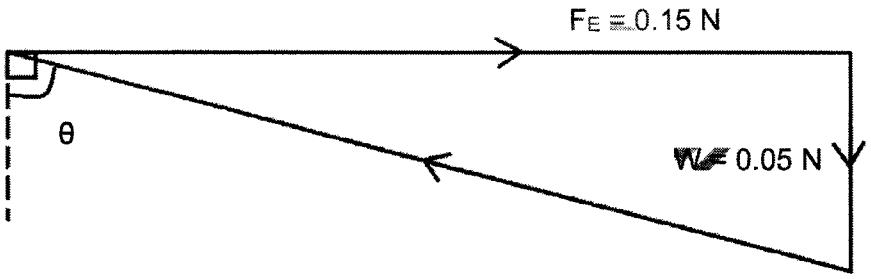
Paper 1 (40 marks)

1	D	6	C	11	C	16	B	21	D	26	D	31	A	36	D
2	B	7	C	12	B	17	C	22	B	27	D	32	C	37	A
3	C	8	B	13	A	18	D	23	B	28	C	33	B	38	A
4	C	9	C	14	D	19	B	24	C	29	D	34	A	39	C
5	B	10	B	15	B	20	A	25	B	30	B	35	A	40	C

Paper 2 Section A (50 marks)

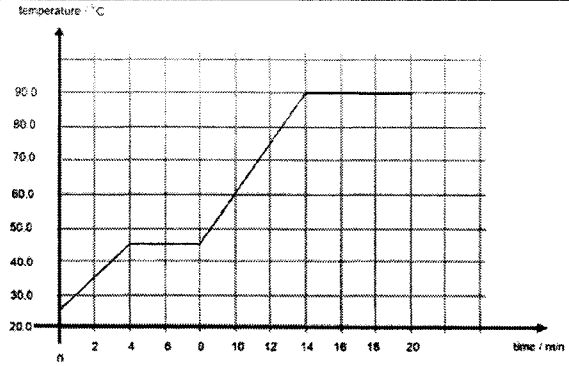
Qn	Answer	Sub marks	Total marks
1ai	The car decelerates uniformly to stop from t = 50 s to 70 s, and remain stationary / at rest for a further 10 s, It reverses / change direction and accelerates uniformly	1 m 1 m	2 m
1aii	a = (v – u) / t = (0 – 30) / 20 = - 1.5 m/s^2 deceleration = 1.5 m/s^2	 1 m 1 m	2 m
1b	Total displacement = distance moved (first 70s) – distance moved (t=80s to 110s) = ½ (50 + 70) x 30 – (½ x 30 x 20) = 1500 m	 1 m 1 m	2 m
1c	 Correct shape of graph Correct values on both x and y axis	 1 m 1 m	2 m
2ai	Using principle of moments about P		2 m

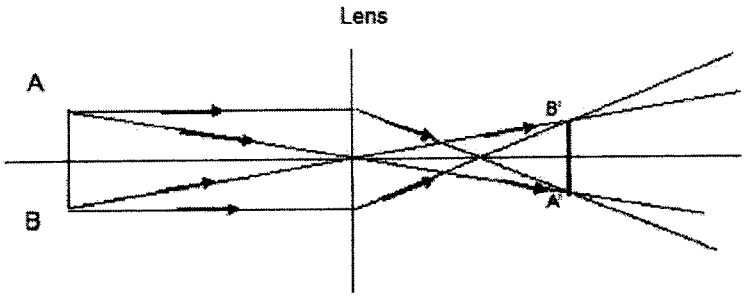
	Total anticlockwise moment = Total clockwise moment T x 80 = (2 x 40) + (8 x 60) T = 7.0 N	 **1 m** **1 m**	
2aii	Let the reaction force at the pivot be R. Since net force = 0 (not moving / at balance) T + R = 2 + 8 7 + R = 10 R = 3 N Direction of R is upwards.	 **1 m** **1 m**	**2 m**
2b	Magnitude (size) of the spring balance reading decreases. The total clockwise moment has decreased as the clockwise moment by the 8 N weight about P has decreased with the reduction in the distance. To maintain equilibrium, the anticlockwise moment by spring must also decrease proportionately. As moment = force x perpendicular distance (and the distance is constant), the spring force must decrease to compensate the reduction in the moment.	**1 m** **1 m**	**2 m**
3a	Total energy is always conserved (remain unchanged) Energy cannot be created or destroyed; They can only be converted from one form to another.	**1 m**	**1 m**
3bi	GPE = mgh = 0.5 x 10 x 13 = 65 J	 **1 m** **1 m**	**2 m**
3bii	Assume no energy is loss and total energy is conserved, $GPE_C + W_{friction}$ = total energy at A 65 + 10.7 = ½ (0.5) (v_0^2) +(0.5 x 10 x 7.5) v_0 = 12.4 m/s	 **1 m** **1 m**	**2 m**
3c	There is no work done against air resistance as the ball moves up to position C.	**1 m**	**1 m**
4ai	i ° = 26° r ° = 35°	 **1 m**	**1 m**
4aii	n = sin i / sin r = sin 35° / sin 26° (+/- 1°) = 1.31 (1.28 to 1.39)	 **1 m** **1 m**	**2 m**
4b	Light can also be refracted from the longer side of the fish tank giving another image of the fish.	**1 m**	**2 m**

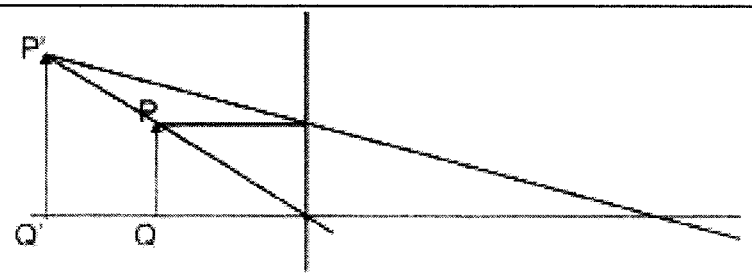
5	Air molecules moving randomly and bombarding / colliding with the tyre walls. This exerts a force on the wall's surface which produces a pressure.	**1 m** **1 m**	**2 m**
6a	Perspex ball is positive charged. As like charges repel, the Perspex ball moves away from the charged metal dome.	**1 m** **1 m**	**2 m**
6b	 Diagram drawn to scale Arrows drawn and values labelled correctly θ = 72° T = 0.16 N	 **1 m** **1 m** **1 m** **1 m**	**4 m**
7ai	$\frac{1}{R_T} = 4 + (\frac{1}{6} + \frac{1}{3+9})^{-1}$ R_T = 8 Ω	**1 m** **1 m**	**2 m**
7aii	I = V / R = 12 / 8 = 1.5 A	 **1 m** **1 m**	**2 m**
7b	The ammeter reading decreases.	**1 m**	**1 m**
7ci	A device that converts other form of energy(s) to electrical energy.	**1 m**	**1 m**
7cii	R_{LDR} / 10 = 2 V / 10 V R_{LDR} = 2.0 kΩ	**1 m** **1 m**	**2 m**
8ai	To overcome inertia of the coil so that it can start to turn / enable the conducting (enameled) part of the wire to be in contact with paper clip to allow current to pass into the coil.	**1 m**	**1 m**
8aii	When electric current flows into the coil via the paper clip say from it sets up a magnetic field around the coil which interact with the magnetic field of the permanent magnet below.	 **1 m**	**2 m**

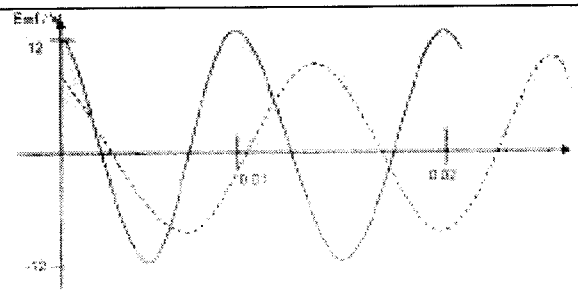
	This produces a force pushing the bottom coil near the bottom tape which turns the coil. This causes the conducting enameled copper wire to rotate.	1 m	
8b	The coil will rotate faster.	1 m	1 m
9a	Comparing the voltages of primary coil to secondary coil: Step down ratio = 3 300 : 220 = 15 : 1 Hence the coils must be step down to the same ratio of 15 : 1 Comparing the turn ratio i.e Coil M : Coil K = 1 500 : 100 = 15 : 1	1 m 1 m	2 m
9b	Input power = 100 / 75 x 15 kW = 20 kW I = P / V = 20 000 / 3 300 = 6.1 A	1 m 1 m	2 m
9c	Feature Explaination (Any one) Laminating the iron core reduces the power loss due to heat produced by induced current in the core itself. Using low resistance (primary and secondary) coils will minimize the amount of heat produced in the coils. To increase the magnetic flux linkage between the primary and secondary coils by using a soft magnetic material (iron core) to link	1 m 1 m	2 m

SECTION B (30 marks)

QN	Answer	Sub-marks	Marks
10ai	 All plots are correct.	1 m	1 m
10aii	melting point = 45 °C boiling point = 90 °C	1 m	1 m
10aiii	Heat supplied by heater = P x t = 1000 x 4 x 60 = 240 000 J Heat supplied by heater = Energy gained by solid X 240 000 = mc ΔT 240 000 = 2 c (45 – 25) c = 6000 J/kg °C	 1 m 1 m 1 m	3 m
10bi	The room temperature is lower than the liquids, thermal energy flows from liquids to the surroundings.	1 m	1 m
10bii	Substance Y When subjected to the same cooling condition, the fall in temperature for substance Y is slower than substance Z. This indicates that a higher amount of energy needs to be lost by substance Y compared to Z for the same amount of fall in temperature.	1 m 1 m	2 m
10biii	Substance Z For the same mass, same period of time, Substance Z takes a longer time to change state indicating that higher amount of latent heat needs to be lost by Z compared to Y to change from liquid to solid state.	1 m 1 m	2 m

11a	A force exerted on the brake pedal acts on the surface area of Piston P in contact with the oil in the master cylinder to create a pressure This pressure in the oil is transmitted to all parts of the oil Since oil is incompressible, this creates a force to slow down the wheels of the car.	**1 m** **1 m**	**2 m**
11bi	Since the pressure acting in the liquid is the same throughout, A small area at Piston P would require a smaller force exerted to produce a larger force at Piston Q.	 **1 m**	**1 m**
11bii	Force exerted on piston Q = $(F_P \times A_Q)/A_P$ = $(120 \times 7.5 \times 10^{-3})/ 5.0 \times 10^{-4}$ = 1800 N	 **1 m** **1 m**	**2 m**
11c	Since air is compressible, pressure exerted at the master cylinder will not be fully transmitted to the disc brakes resulting in an insufficient force to stop the revolution.	**1 m** **1 m**	**2 m**
11di	On a wet road, there is less friction between the wheels and the road. When wheels suddenly stops turning, the forward force is greater than the frictional force between the road and wheels causing the car to skid.	**1 m** **1 m**	**2 m**
11dii	The threads allows water the flow through them, increasing the friction between the car and the road surface to prevent skidding.	**1 m**	**1 m**
Either 12ai	 Correct pair of rays from A to A' Correct pair of rays from A to A'	 **1 m** **1 m**	**1 m**
12aii	As the object is brought nearer to the lens towards one focal length distance, image becomes magnified but remain inverted and real When the object is less that one focal length distance from the lens, the image becomes magnified, upright and virtual.	**1 m** **1 m**	**2 m**

12b	 Correct line passing through top of object and image to locate position of lens, Correct line from object to lens, combined with line Focal length between 4.7 to 5.1 cm	1 m 1 m	2 m
12ci	Diverging lens. Diverging lens will spread the incoming rays before it reaches the lens The more diverged rays entering the lens will be focused at a further distance in the eye onto the retina	1 m 1 m	2 m
12cii	When rays enter the less rounded cornea, it undergoes lesser refraction/less converging This causes the lesser refracted rays to be focused at a further distance in the eye after passing through the lens.	1 m 1 m	2 m
OR 12ai	When the supply is turned on, a changing magnetic field is produced around the solenoid The changing magnetic flux/magnetic field lines cutting the aluminium ring induces an emf on the ring By Lenz's law, the induced emf on the ring is such that the magnetic field induced around the aluminium ring opposes the magnetic field of the solenoid that produced it Like poles will exist between the aluminium ring and the solenoid And repel the ring upwards since like poles repel	1 m 1 m 1 m	3 m
12aii	The ring will move upwards momentarily and subsequently falls back down and rest on top of the solenoid.	1 m	1 m
12aiii	The C-shaped ring does not allow current to pass around the aluminium continuously. This does not allow any induced current, magnetic force/field to be produced around the C-shaped ring. Hence the ring will remain at rest on the top part of the solenoid.	1 m 1 m	2 m

12bi	 Solid line: max emf 12 V, min emf 12 V. period = 0.01 s	 1 m 1 m	2 m
12bii	Dotted line in diagram above Smaller peaks, longer peroid	1 m	1 m
12biii	A lower speed of rotation results in smaller voltage produced as the rate of magnetic flux is reduced.	1 m	1 m