O

Preliminary 2 Examination 2016

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PHYSICS

5059/01

Paper 1 Multiple Choice

30 August 2016
1 hour

Sec 4 Express

Additional Materials: OTAS

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.
Write your name, class and index number on the OTAS.

There are forty questions in this paper. Answer all questions. For each question there are four possible answers **A**, **B**, **C**, and **D**.
Choose the one you consider correct and record your choice in soft pencil on the separate OTAS.

Read the instructions on the OTAS very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

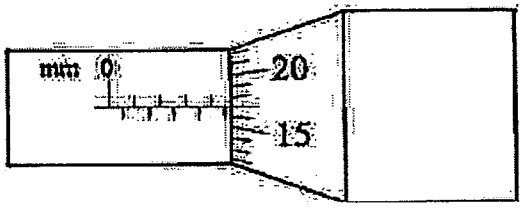
Any rough working should be done in this booklet.

Total Marks
40

1 Sir Isaac Newton discovered gravity by watching an apple fall from an apple tree. Newton's law of gravitation states that any two bodies, at a distance of r metres apart and of masses m_1 and m_2 kilogrammes, will exert a gravitational force of attraction on each other according to the equation $F = G\frac{m_1 m_2}{r^2}$ where G is known as Newton's constant. What is the unit of G?

A $kg\ m^3\ s^{-2}$ B $N^{-1}\ m^2\ kg^2$ C $N\ m^2\ kg^{-2}$ D $m^2\ kg^{-2}$

2 A length of wire is wrapped tightly around the length of a pencil. The diameter of the wire is measured using a micrometer screw gauge and the reading is shown.



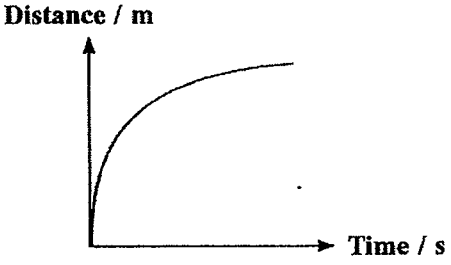
If 50 turns of wire is required to cover the whole length of the pencil, what is the length of the pencil?

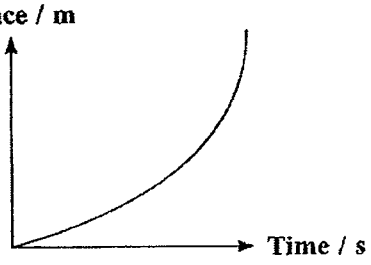
A 20.85 cm B 21.15 cm C 23.35 cm D 23.65 cm

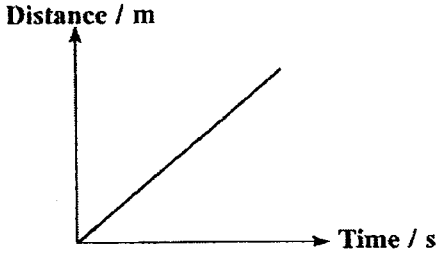
3 Fireworks are fired vertically into the air during National Day with an initial speed of 25 $m\ s^{-1}$. The fireworks reach a maximum height of h m before exploding into beautiful patterns. Given that g = 10 $m\ s^{-2}$ and ignoring air resistance, what is the maximum height h?

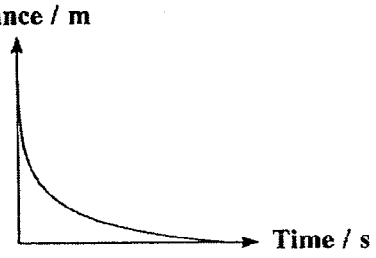
A 22.50 m B 25.00 m C 31.25 m D 45.00 m

4 Which distance-time graph best describes the motion of the fireworks during National Day?

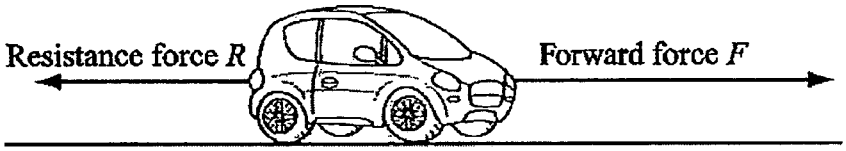
A


B


C


D


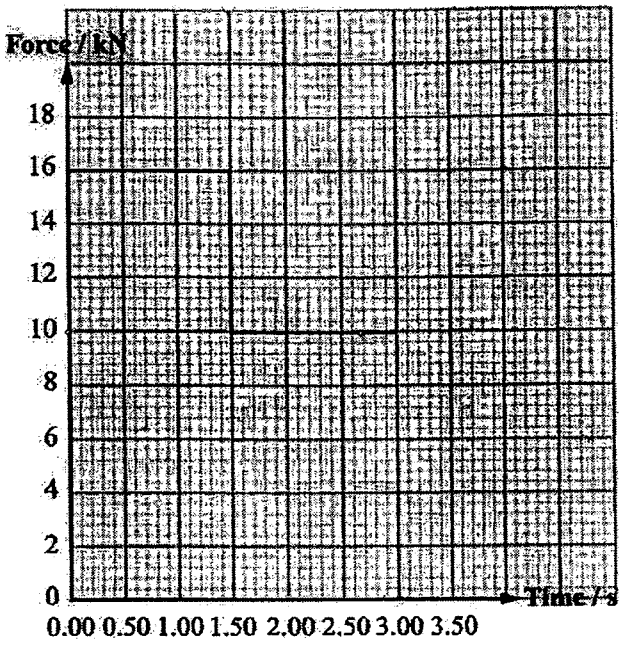
5 The diagram below shows the horizontal forces acting on a car as it travels on a road.



How many forces are acting on the car?

A 0 **B** 2 **C** 3 **D** 4

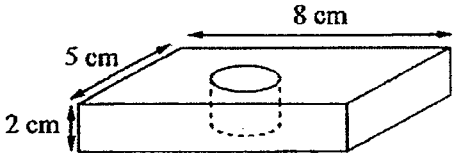
6 The graph below shows the driving force generated by a car engine. The car of mass 2 000 kg starts to cruise at a constant speed of 60 km h^{-1} after travelling for 1.50 s along a rough road. Assume that the friction acting on the car remains constant throughout its journey.



What is the acceleration of the car in the first 0.5 s?

A 0 m s^{-2} **B** 3 m s^{-2} **C** 5 m s^{-2} **D** 8 m s^{-2}

7 The diagram shows a composite rectangular plastic block with a cylindrical hole cut out and fitted with a cylinder of density 2.0 g cm^{-3}. The combined mass is 104 g and the cross-sectional area of the cylinder is 35 % that of the uncut rectangular cross-sectional area.



On which of the following liquid(s), chloroform (1 465 kg m^{-3}), coconut oil (925 kg m^{-3}) and/or water (1 000 kg m^{-3}) will the composite block float?

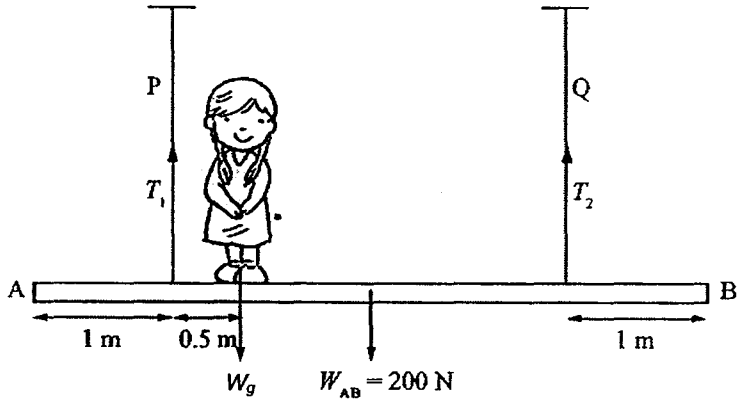
A chloroform

B chloroform and coconut oil

C coconut oil and water

D chloroform, coconut oil and water

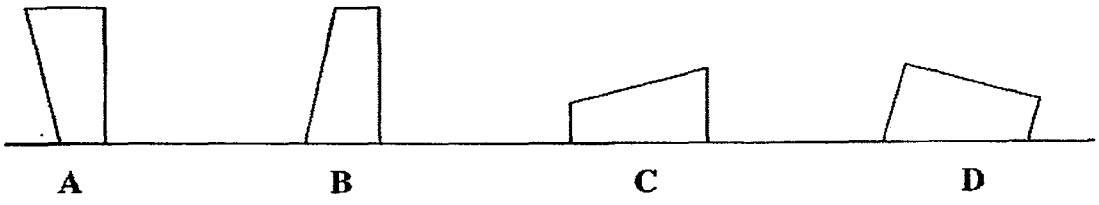
8 A girl of mass 50 kg stands on a uniform plank *AB* supported by two cords *P* and *Q*. The length of the plank *AB* is 5.0 m. Let W_g denote the weight of the girl.



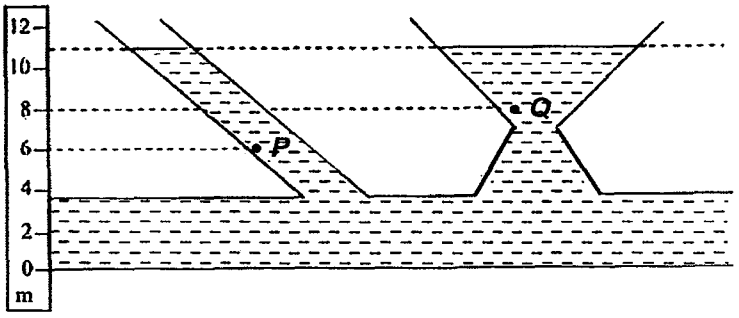
What are the values of T_1 and T_2 when the girl is at her current position?

	T_1 / N	T_2 / N
A	183	517
B	350	350
C	500	200
D	517	183

9 Which of the following diagrams shows a trapezoid placed on the ground such that it has the greatest stability?



10 The diagram below shows two communicating vessels filled with mercury of density 13 600 kg m^{-3}. The height of fluid in the vessels is 11 m.



What is the ratio of the liquid pressure at *P* to that at *Q*?

A 1 : 2 **B** 3 : 4 **C** 5 : 3 **D** 5 : 8

11 A 5.0 cm mercury column is suspended along a glass tube as shown in Fig 11a.

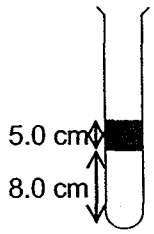


Fig. 11a

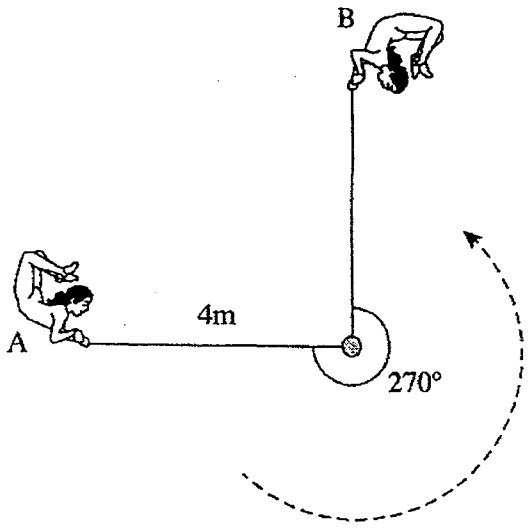
Fig. 11b

(Diagrams are not drawn to scale.)

Given that the length of the trapped air is 8.0 cm and the atmospheric pressure is 75 cm Hg, what is the length of the trapped air when the glass tube is inverted to the position shown in Fig. 11b?

A 7.0 cm **B** 8.0 cm **C** 9.1 cm **D** 10.3 cm

12 An acrobat swings from point *A* to point *B* as shown.



Given that the light swinging rod is 4 m long, what is the minimum initial speed the acrobat must have at point *A*?

A 6.32 m s^{-1} **B** 8.94 m s^{-1} **C** 10.0 m s^{-1} **D** 80.0 m s^{-1}

13 A battery supplies 500 J of electrical energy to a motor. The motor drags an object horizontally for 50 m along a floor with frictional force of 2 N. What is the maximum efficiency of the motor?

A 10 % **B** 20 % **C** 80 % **D** 90 %

14 The table below shows some physical properties of some substances.

Substance	Melting point / °C	Boiling point / °C	Density / kg m^{-3}
Bromine	– 7	59	3 100
Caesium	29	670	1 840
Isobutanol	– 102	108	802
Oxygen	– 219	– 183	1 140
Zinc	420	907	7 140

How many substances have particles that vibrate about fixed positions at 298 K?

A 1 **B** 2 **C** 3 **D** 4

15 Which of the following will occur if the sealed container is heated to 100 °C while the piston is allowed to move freely?

I The average distance between air molecules will increase.

II The average kinetic energy of air molecules will increase.

III The pressure of the trapped air will increase.

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

16 Water at 0 °C is mixed with ice at 0 °C. If energy is only exchanged between the water and ice, which of the following statements is correct?

A All the ice will melt.

B All the water will freeze.

C No ice will melt and no water will freeze.

D Not enough information is known to make the correct deduction.

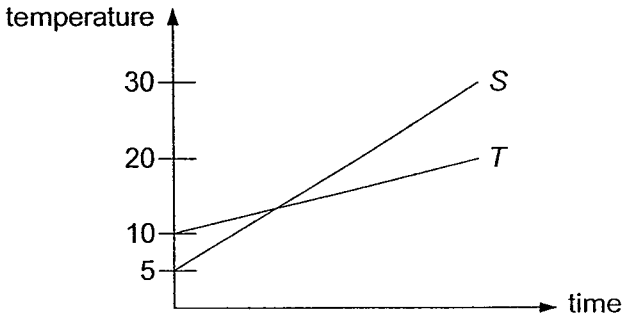
17 Certain pizza restaurant serves baked rice in a white porcelain bowl. Mr Lee puts his finger near the side of the bowl and does not feel heat from the bowl. Unexpectedly, his finger gets burn by the bowl when he touches it. Which of the following explains the situation?

	Bowl is not hot when finger is placed near the side of bowl	**Bowl burns finger when touched**
A	porcelain is a poor conductor	porcelain is a good emitter of radiation
B	porcelain is a poor conductor	porcelain is a poor emitter of radiation
C	porcelain is a poor emitter of radiation	porcelain conducts heat to the finger
D	porcelain is a poor emitter of radiation	porcelain radiates heat to the finger

18 A mercury-in-glass thermometer is calibrated by measuring the length of the mercury thread at different temperatures. The lengths of mercury thread at 0 °C and 100 °C are 7.0 cm and 48.0 cm respectively. What is the temperature when the length of mercury thread is at 32.0 cm?

A 43.8 °C **B** 52.1 °C **C** 61.0 °C **D** 66.7 °C

19 An electric heater is used to heat up two blocks, *S* and *T* for the same period of time. The mass of block *S* is half of block *T*. Their temperature against time graphs are plotted as shown.



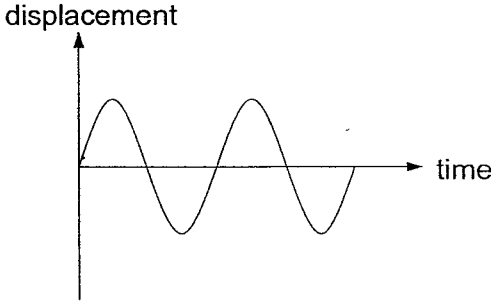
What is the ratio between the specific heat capacities of *S* to *T*?

A 0.40 **B** 0.80 **C** 2.5 **D** 3.0

20 An ice cube of mass 10 g is dropped into a beaker containing 100 g of water at 20.0 °C. The specific latent heat of fusion of ice is 330 kJ kg^{-1} and the specific heat capacity of water is 4 200 J kg^{-1} $°C^{-1}$. What is the minimum number of identical ice cubes required to lower the temperature of the contents of the beaker to below 5.0 °C?

A 1 **B** 2 **C** 3 **D** 4

21 The graph shows the displacement of a particle from its original position as a wave passes through it.

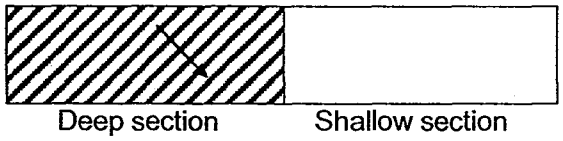


From the graph, the wave is likely to be a ..... .

I light wave II sound wave III water wave

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

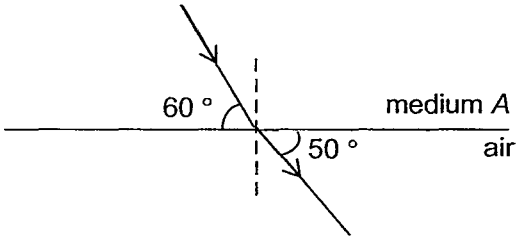
22 The diagram below shows part of a ripple tank. A machine in the deep section generates 1 800 water waves every minute. The waves move in the direction shown into the shallow section such that the distance between the two successive crests is λ m in deep section.



What is the speed of the waves in the deep section when $\lambda = 0.03$?

A 0.01 m s^{-1} **B** 0.90 m s^{-1} **C** 4.05 m s^{-1} **D** 120 m s^{-1}

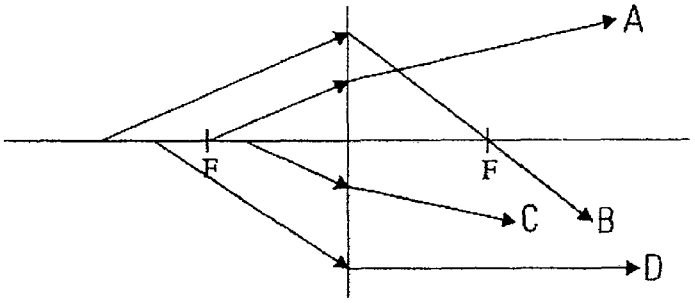
23 Refraction takes place when light travels from medium *A* to air as shown.



What is the critical angle for the above situation?

A 48 ° **B** 51 ° **C** 55 ° **D** 60 °

24 Which of the following light rays behaves correctly when it passes through the converging lens?



converging lens

25 Red light travels in optical fibre with a refractive index of 1.62. Given that the frequency of a light source is 4×10^{14} Hz, what is the wavelength of this light ray?

A 2.85×10^{-7} m **B** 4.62×10^{-7} m

C 7.48×10^{-7} m **D** 8.23×10^{5} m

26 Which of the following shows the **incorrect** use for each electromagnetic wave?

	electromagnetic wave	use
A	gamma ray	medical treatment
B	infrared	detecting broken bones
C	radio waves	telecommunication
D	X-rays	radiology

27 To measure the length of a room, a sonic 'tape measure' is used. It measures a time interval of 0.06 s between transmitting a sound pulse and receiving the echo. The speed of sound in air is 330 m s^{-1}. What is the length of the room?

A 3.3 m **B** 6.0 m **C** 9.0 m **D** 9.9 m

28 The sound wave from a flute has a smaller amplitude than that of a violin. The sound wave from the flute has a higher frequency than that from the violin. Which instrument produced a softer sound and which instrument produced a higher pitch?

	Softer sound	Higher pitch
A	Flute	Flute
B	Violin	Flute
C	Flute	Violin
D	Violin	Violin

29 When Jasmine brings a positively charged rod near the knob of an uncharged electroscope, the leaves will diverge because ..... .

A negative charges are attracted to the knob

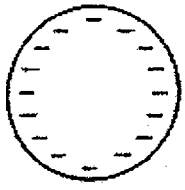
B negative charges are transferred from the leaves to the rod

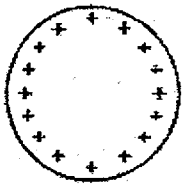
C positive charges are transferred from the rod to the leaves

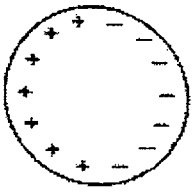
D positive charges on the knob are moved to the leaves

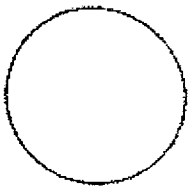
30 A negatively-charged sphere *X* is brought up to an identical uncharged sphere *Y*. The spheres do not touch.

Sphere *Y* is earthed by touching it with a finger. Sphere *X* is then moved away from sphere *Y*, followed by the finger. What is the final charge, if any, on sphere *Y*?

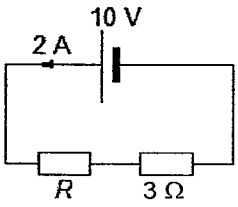
A 

B 

C 

D 

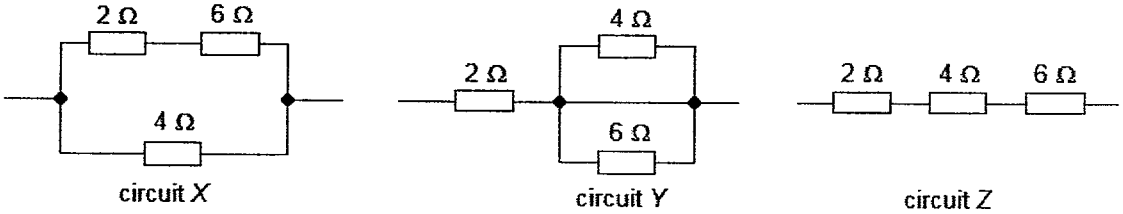
31 The circuit below is switched on for 2 minutes.



What is the amount of energy dissipated by resistor *R*?

A 16 J B 40 J C 240 J D 960 J

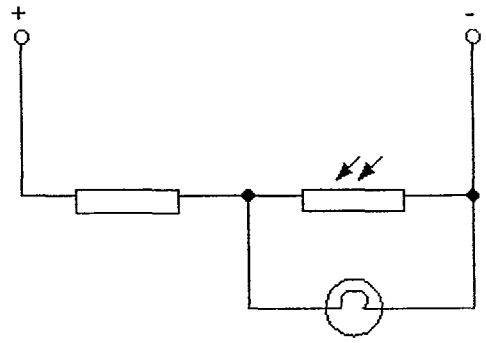
32 Three resistors of resistance 2 Ω, 4 Ω and 6 Ω are used to make circuits *X*, *Y* and *Z*.



Which of the following gives the combinations in order of decreasing resistance?

A *ZXY* B *ZYX* C *YZX* D *XYZ*

33 The bulb in the circuit below will light up ..... .



A in a dark room

B on a cold day

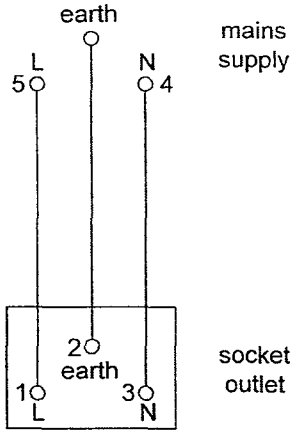
C on a hot day

D under bright light

34 A square solar panel has dimensions of 0.2 m × 0.2 m. Under the sunlight, the intensity of the light is 1 000 W m^{-2} and the panel delivers a current of 1.6 A at a voltage of 15 V. What is the efficiency of this solar panel in converting solar energy into electrical energy?

A 9.6 % **B** 12 % **C** 40 % **D** 60 %

35 The wiring from a 240 V mains supply to a socket outlet in a house is shown below in the diagram.



To measure the voltage at the socket outlet, where should the voltmeter be connected?

A 1 and 3 **B** 2 and 3 **C** 2 and 4 **D** 3 and 4

36 Rachel attaches one end of a string to a steel paper clip and the other end to a table. The string is very light. She then uses a magnet to attract it so the clip seems to float in air. However, when she lifts the magnet, the paper clip falls. What is the reason for this?

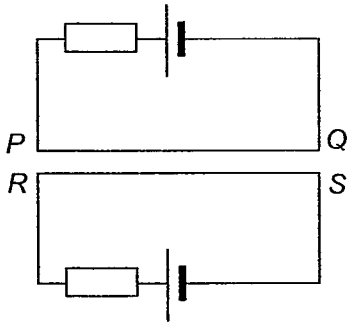
A The gravitational potential energy of the clip increases.

B The gravitational force near the magnet increases.

C The magnetic properties of the clip decreases.

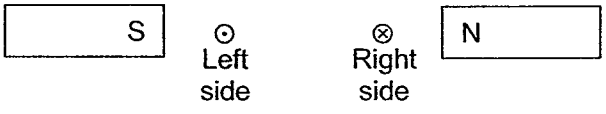
D The magnetic field strength near the clip decreases.

37 Which of the following shows the movements of the wires correctly when the two circuits are brought together as shown?



	PQ	*RS*
A	↓	↑
B	↓	↓
C	↑	↓
D	↑	↑

38 The cross-sectional view of a d.c. motor is shown below.



Which of the following will be observed when current flows through the d.c. motor?

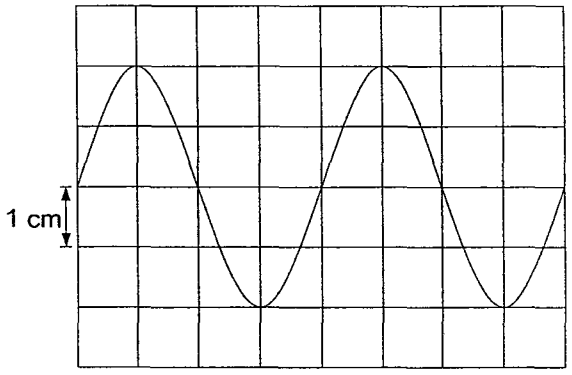
I The coil turns anticlockwise.

II The wire on the left moves towards the south pole.

III The wire on the right moves towards the north pole.

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

39 The diagram below shows the display of a c.r.o. when an a.c. generator is connected to the c.r.o.. The Y-gain is set to 2 V cm^{-1} and the time-base is set to 4.0 ms cm^{-1}.



What is the peak voltage of the waveform shown if the speed of rotation of the coil is halved?

A 2 V **B** 4 V **C** 8 V **D** 16 V

40 A transformer is used to reduce power loss in transmitting cables. A power station produces 1 MW of power at a potential difference 20 kV. What should be the turns ratio such that the output current is reduced to one-fifth of its input value?

A 1 : 25 **B** 1 : 6 **C** 1 : 5 **D** 5 : 1

END OF PAPER

O

Preliminary 2 Examination 2016

CANDIDATE NAME			
CLASS		**INDEX NUMBER**	

PHYSICS

5059/02

Paper 2

26 August 2016
1 hour 45 minutes

Sec 4 Express

Candidates answer on the Question Paper.

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer **all** questions. **Question 12** has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

For Examiner's Use

Section A [50 marks]

Answer **all** the questions in this section.

1 Fig. 1 shows how the speed of a sky-diver of mass 75 kg varies with time after he jumps from a helicopter.

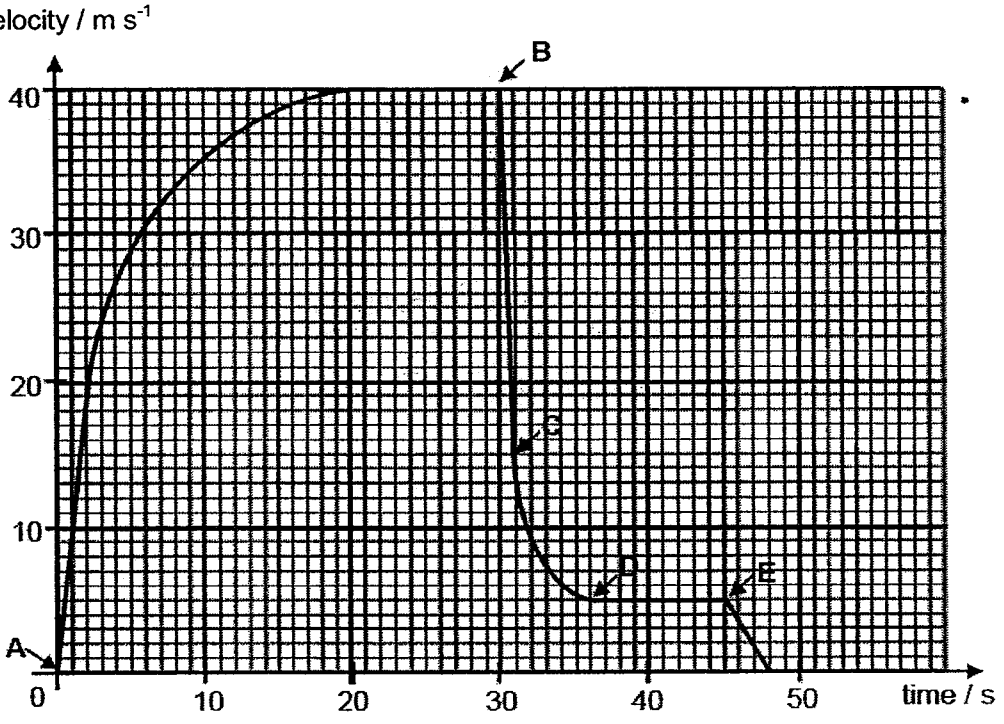


Fig. 1

Assume that the total mass of the parachute and pack is negligible.

(a) Describe the motion of the sky-diver between *A* and *B*.

.....

.....

.....

.....

.....

..... [3]

For Examiner's Use

1 **(b)** At *B*, the sky-diver opens his parachute.

(i) Determine the value of the acceleration between *B* and *C*.

acceleration = ... [2]

(ii) Explain, in terms of the forces acting on the sky-diver, his motion between *B* and *D*.

.....

.....

.....

..... [2]

(c) The sky-diver touches down at *E*. Explain, in terms of forces acting on him, why a smaller touchdown velocity ensures that he can land safely.

.....

.....

.....

.....

.....

..... [2]

For Examiner's Use

2 The Mars rover named Curiosity, as shown in Fig. 2, is designed to find out whether the environment on Mars has ever been habitable to life. The rover has a weight of 8 990 N on Earth and a weight of 3 335 N on the planet Mars.

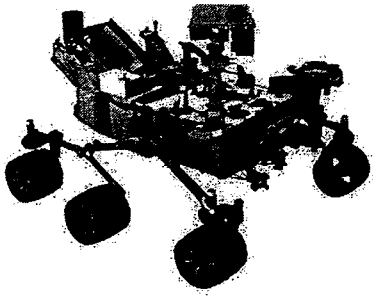


Fig. 2

(a) State what is meant by *gravitational field strength*.

.....

..... [1]

(b) If the gravitational field strength on Earth is 10 N/kg, calculate the gravitational field strength on the planet Mars.

gravitational field strength = ... [2]

(c) The rover falls vertically from rest through a gap in the soil of Mars. It hits the bottom of the gap in 4.2 s. Calculate the depth of the gap.

depth = ... [2]

For Examiner's Use

3 The water current causes the wooden sphere to be displaced until the rope makes an angle of 30 ° with the vertical as shown in Fig. 3. When the sphere is at this equilibrium position, three forces are exerted on it. These three forces are the tension T in the rope, a horizontal force F_w by water current and a vertical force F_y of 465 N.

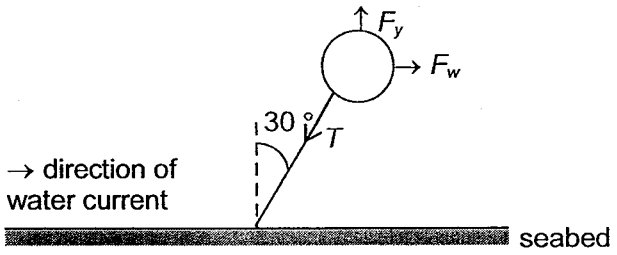


Fig. 3

Use a suitable scale, draw a vector diagram for the three forces acting on the sphere to determine the magnitude of tension T. [2]

T = ... [1]

For Examiner's Use

4 A manometer is connected to a gas cylinder. The atmospheric pressure is 75 cm Hg.

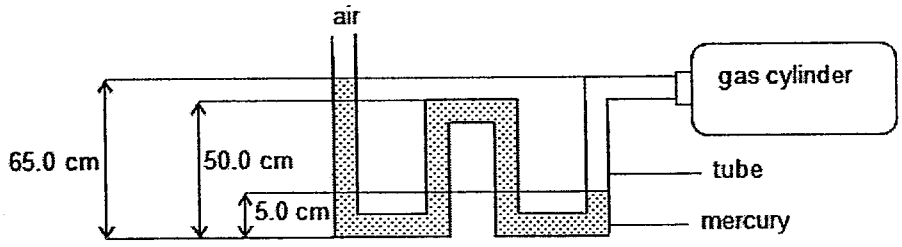


Fig. 4.1

(a) (i) Calculate the gas pressure, in cm Hg.

gas pressure = ... [1]

(ii) Given the density of mercury is 13 600 kg/m^3, calculate the gas pressure in Pascal.

gas pressure = ... [1]

For Examiner's Use

4 **(b)** Fig. 4.2 shows a car windscreen washer pump.

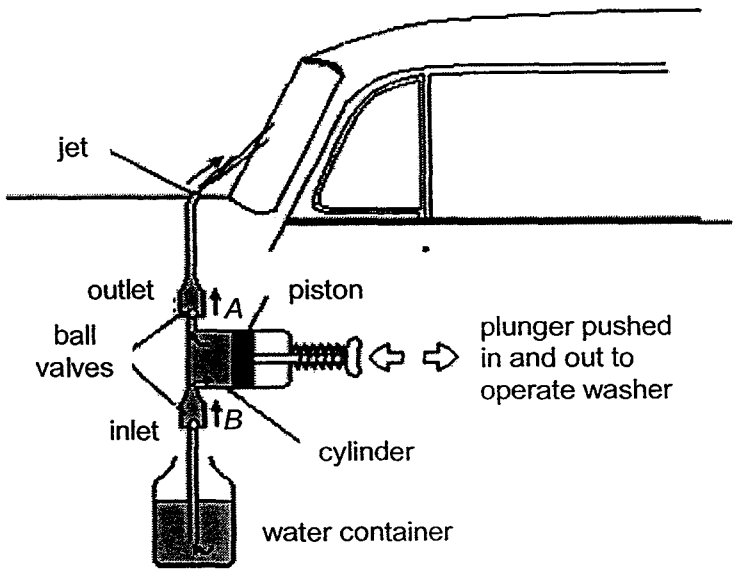


Fig. 4.2

The plunger can be pushed in and out to open the ball valves *A* and *B* to facilitate the flow of water from the water container at the bottom to the jet in front of the windscreen.

(i) If the cross-sectional area of the piston is 16 cm^2, calculate the amount of force exerted at the plunger in order to create a force of 100 N at the jet. The cross-sectional area of the mouth of the jet is 2 cm^2.

force = ... [2]

(ii) State and explain how the force calculated in **(i)** will differ if some air bubbles enter into the system.

.....

.....

.....

..... [2]

For Examiner's Use

5 (a) Explain why a sleeping bag is made of two layers of plastic and woolen material to keep you warm on a cold night and how it will become useless if the layer is wet.

.....

.....

.....

.....

.....

..... [2]

(b) Fig. 5 shows part of a table lamp.

Fig. 5

Explain why there are holes in the shade of the lamp.

.....

.....

.....

.....

.....

..... [2]

For Examiner's Use

6 (a) Fig. 6.1 gives the names of five components of the electromagnetic spectrum.

gamma rays	microwaves	X-rays	visible light	radio waves

Fig. 6.1

(i) One of the components of the electromagnetic spectrum in Fig. 6.1 is not in the correct position. State the name of this component.

..... [1]

(ii) Explain why ultrasound is not a component of the electromagnetic spectrum.

.....

..... [1]

(iii) Information can be transmitted by light in optical fibres, in copper wires, or by an electromagnetic wave. State **one** advantage of using optical fibres to transmit information rather than using copper wires.

.....

..... [1]

For Examiner's Use

6 (b) **RADAR**, short for **RA**dio **D**etection **A**nd **R**anging, has many applications. It is a system used to detect and determine the distance of objects such as aircraft. Strong radio waves are transmitted and a receiver listens for any echoes. Fig. 6.2 shows a radar station that has detected an incoming aircraft.

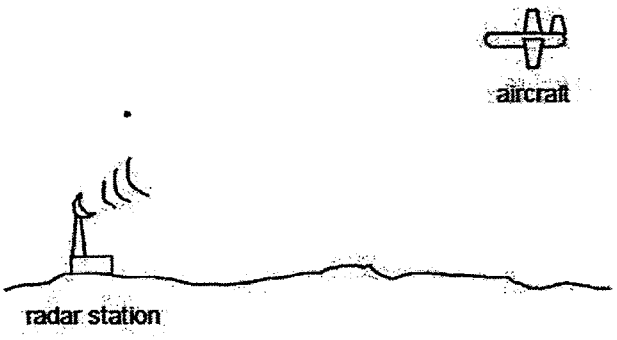


Fig. 6.2

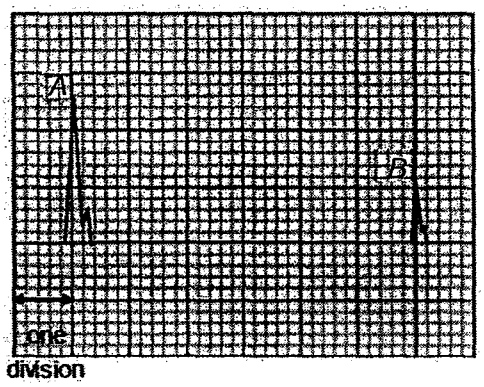


Fig. 6.3

Fig 6.3 shows the display of a c.r.o. screen. *A* represents the pulse of the emitted radio waves while *B* represents the pulse of the echo. Time base is set at 0.2 ms per division. Radio waves travels at a speed of 3×10^8 m/s. Using Fig. 6.3, determine the distance of the aircraft from the radar station.

distance = ... [3]

For Examiner's Use

7 Fig. 7 shows the graphs of current against voltage plotted for bulb *X* and wire *R*.

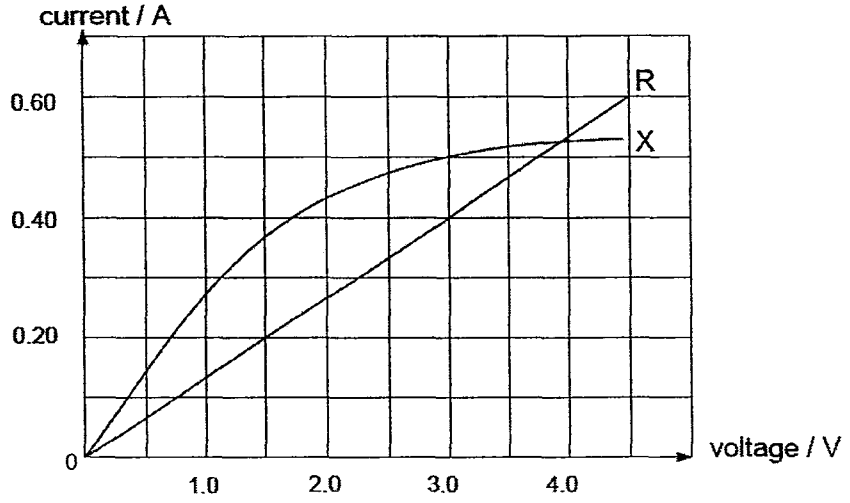


Fig. 7

(a) If the length of wire *R* is 1.5 m and the cross-sectional area is 2.0×10^{-6} m^2, calculate the resistivity of the wire.

resistivity = ... [3]

(b) Bulb *X* and wire *R* are connected in parallel to a 3.0 V cell. Calculate the current passing through the cell and the resistance of the bulb.

current = ... [2]

resistance = ... [1]

For Examiner's Use

8 Fig. 8.1 shows part of the mains electrical circuit in a house. Two lamps *A* and *B*, each rated at 60 W 240 V, are connected to the live wire through fuse *X*. An electric kettle, rated at 840 W 240 V, is connected to the live wire though fuse *Y*. Fuse *Z* protects the whole circuit. The electric kettle has a metal case which is connected to Earth. The mains supply voltage is 240 V.

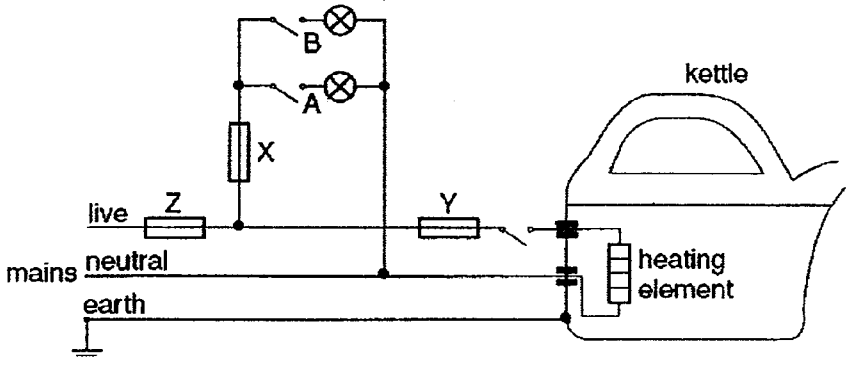


Fig. 8.1

(a) Calculate the current in fuse *Z* when the electric kettle and both the lamps are switched on.

current = ... [2]

(b) A fault develops in the electric kettle, causing a current of 10 A in fuse *Y*. The lamps *A* and *B* remain switched on. The maximum current ratings of the fuses are shown in Fig. 8.2.

	Fuse *X*	Fuse *Y*	Fuse *Z*
current rating / A	3	5	15

Fig. 8.2

Describe and explain what happens to each of the fuses *X*, *Y* and *Z* at the instant when the fault develops.

.....

.....

.....

.....

.....

..... [3]

For Examiner's Use

9 Fig. 9.1 shows a quality control setup of a factory producing magnets. Newly produced permanent magnets are positioned on a conveyor belt and are moved under a detecting device. This device consists of a coil of wire, wound on a soft-iron core and connected to a sensitive voltmeter.

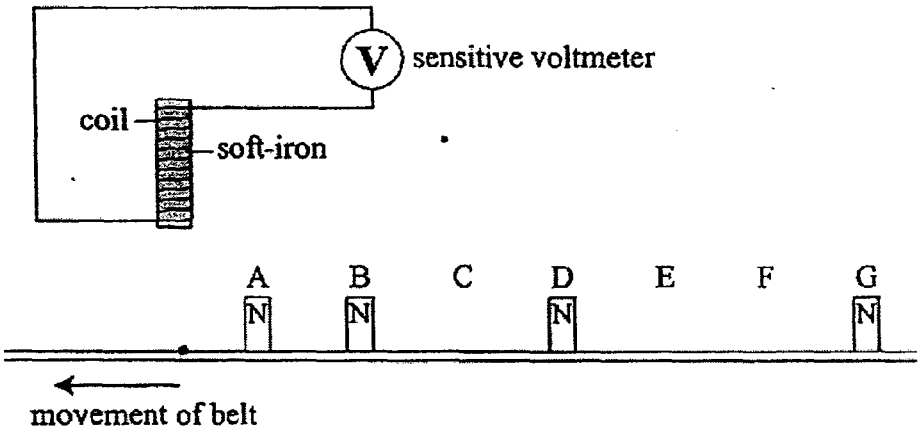


Fig. 9.1

As the conveyor belt moves along at constant speed, voltage pulses are recorded by the voltmeter. These pulses are sent to a c.r.o. and they are displayed in the graph shown in Fig. 9.2. The letters *A* to *G* correspond to the positions on the belt as each magnet passes under the coil.

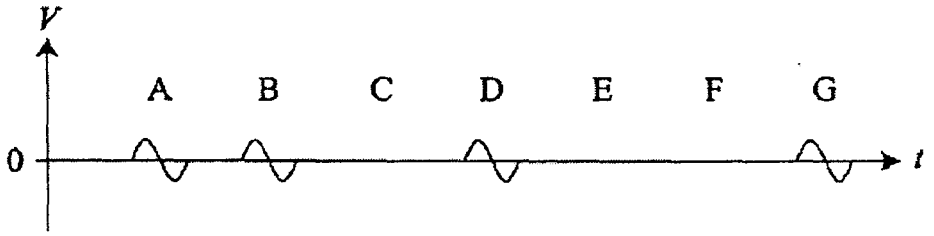


Fig. 9.2

(a) Explain why these pulses occur as each magnet passes under the coil.

.....

.....

.....

..... [2]

For Examiner's Use

9 **(b)** Explain why the pulse produced by each magnet has a positive and a negative region.

.....

.....

.....

.....

.....

..... [2]

(c) State **one** way in which the detecting device can be made more sensitive.

.....

..... [1]

(d) State how the pulses are affected if the soft iron core is removed.

.....

..... [1]

For Examiner's Use

Section B [30 marks]

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

10 A domestic room heater burns natural gas to generate heat for a family.

Table of information	
Description	**Value**
Output power of heater / kW	4.5
Energy obtained from burning 1.0 m^3 of natural gas / MJ	39
Average density of gas / kg m^{-3}	0.72
Specific heat capacity of natural gas / J kg^{-1} $°C^{-1}$	990
Number of gas molecules in 1.0 mol of gas	6.02×10^{23}

Fig. 10

Using the information in Fig. 10,

(a) show that the volume of gas which must be burnt to produce a steady power output of 4.5 kW is 6.9×10^{-3} m^3 each minute. [3]

(b) calculate

(i) the mass of natural gas burnt in one minute.

mass = ... [2]

For Examiner's Use

10 (b) (ii) the number of molecules of natural gas which pass through the burner each minute if the molar mass of the gas is 1.6×10^{-2} kg/mol.

number of molecules = ... [2]

(c) Explain why the heater cannot be operated using a 13 A, 230 V socket. Include a suitable calculation in your answer.

.....

.....

..... [3]

For Examiner's Use

11 Fig. 11.1 shows a simplified d.c. motor.

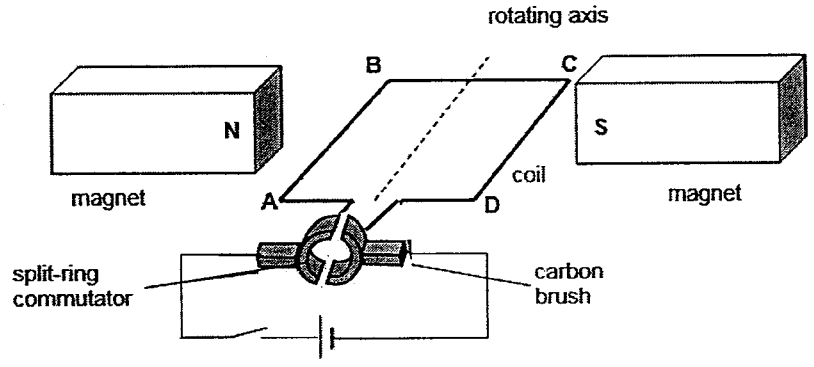


Fig. 11.1

(a) State the direction in which the coil turns when the switch is closed.

..... [1]

(b) Explain why the coil turns when the switch is closed.

.....

.....

.....

..... [2]

(c) The rotating coil is a rectangle. *AB* has a length of 0.04 m and *BC* has a length of 0.03 m. If the total turning effect of the coil is 0.6 N m, calculate the force on each side of the coil which causes the turning effect.

force on side *AB* = ... [1]

force on side *CD* = ... [1]

For Examiner's Use

11 Fig. 11.2 shows the variation of the moment of the coil with time.

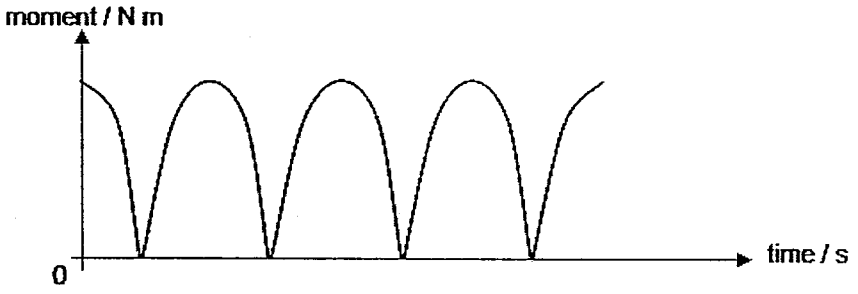


Fig. 11.2

(d) From Fig. 11.2, state the number of complete rounds the coil has rotated.

..... [1]

(e) State and explain the position of the coil at which the moment would be zero.

.....

.....

.....

..... [2]

(f) Describe **two** changes to the graph if the current in the coil is reduced.

.....

.....

.....

..... [2]

For Examiner's Use

12 EITHER

A thermistor is placed in an environment where the surrounding temperature increases a constant rate of 1 °C per minute. The graph below shows how the resistance of a thermistor changes with its surrounding temperature.

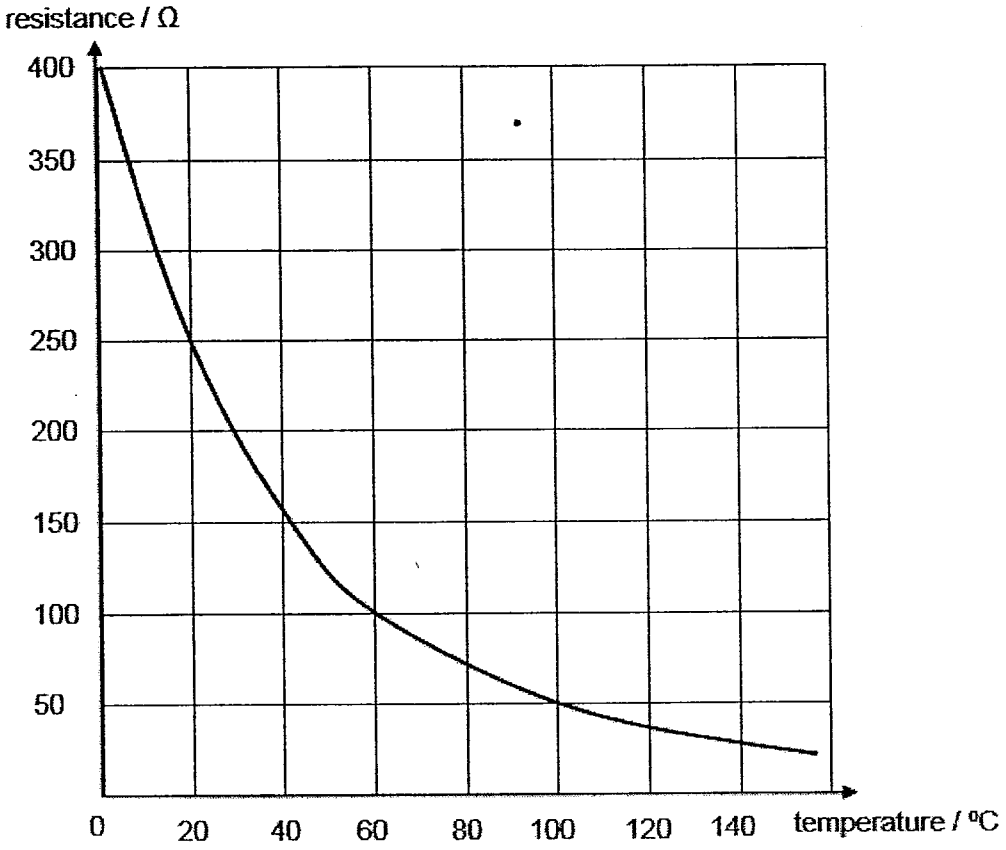


Fig. 12.1

(a) Describe how the resistance of a thermistor changes with surrounding temperature.

.....

.....

.....

..... [2]

For Examiner's Use

12 The thermistor is connected in series with a bulb of resistance 10 Ω. They are then connected in parallel with a heating filament of resistance 10 Ω which is mounted very close to the thermistor as shown in Fig. 12.2.

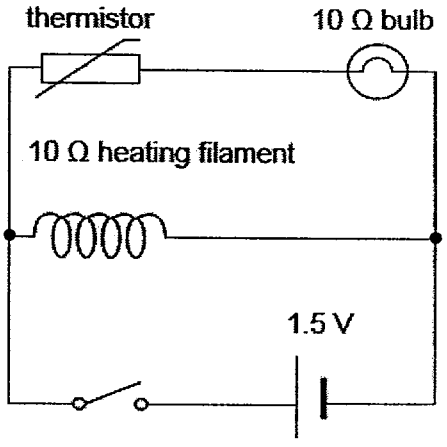


Fig. 12.2

(b) When the switch is closed, the bulb fails to light up at first. Explain why the bulb slowly lights up after a while.

.....

.....

.....

.....[2]

(c) Determine the temperature of the thermistor when a current of 0.025 A flows through the light bulb.

temperature = ... [4]

For Examiner's Use

12 (d) Calculate the effective resistance of the whole circuit when the temperature of the thermistor is 100 °C.

effective resistance = ... [2]

For Examiner's Use

12 OR

(a) State *Faraday's Law*.

.....

.....

..... [1]

(b) State *Lenz's Law*.

.....

.....

..... [1]

(c) Explain how Lenz's Law demonstrates the Principle of Conservation of Energy.

.....

.....

.....

.....

.....

.....

.....

..... [2]

For Examiner's Use

12 (d) In Fig. 12.1, a varying magnetic field is generated within the square loop *ABCD*. The magnetic field is pointing into the page and its magnitude also increases with time. Surrounding the magnetic field is a length of conducting wire of negligible resistance that forms a square loop *ABCD*. At the midpoints of sides *AD* and *BC*, two identical light bulbs *X* and *Y* are connected respectively.

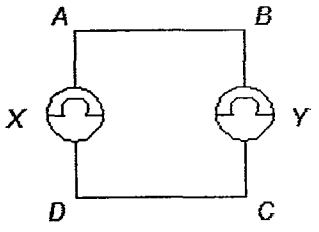


Fig. 12.1

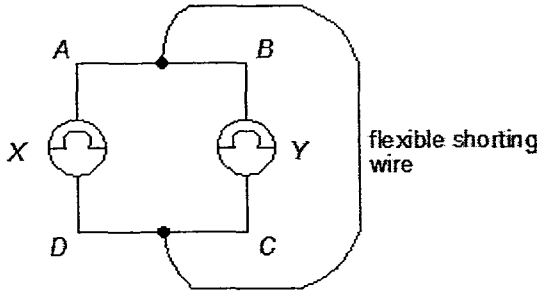


Fig. 12.2

(i) With reference to Fig. 12.1, comment on whether bulbs *X* and *Y* will light up.

.....

.....

.....

..... [2]

(ii) A flexible wire with negligible resistance is connected to the midpoint of *AB* and *CD* as shown in Fig. 12.2. This produces a short circuit.

After the shorting wire is placed, discuss what you think will happen to

bulb *X*

.....

.....

..... [2]

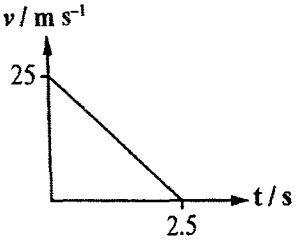
bulb *Y*

.....

.....

..... [2]

END OF PAPER

Question	Answer	Explanation
1	C	$F = G\frac{m_1 m_2}{r^2}$ $G = \frac{Fr^2}{m_1 m_2}$ Unit of $G = \frac{\text{N} \times \text{m}^2}{\text{kg}^2}$ $= \underline{\text{N m}^2\ \text{kg}^{-2}}$
2	C	Micrometer reading = 4.5 mm + 0.17 mm = 4.67 mm Length of pencil = $50 \times \left(\frac{4.67}{10}\right)$ = <u>23.35 cm</u>
3	C	time taken to reach maximum height $= \frac{25\ \text{m s}^{-1}}{10\ \text{m s}^{-2}}$ = 2.5 s *h* = area under *v-t* graph = ½ × 2.5 s × 25 m s^{-1} = <u>31.25 m</u> 
4	A	Since the firework decelerates as they get higher, the distance travelled increases at a decreasing rate.
5	D	Weight and normal reaction are not shown in the diagram. They are the vertical forces acting on the car.
6	B	$F = ma$ 16 kN – 10 kN = 2 000 kg × *a* $a = \underline{3\ \text{m s}^{-2}}$
7	A	density of composite block = $\frac{104\ \text{g}}{(8\ \text{cm} \times 5\ \text{cm} \times 2\ \text{cm})}$ = 1.3 g cm^{-3} Since the density of the composite block is 1.3 g cm^{-3}, it can only float on chloroform.
8	D	Taking moments about *Q*, $T_1 \times (5\ \text{m} - 1\ \text{m} - 1\ \text{m})$ $= \{200\ \text{N} \times \left[\left(\frac{5.0\ \text{m}}{2}\right) - 1\text{m}\right]\} + \left[(50\ \text{kg} \times 10\ \text{N kg}^{-1}) \times (5.0\ \text{m} - 1\text{m} - 1\text{m} - 0.5\ \text{m})\right]$ ↑ T_1 = <u>517 N</u> ↑ 517 N + T_2 = 200 N + 500 N ↑ T_2 = <u>183 N</u>

Question	Answer	Explanation
9	D	The trapezoid in D has the largest base area while having a lower centre of gravity. Therefore, it is the most stable.
10	C	ratio of heights of P : Q = (11 – 6) m : (11 – 8) m = 5 : 3
11	C	On the left diagram, pressure of trapped air = 75 cm Hg + 5 cm Hg = 80 cm Hg On the right diagram, 75 cm Hg = pressure of trapped air + 5 cm Hg pressure of trapped air = 70 cm Hg Let A be the cross-sectional area of the glass tube. According to Boyle's Law, $80 \times (8 \times A) = 70 \times (h \times A)$ h = 9.1 cm
12	B	By the principle of conservation of energy, E_k at point A = E_p at point B $\frac{1}{2}mv^2 = mgh$ $\frac{1}{2}v^2 = 10 \times 4$ v = 8.94 m s^{-1}
13	C	Efficiency of motor = $\frac{\text{useful energy}}{\text{total energy}} \times 100\,\%$ $= \frac{[500 - (2 \times 50)]}{500} \times 100\,\%$ = 80 %
14	B	298 K = 25 °C Particles vibrate about fixed positions are solids. Caesium and zinc are solids at 25 °C.
15	B	Heating increases the temperature of the air, and the kinetic energy of the air molecules. The piston will move outwards during heating to keep the pressure of the trapped air close to atmospheric pressure, so the volume of the trapped air will increase. This increases the average distance between air molecules. Since the piston can move freely, it will be pushed out and the pressure of the trapped air remains the same.
16	C	No energy transfer occurs when they are at the same temperature.
17	C	The white surface of the bowl is a poor emitter of radiant heat. Many restaurants choose white bowl to minimize heat loss from the bowl to the surroundings. Although the bowl is very hot, the finger near the side of the bowl cannot feel the emission of heat as the rate of heat radiation is low. Air is a poor conductor. The small gap between the finger and the bowl discourages the conduction from the bowl to the finger. When finger touched the bowl, the heat conducts effectively from the bowl directly to the finger, causing pain to Mr Lee.

Question	Answer	Explanation
18	C	$\theta = \frac{l_\theta - l_0}{l_{100} - l_0} \times 100$ $= \frac{32.0 - 7.0}{48.0 - 7.0} \times 100$ $= \underline{61.0\ °C}$
19	B	$m_T = 2m_S$ Using the same heater, heat absorbed by S = heat absorbed by T $m_S c_S \Delta\theta_S = m_T c_T \Delta\theta_T$ $m_S c_S (30 - 5) = 2m_S c_T (20 - 10)$ $\frac{c_S}{c_T} = \frac{2 \times 10}{25}$ $= \underline{0.80}$
20	B	Let n be the minimum number of ice cubes needed. heat gained by ice = heat lost by water $n \times 0.010 \times (330 \times 10^3) = 0.100 \times 4\,200 \times (20.0 - 5.0)$ $n \approx \underline{2}$
21	D	The graph only shows the displacement of a particle, so it can either be a longitudinal wave or a transverse wave.
22	B	$v = f\lambda$ $= \frac{1800}{60} \times 0.03$ $= \underline{0.90\ m\ s^{-1}}$
23	B	$i = 30°$, $r = 40°$ $\frac{\sin r}{\sin i} = \frac{1}{\sin c}$ $\frac{\sin 40°}{\sin 30°} = \frac{1}{\sin c}$ $c = \underline{51°}$
24	C	Incident light ray passing through the focal point must move parallel to the principal axis after passing through the converging lens.
25	B	$n = \frac{c}{v}$ $1.62 = \frac{3 \times 10^8}{v}$ $v = 1.85 \times 10^8\ m\ s^{-1}$ $v = f\lambda$ $1.85 \times 10^8 = (4 \times 10^{14})\lambda$ $\lambda = \underline{4.62 \times 10^{-7}\ m}$
26	B	X-rays are used for detecting broken bones.

Question	Answer	Explanation
27	D	$v = \frac{2d}{t}$ $330 = \frac{2d}{0.06}$ $d = \underline{9.9\text{ m}}$
28	A	The smaller the amplitude, the softer the sound. The higher the frequency, the higher the pitch. Flute produces a softer sound with higher pitch than violin.
29	A	Only negative charges can move. The positively charged rod attracts the negative charges in the electroscope to move towards the knob as unlike charges attract. The remaining positive charges in the leaves cause the leaves to diverge as like charges repel.
30	D	Sphere X is removed first before the finger. Hence, sphere Y is neutral as it has been earthed by the finger. No charge is drawn on sphere Y as there is same number of positive and negative charges within it.
31	D	p.d. across the 3 Ω resistor = 2 × 3 = 6 V p.d. across R = 10 – 6 = 4 V amount of charge flowing through R in 2 minutes = 2 × (2 × 60) = 240 C Energy dissipated by R = 240 × 4 = <u>960 J</u>
32	A	Effective resistance of circuit $X = \left(\frac{1}{(2+6)} + \frac{1}{4}\right)^{-1} = 2.67\ \Omega$ Effective resistance of circuit Y = 2 Ω (short circuit) Effective resistance of circuit Z = 2 + 4 + 6 = 12 Ω Order of decreasing resistance is <u>ZXY</u>
33	A	The resistance of a LDR will increase when the surrounding is dark and decrease when the surrounding is bright. For the bulb to light up, the p.d. across the LDR must be higher. The p.d. will increase when its resistance increases. To increase its resistance, the environment must be darker.
34	D	$\text{Efficiency} = \frac{\text{useful energy}}{\text{total energy}} \times 100\ \%$ $= \frac{(15 \times 1.6)}{[1000 \times (0.2 \times 0.2)]} \times 100\ \%$ $= \underline{60\ \%}$
35	A	To measure the voltage of the socket outlet, a voltmeter must be connected across the live and neutral terminals of the socket.
36	D	As the magnet is lifted, the distance between the magnet and the paper clip increases. Hence, the magnetic force of attraction weakens and can no longer overcome the clip's weight, causing it to fall.
37	A	Wires carrying currents flowing in the same direction attract each other.

Question	Answer	Explanation
38	A	The coil will experience a turning effect but not a deformation in shape which means that the wires will not move towards the poles.
39	A	The original peak voltage is 4 V. If the speed of rotation is halved, the peak voltage will reduce by half, i.e. 2 V.
40	D	$I_s = 0.2\ I_p$ $\frac{V_s}{V_p} = \frac{N_s}{N_p} = \frac{I_p}{I_s}$ $\frac{N_s}{N_p} = \frac{I_p}{0.2I_p}$ $= \underline{5 : 1}$

O

Preliminary 2 Examination 2016

CANDIDATE NAME	**MARKING SCHEME**
CLASS	
INDEX NUMBER	

PHYSICS

5059/02

Paper 2

26 August 2016
1 hour 45 minutes

Sec 4 Express

Candidates answer on the Question Paper.

Calculators are allowed in the examination

READ THESE INSTRUCTIONS FIRST

Write your class, index number and name on all the work you hand in.
Write in dark blue or black pen on both sides of the paper.
You may use a soft pencil for any diagrams or graphs.
Do not use staples, paper clips, highlighters, glue or correction fluid/tape.

Section A
Answer **all** questions.

Section B
Answer **all** questions. **Question 12** has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
Candidates are advised to show all their working in a clear and orderly manner, as more marks are awarded for sound use of Physics than for correct answers.

At the end of the examination, fasten all your work securely.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
Section A	/50
Section B	/30
Total	/80

For Examiner's Use

Section A [50 marks]

Answer **all** the questions in this section.

1 Fig. 1 shows how the speed of a sky-diver of mass 75 kg varies with time after he jumps from a helicopter.

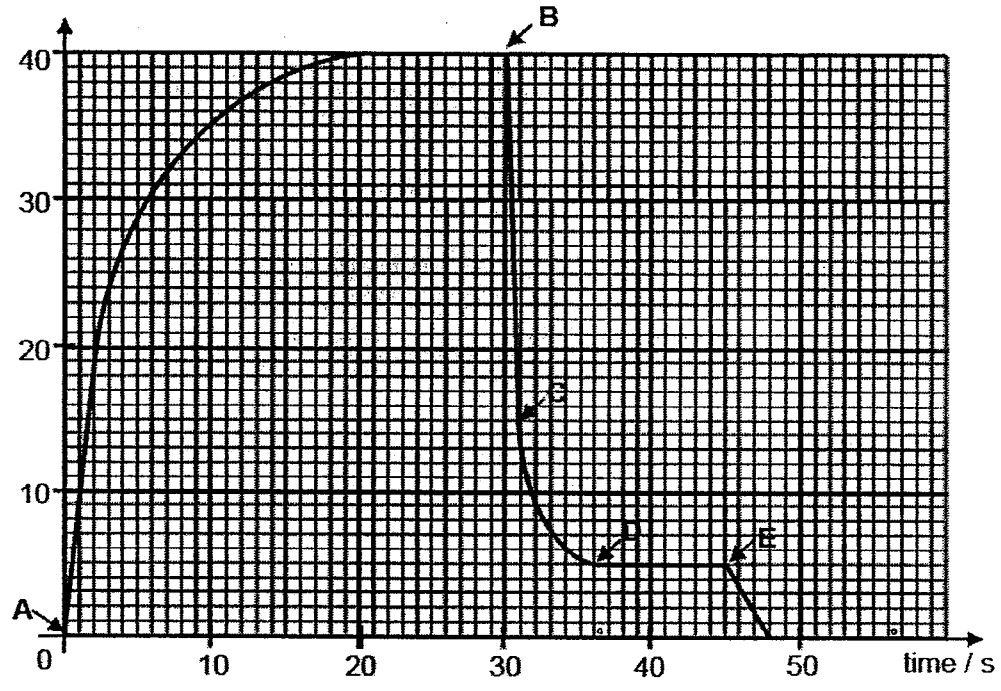


Fig. 1

Assume that the total mass of the parachute and pack is negligible.

(a) Describe the motion of the sky-diver between *A* and *B*.

Either From t = 0 s to 2 s, **velocity increases linearly** from 0 m/s to 20 m/s. [B1] From t = 2 s to 20 s, **velocity increases at a decreasing rate** from 20 m/s to 40 m/s. [B1] From t = 20 s to 30 s, **velocity remains constant at 40 m/s.** [B1]

Or From t = 0 s to 2 s, he experiences **a constant acceleration of 10 m/s^2.** [B1] From t = 2 s to 20 s, **his acceleration decreases.** [B1] From t = 20 s to 30 s, he experiences **zero acceleration.** [B1]

(b) At *B*, the sky-diver opens his parachute.

(i) Determine the value of the acceleration between *B* and *C*.

$$a = \frac{v - u}{t}$$
$$= \frac{15 - 40}{1}$$
$$= -25 \text{ m s}^{-2}$$

[M1]

acceleration = **– 25 m s^{-2}** [A1]

For Examiner's Use

1 (b) (ii) Explain, in terms of the forces acting on the sky-diver, his motion between *B* and *D*.

When the sky diver first opens his parachute, **the air resistance acting upwards increases and is bigger than his weight / net force is acting upwards,** which results in **deceleration.** [B1] As his velocity decreases, **air resistance acting on him decreases. The net force acting upwards decreases,** resulting in a **decreasing deceleration.** [B1]

(c) The sky-diver touches down at *E*. Explain, in terms of forces acting on him, why a smaller touchdown velocity ensures that he can land safely.

The final velocity of sky diver is 0 m/s and assume the time taken to stop to sky-diver is the same. With smaller touchdown speed, the **deceleration upon contact with ground is smaller / kinetic energy is smaller,** hence the **work done on the sky-diver to stop him is smaller.** [B1] **Force acting on sky diver to stop him is smaller.** [B1]

2 The Mars rover named Curiosity, as shown in Fig. 2, is designed to find out whether the environment on Mars has ever been habitable to life. The rover has a weight of 8 990 N on Earth and a weight of 3 335 N on the planet Mars.

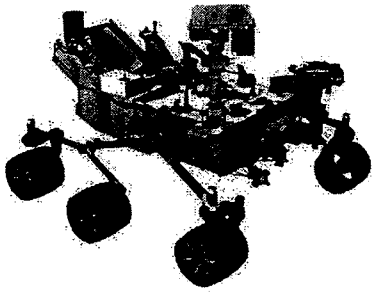


Fig. 2

(a) State what is meant by *gravitational field strength*.

Gravitational field strength is **the gravitational force acting per unit mass.** [B1]

(b) If the gravitational field strength on Earth is 10 N/kg, calculate the gravitational field strength on the planet Mars.

$W_E = mg_E$
$8\,990 = m \times 10$
$m = 899$ kg [B1]
$W_M = mg_M$
$3\,335 = 899 \times g_M$
$g_M = 3.71$ N/kg

gravitational field strength = **3.71 N/kg** [B1]

For Examiner's Use

2 **(c)** The rover falls vertically from rest through a gap in the soil of Mars. It hits the bottom of the gap in 4.2 s. Calculate the depth of the gap.

$$a = \frac{v-u}{t}$$

$$3.71 = \frac{v-0}{4.2}$$

$v = 15.582 \text{ m s}^{-1}$ [B1]

depth = area under velocity-time graph

$= \frac{1}{2} \times 4.2 \times 15.582$

$= \underline{32.7 \text{ m}}$

depth = **32.7 m** [B1]

3 The water current causes the wooden sphere to be displaced until the rope makes an angle of 30 ° with the vertical as shown in Fig. 3. When the sphere is at this equilibrium position, three forces are exerted on it. These three forces are the tension T in the rope, a horizontal force F_w by water current and a vertical force F_y of 465 N.

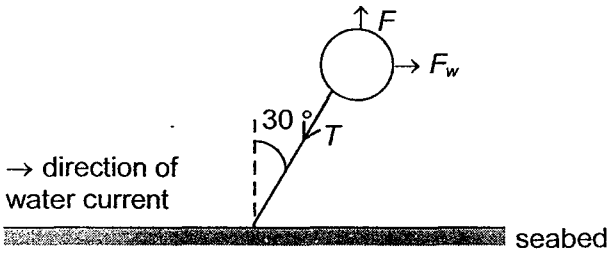


Fig. 3

Use a suitable scale, draw a vector diagram for the three forces acting on the sphere to determine the magnitude of tension T. [2]

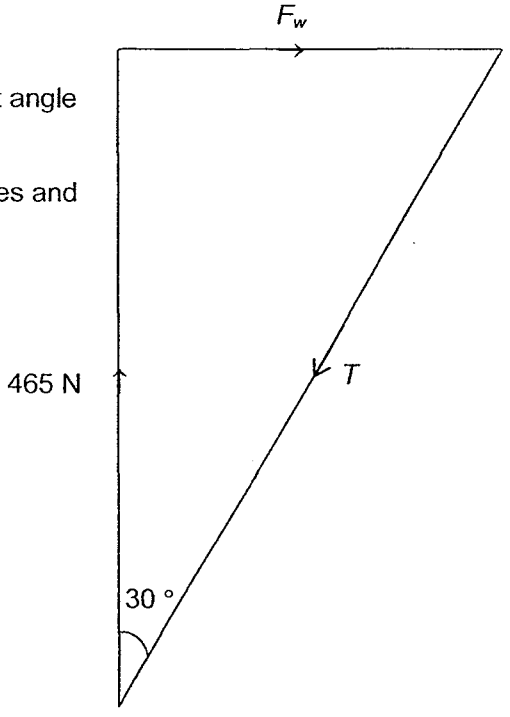
Let 1 cm : 50 N.

[B1] for drawing right angle triangle to scale

[B1] for drawing forces and direction of forces

$T = 10.8 \times 50$

$= \underline{540 \text{ N}}$



$T = \underline{\textbf{535 N – 545 N}}$ [B1]

For Examiner's Use

4 A manometer is connected to a gas cylinder. The atmospheric pressure is 75 cm Hg.

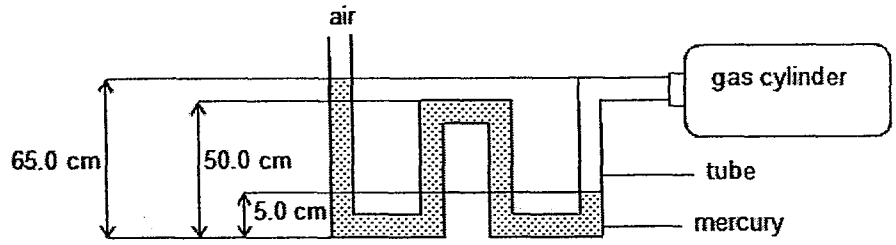


Fig. 4.1

(a) (i) Calculate the gas pressure, in cm Hg.

gas pressure = 75 + (65.0 – 5.0)
= 135 cm Hg

gas pressure = **135 cm Hg** [B1]

(ii) Given the density of mercury is 13 600 kg/m^3, calculate the gas pressure in Pascal.

gas pressure = $h\rho g$

$$= \frac{135}{100} \times 13\,600 \times 10$$

= 183 600 Pa

gas pressure = **184 000 Pa** [B1]

(b) Fig. 4.2 shows a car windscreen washer pump.

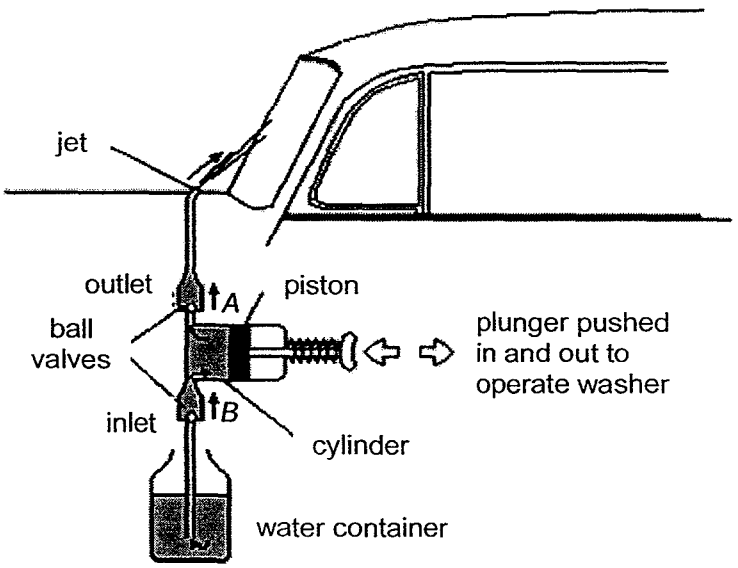


Fig. 4.2

For Examiner's Use

4 **(b)** The plunger can be pushed in and out to open the ball valves *A* and *B* to facilitate the flow of water from the water container at the bottom to the jet in front of the windscreen.

(i) If the cross-sectional area of the piston is 16 cm^2, calculate the amount of force exerted at the plunger in order to create a force of 100 N at the jet. The cross-sectional area of the mouth of the jet is 2 cm^2.

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

$$\frac{100}{2} = \frac{F}{16}$$

$F =$ 800 N [M1]

force = **800 N** [A1]

(ii) State and explain how the force calculated in **(i)** will differ if some air bubbles enter into the system.

The force will be **bigger** [B1] as **air is compressible** and **pressure cannot be transmitted effectively.** [B1]

5 **(a)** Explain why a sleeping bag is made of two layers of plastic and woolen material to keep you warm on a cold night and how it will become useless if the layer is wet.

With the double layers, there is **air trapped. Air is a poor conductor of heat,** thus our body's heat is not lost easily. [B1] When the layer is wet, **evaporation of water will take away our body's heat**, causing us to feel cold. [B1]

(b) Fig. 5 shows part of a table lamp.

Fig. 5

Explain why there are holes in the shade of the lamp.

Warm air, being less dense, rises from the lamp by convection. [B1] With the holes, this **warm air is not trapped.** [B1]

For Examiner's Use

6 (a) Fig. 6.1 gives the names of five components of the electromagnetic spectrum.

gamma rays	microwaves	X-rays	visible light	radio waves

Fig. 6.1

(i) One of the components of the electromagnetic spectrum in Fig. 6.1 is not in the correct position. State the name of this component.

Microwaves [B1]

(ii) Explain why ultrasound is not a component of the electromagnetic spectrum.

Ultrasound is a longitudinal wave whereas electromagnetic waves are transverse waves. [B1]

(iii) Information can be transmitted by light in optical fibres, in copper wires, or by an electromagnetic wave. State **one** advantage of using optical fibres to transmit information rather than using copper wires.

It is cheaper / transmits faster / is more efficient in carrying information. [B1 for any **one** advantage]

For Examiner's Use

6 (b) **RADAR**, short for **RA**dio **D**etection **A**nd **R**anging, has many applications. It is a system used to detect and determine the distance of objects such as aircraft. Strong radio waves are transmitted and a receiver listens for any echoes. Fig. 6.2 shows a radar station that has detected an incoming aircraft.

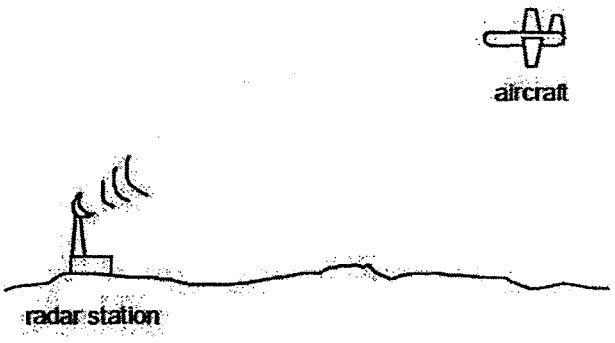


Fig. 6.2

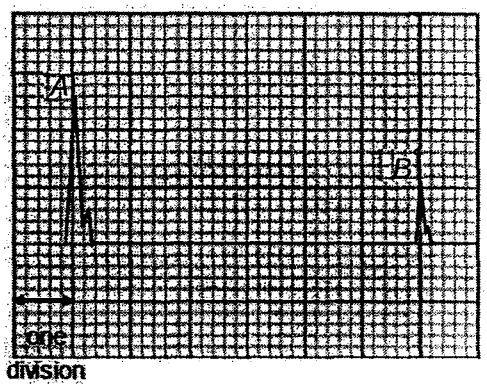


Fig. 6.3

Fig 6.3 shows the display of a c.r.o. screen. *A* represents the pulse of the emitted radio waves while *B* represents the pulse of the echo. Time base is set at 0.2 ms per division. Radio waves travels at a speed of 3 x 10^8 m/s. Using Fig. 6.3, determine the distance of the aircraft from the radar station.

$$v = \frac{2d}{t}$$

$$3\times10^8 = \frac{2d}{\left[6\times\left(0.2\times10^{-3}\right)\right]}$$ [M1, M1]

d = 180 000 m

distance = **180 000 m** [A1]

7 Fig. 7 shows the graphs of current against voltage plotted for bulb *X* and wire *R*.

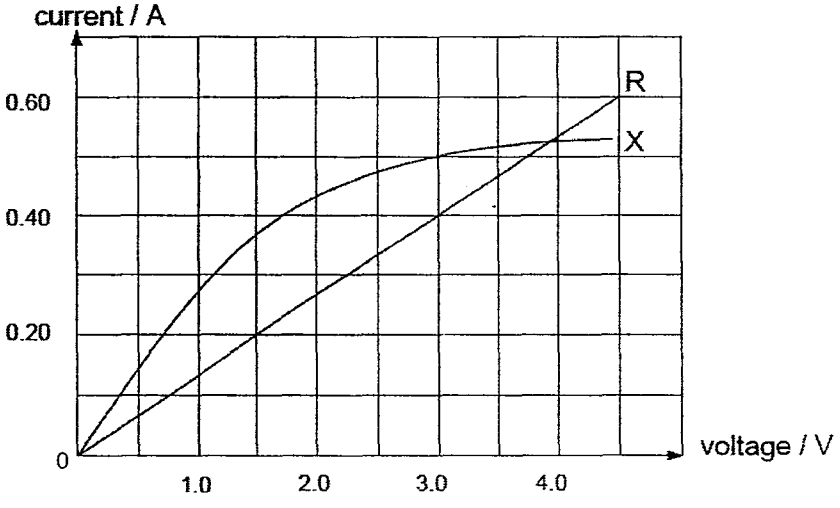


Fig. 7

For Examiner's Use

7 (a) If the length of wire R is 1.5 m and the cross-sectional area is 2.0×10^{-6} m^2, calculate the resistivity of the wire.

$$R = \frac{V}{I}$$
$$= \frac{4.5}{0.60}$$
$$= 7.5\ \Omega \quad \text{[B1]}$$
$$R = \frac{\rho \ell}{A}$$
$$7.5 = \frac{\rho \times 1.5}{(2.0 \times 10^{-6})} \quad \text{[M1]}$$
$$\rho = \underline{1.00 \times 10^{-5}\ \Omega\ \text{m}}$$

resistivity = **1.00 × 10^{-5} Ω m** [A1]

(b) Bulb X and wire R are connected in parallel to a 3.0 V cell. Calculate the current passing through the cell and the resistance of the bulb.

current = 0.40 + 0.50 [B1]
= 0.90 A

current = **0.900 A** [B1]

$$\text{resistance} = \frac{3.0}{0.50}$$
$$= \underline{6.0\ \Omega}$$

resistance = **6.00 Ω** [B1]

8 Fig. 8.1 shows part of the mains electrical circuit in a house. Two lamps A and B, each rated at 60 W 240 V, are connected to the live wire through fuse X. An electric kettle, rated at 840 W 240 V, is connected to the live wire though fuse Y. Fuse Z protects the whole circuit. The electric kettle has a metal case which is connected to Earth. The mains supply voltage is 240 V.

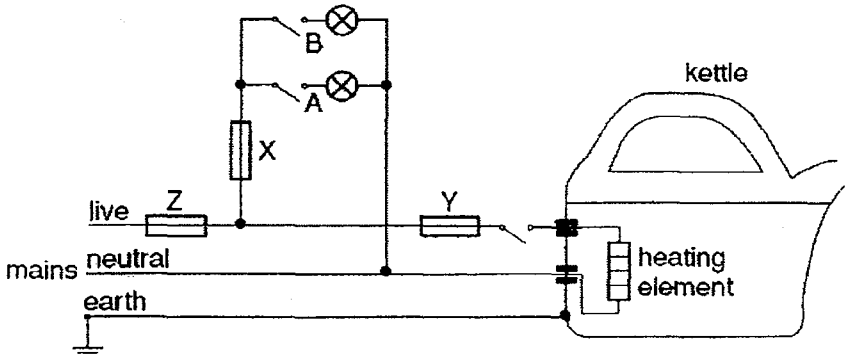


Fig. 8.1

For Examiner's Use

8 (a) Calculate the current in fuse *Z* when the electric kettle and both the lamps are switched on.

$$\text{current} = \left[2 \times \left(\frac{60}{240}\right)\right] + \left(\frac{840}{240}\right) \quad \text{[M1]}$$

$$= \underline{4.0\ \text{A}}$$

current = **4.00 A** [A1]

(b) A fault develops in the electric kettle, causing a current of 10 A in fuse *Y*. The lamps *A* and *B* remain switched on. The maximum current ratings of the fuses are shown in Fig. 8.2.

	Fuse *X*	Fuse *Y*	Fuse *Z*
current rating / A	3	5	15

Fig. 8.2

Describe and explain what happens to each of the fuses *X*, *Y* and *Z* at the instant when the fault develops.

Fuse *X* will be unaffected as there is no change in the amount of current flowing through it which is less than its current rating. [B1] **Fuse *Y* will melt and break the circuit as the amount of current flowing through it is more than its current rating.** [B1] **Fuse *Z* will be unaffected as the amount of current flowing through it is less than its current rating.** [B1]

9 Fig. 9.1 shows a quality control setup of a factory producing magnets. Newly produced permanent magnets are positioned on a conveyor belt and are moved under a detecting device. This device consists of a coil of wire, wound on a soft-iron core and connected to a sensitive voltmeter.

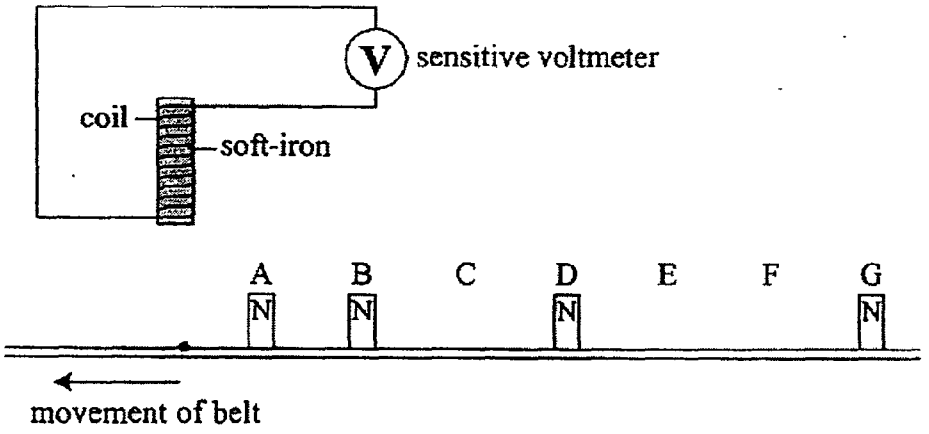


Fig. 9.1

For Examiner's Use

9 As the conveyor belt moves along at constant speed, voltage pulses are recorded by the voltmeter. These pulses are sent to a c.r.o. and they are displayed in the graph shown in Fig. 9.2. The letters *A* to *G* correspond to the positions on the belt as each magnet passes under the coil.

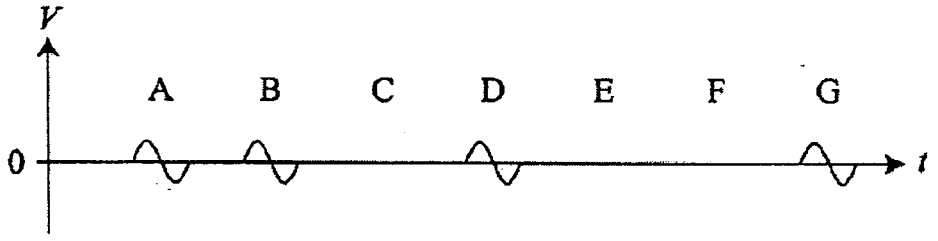


Fig. 9.2

(a) Explain why these pulses occur as each magnet passes under the coil.

As the magnet passes under the coil, **the coil experiences a rate of change of magnetic flux linkage** [B1] **which induces an electromotive force,** [B1] thus these pulses occur.

(b) Explain why the pulse produced by each magnet has a positive and a negative region.

Either
As the magnet **approaches** the coil, the coil experiences a **changing magnetic flux that induces an emf in one direction to try to repel the magnet.** [B1] As the magnet **moves away** from the coil, the coil experiences **a changing magnetic flux, producing an emf in the opposite direction to try to attract the magnet.** [B1]

Or
As the magnet approaches the coil, the coil will **induce a current to produce a north pole** as like poles repel **to resist the magnet from approaching it and thus produce a pulse of positive region.** [B1] As the magnet moves away from it, it will **induce a current** in the opposite direction **to produce a south pole** as unlike poles attract **to resist the magnet from moving away and thus produce a pulse of negative region.** [B1]

(c) State **one** way in which the detecting device can be made more sensitive.

Increase the number of turns in the coil / Move the coil nearer to the permanent magnet / Increase the speed of the conveyor belt [B1 for any **one** way]

(d) State how the pulses are affected if the soft iron core is removed.

The amplitude of the pulses will be smaller. [B1]

For Examiner's Use

Section B [30 marks]

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

10 A domestic room heater burns natural gas to generate heat for a family.

Table of information	
Description	**Value**
Output power of heater / kW	4.5
Energy obtained from burning 1.0 m^3 of natural gas / MJ	39
Average density of gas / kg m^{-3}	0.72
Specific heat capacity of natural gas / J kg^{-1} $°C^{-1}$	990
Number of gas molecules in 1.0 mol of gas	6.02×10^{23}

Fig. 10

Using the information in Fig. 10,

(a) show that the volume of gas which must be burnt to produce a steady power output of 4.5 kW is 6.9×10^{-3} m^3 each minute.

energy generated by heater = $(4.5 \times 10^3) \times (1 \times 60)$
= 270 000 J [B1]

volume of gas burnt to produce 270 000 J = $\left[\dfrac{\left(\dfrac{270000}{10^6}\right)}{39}\right] \times 1.0$ [M1]

= 0.006 9 m^3
= $\underline{6.9 \times 10^{-3}\ m^3}$ (shown) [A1]

(b) calculate

(i) the mass of natural gas burnt in one minute.

mass = $0.72 \times (6.9 \times 10^{-3})$ [M1]
= $\underline{0.004\ 97\ kg}$

mass = **$\underline{0.004\ 97\ kg}$** [A1]
(0.00498 kg is also acceptable)

(ii) the number of molecules of natural gas which pass through the burner each minute if the molar mass of the gas is 1.6×10^{-2} kg/mol.

0.004 97 kg of gas contains $\dfrac{0.00497}{(1.6 \times 10^{-2})}$ = 0.311 mole of gas. [B1]

number of molecules = $0.311 \times (6.02 \times 10^{23})$
= $\underline{1.87 \times 10^{23}}$

number of molecules = **$\underline{1.87 \times 10^{23}}$** [B1]

For Examiner's Use

10 **(c)** Explain why the heater cannot be operated using a 13 A, 230 V socket. Include a suitable calculation in your answer.

$$I = \frac{P}{V}$$
$$= \frac{(4.5 \times 10^3)}{230}$$
$$= \underline{\textbf{19.6 A}} \quad [B1]$$

This current is much higher than the fuse rating of 13 A. [B1] **The fuse will melt if the heater is used.** [B1]

11 Fig. 11.1 shows a simplified d.c. motor.

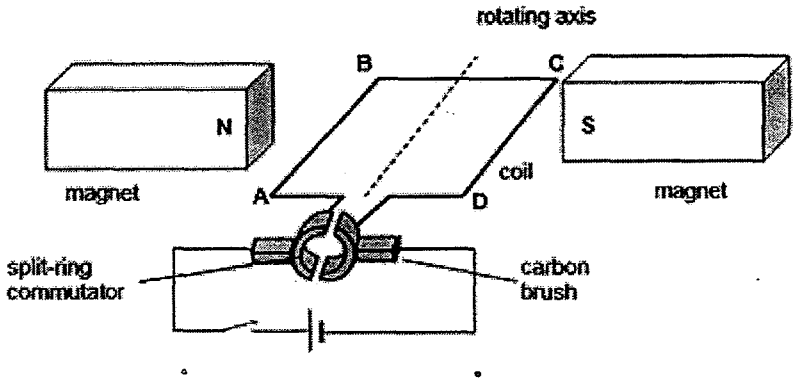


Fig. 11.1

(a) State the direction in which the coil turns when the switch is closed.

The coil will rotate **anticlockwise.** [B1]

(b) Explain why the coil turns when the switch is closed.

The magnetic field created by the current flowing in the coil interacts with the permanent magnets. [B1] **This will produce a resultant force, causing the coil to turn.** [B1]

(c) The rotating coil is a rectangle. *AB* has a length of 0.04 m and *BC* has a length of 0.03 m. If the total turning effect of the coil is 0.6 N m, calculate the force on each side of the coil which causes the turning effect.

The force on side *AB* is the same as that on side *CD*.

$$\left[F \times \left(\frac{0.03}{2}\right)\right] + \left[F \times \left(\frac{0.03}{2}\right)\right] = 0.6 \quad [B1]$$

$F =$ 20 N [B1]

force on side *AB* = **20 N**

force on side *CD* = **20 N**

For Examiner's Use

11 Fig. 11.2 shows the variation of the moment of the coil with time.

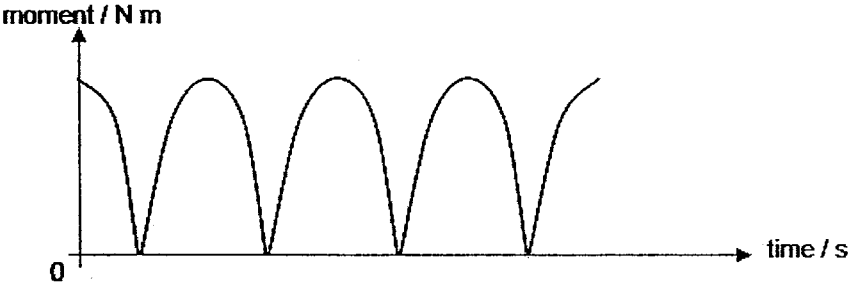


Fig. 11.2

(d) From Fig. 11.2, state the number of complete rounds the coil has rotated.

The coil has rotated **2** complete rounds. [B1]

(e) State and explain the position of the coil at which the moment would be zero.

The moment would be zero when **the coil is at the vertical position** [B1] as there is **no force acting on the coil at this position.** [B1]

(f) Describe **two** changes to the graph if the current in the coil is reduced.

The amplitude of the graph will decrease. [B1] **The number of cycles in the graph will fewer for the same period of time.** [B1]

For Examiner's Use

12 EITHER

A thermistor is placed in an environment where the surrounding temperature increases a constant rate of 1 °C per minute. The graph below shows how the resistance of a thermistor changes with its surrounding temperature.

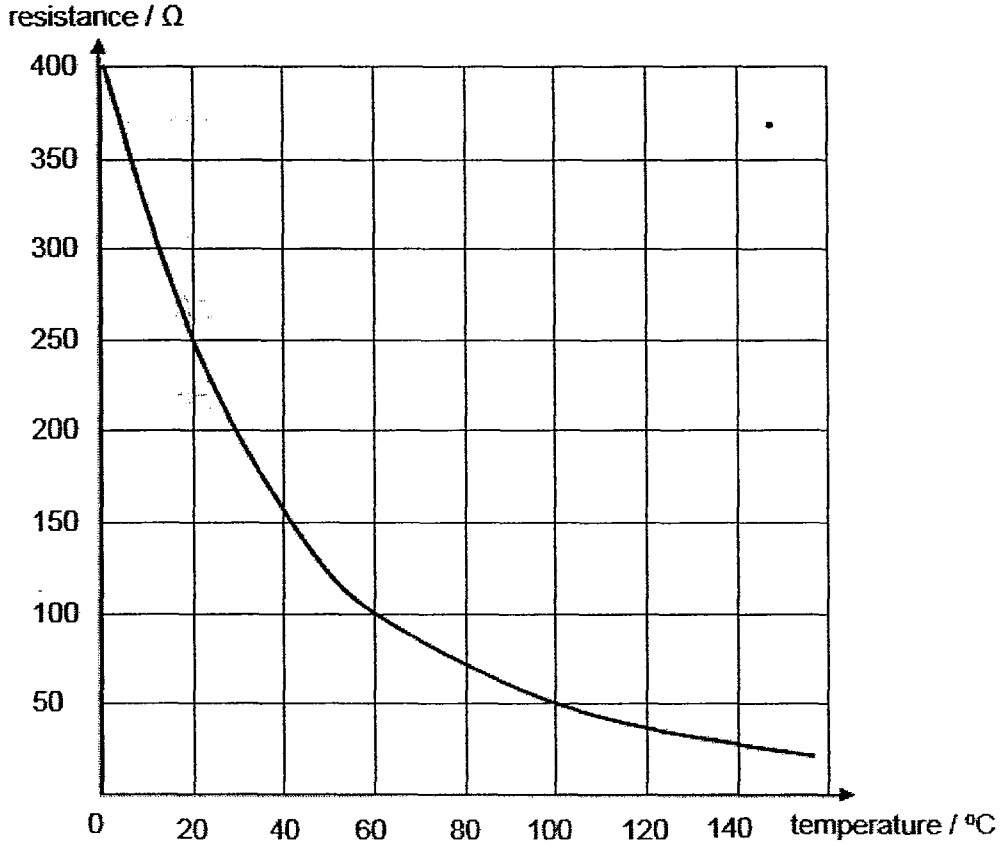


Fig. 12.1

(a) Describe how the resistance of a thermistor changes with surrounding temperature.

The resistance decreases as the temperature increases [B1] **at a decreasing rate.** [B1]

For Examiner's Use

12 The thermistor is connected in series with a bulb of resistance 10 Ω. They are then connected in parallel with a heating filament of resistance 10 Ω which is mounted very close to the thermistor as shown in Fig. 12.2.

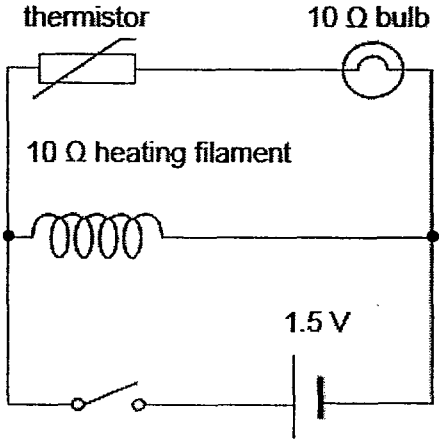


Fig. 12.2

(b) When the switch is closed, the bulb fails to light up at first. Explain why the bulb slowly lights up after a while.

Initially the thermistor's resistance is very high as room temperature is low, thus current flowing through the thermistor and the bulb is very low. [B1]
As the temperature of the heating coil increases, thermistor's resistance drops and current through them increases. [B1]

(c) Determine the temperature of the thermistor when a current of 0.025 A flows through the light bulb.

p.d. across bulb = 0.025 × 10
= 0.25 V [M1]

p.d. across thermistor = 1.5 – 0.25
= 1.25 V [M1]

thermistor's resistance $= \frac{1.25}{0.025}$
= 50 Ω [M1]

temperature = **100 °C** [A1]

(d) Calculate the effective resistance of the whole circuit when the temperature of the thermistor is 100 °C.

$\frac{1}{R} = \frac{1}{10} + \frac{1}{(50+10)}$ [M1]

R = 8.57 Ω

effective resistance = **8.57 Ω** [A1]

For Examiner's Use

12 OR

(a) State *Faraday's Law*.

Faraday's Law states that **the magnitude of the induced electromotive in a conductor is proportional to the rate at which magnetic field lines are cut by the conductor.** [B1]

(b) State *Lenz's Law*.

Lenz's Law states that **the induced current is always in a direction to oppose the change producing it.** [B1]

(c) Explain how Lenz's Law demonstrates the Principle of Conservation of Energy.

If the induced current in the coil moves in the direction to create a magnetic field to attract the magnet, no work needs to be done to move the magnet towards the coil and yet the kinetic energy of the magnet and the electrical energy in the coil continue to increase. This violates the Principle of Conservation of Energy where energy cannot be created or destroyed. [B1] **Hence, according to Lenz's Law, the induced current has to flow in a direction to create a magnetic field to oppose the approaching magnet.** [B1]

(d) In Fig. 12.1, a varying magnetic field is generated within the square loop *ABCD*. The magnetic field is pointing into the page and its magnitude also increases with time. Surrounding the magnetic field is a length of conducting wire of negligible resistance that forms a square loop *ABCD*. At the midpoints of sides *AD* and *BC*, two identical light bulbs *X* and *Y* are connected respectively.

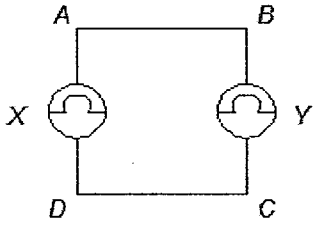


Fig. 12.1

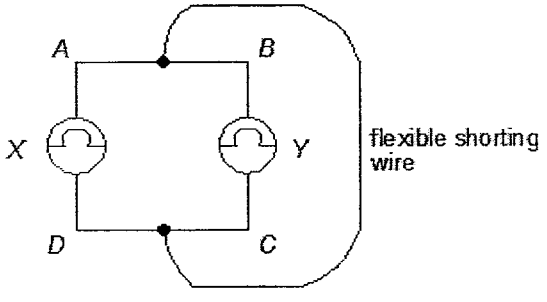


Fig. 12.2

(i) With reference to Fig. 12.1, comment on whether bulbs *X* and *Y* will light up.

The magnetic flux linking the square loop *ABCD* changes with time. An electromotive force is induced in the loop, causing an induced current to flow in the loop. [B1] **Since there is current flowing, both bulbs will light up.** [B1]

For Examiner's Use

12 (d) (ii) A flexible wire with negligible resistance is connected to the midpoint of *AB* and *CD* as shown in Fig. 12.2. This produces a short circuit.

After the shorting wire is placed, discuss what you think will happen to

bulb *X*

Bulb *X* will continue to light up. [B1] **The circuit with bulb *X* still contains the changing magnetic field, thus an induced current will flow in the wires leading to a potential difference across bulb *X*.** [B1]

bulb *Y*

Bulb *Y* will not light up. [B1] **The circuit with bulb *Y* excludes the changing magnetic field, thus no current flows in the wires.** [B1]

END OF PAPER