O

Preliminary Examination 2016
Secondary Four Express & Five Normal

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

PHYSICS **5059/01**

Paper 1 Multiple Choice

29 August 2016

1 hour

1300 – 1400h

Additional Materials: Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

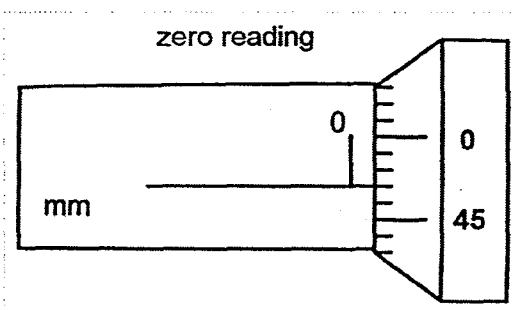
Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid/tape.
Write your name, class and index number on the Answer Sheet in the spaces provided.

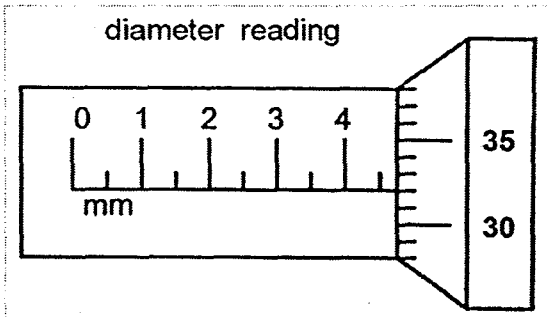
There are **forty** questions on this paper. Answer **all** questions. For each question, there are four possible answers **A**, **B**, **C** or **D**.
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet 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.
The use of an approved scientific calculator is expected, where appropriate.

1 The diameter of a steel ball is measured using a micrometer screw gauge. A student takes an initial zero error reading and then a reading of the diameter as shown.





What is the actual diameter of the steel ball?

A 4.35 mm **B** 4.75 mm **C** 4.85 mm **D** 5.29 mm

2 At $t = 0$ s, a stone is thrown vertically up into the air at 20 m/s.

Which of the following best describes the motion of the stone in the air at $t = 2.0$ s?

	speed / m/s	acceleration / m/s^2
A	10	0
B	10	10
C	0	0
D	0	10

3 A girl takes 90 s to walk 80 m towards the north. She then runs 60 m towards the east for 10 s.

What is her average speed and average velocity?

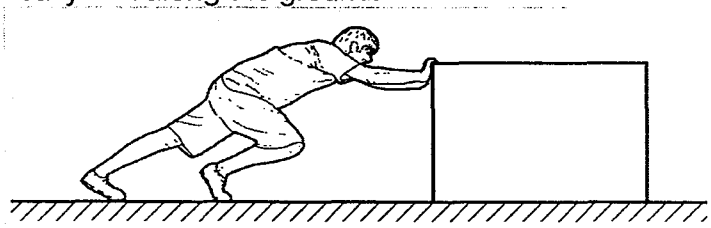
	average speed / m/s	average velocity / m/s
A	1.4	1.0
B	1.4	6.1
C	2.0	1.0
D	3.4	6.9

4 When a horizontal force of 5.0 N is applied to a wooden block of mass 3.0 kg on a horizontal surface, the block moves with a constant velocity.

If the force is increased to 12 N, what is the acceleration of the block?

A 1.7 m/s^2 **B** 2.3 m/s^2 **C** 4.0 m/s^2 **D** 5.7 m/s^2

5 A man pushes a heavy box along the ground.

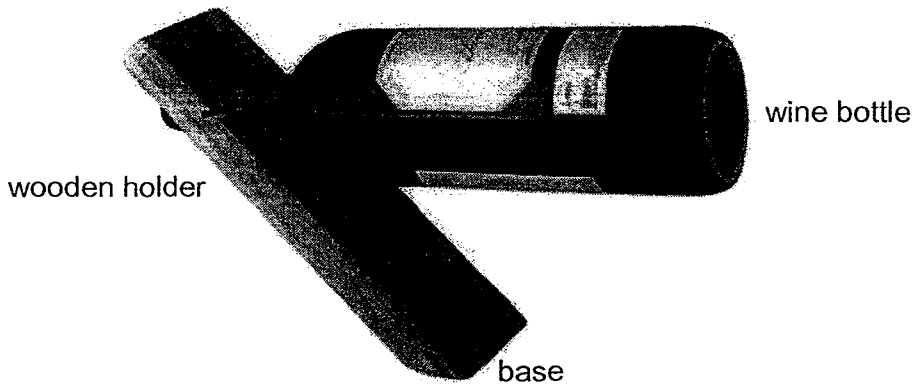


A force acts between the man's hands and the box. Another force acts between the man's feet and the floor.

In which directions do these forces act on the man?

	force on man's hands	force on man's feet
A	towards the left	towards the left
B	towards the left	towards the right
C	towards the right	towards the left
D	towards the right	towards the right

6 The diagram below shows a wine bottle placed in a wooden holder. The bottle and the holder are in equilibrium.



Which of the following statements is true about the set-up?

A The centre of gravity of the bottle is directly above the base of the wooden holder.

B The centre of gravity of the bottle and that of the wooden holder are at the same point.

C The centre of gravity of the wooden holder is directly above the base of the wooden holder.

D The centre of gravity of the bottle and the wooden holder is directly above the base of the wooden holder.

7 200 cm^3 of liquid A with density 1.0 g/cm^3 is mixed with 300 cm^3 of liquid B with density 0.80 g/cm^3.

Assuming there is no change in total volume after mixing, what is the density of the mixture?

A 0.88 g/cm^3 **B** 0.90 g/cm^3 **C** 1.1 g/cm^3 **D** 1.8 g/cm^3

8 Two mercury barometers X and Y are placed next to each other in a room. The height of the mercury column in X is slightly lower than that in Y.

What is a possible reason for the difference in height?

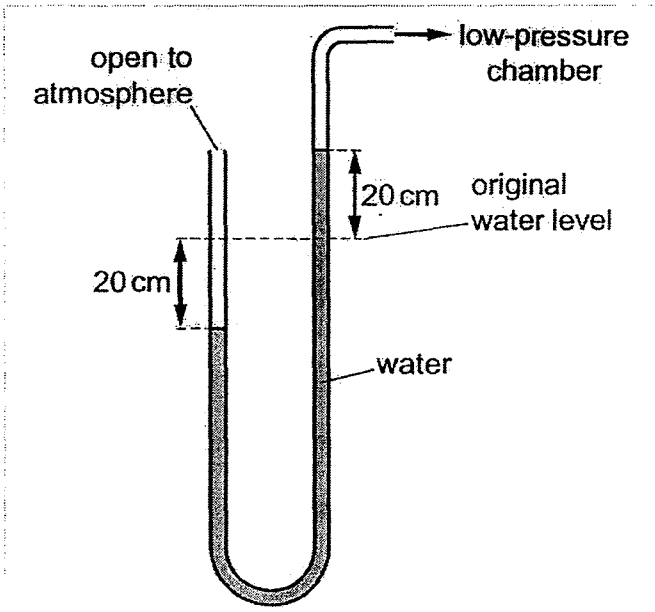
A The atmospheric pressure is different.

B There is air in the space above liquid X.

C The diameter of the tube of X is larger than of Y.

D Barometer X is slightly tilted while barometer Y is standing upright.

9 A U-tube containing water is used as a manometer. When one end of the manometer is connected to a low-pressure chamber, both water levels in the manometer change by 20 cm as shown.

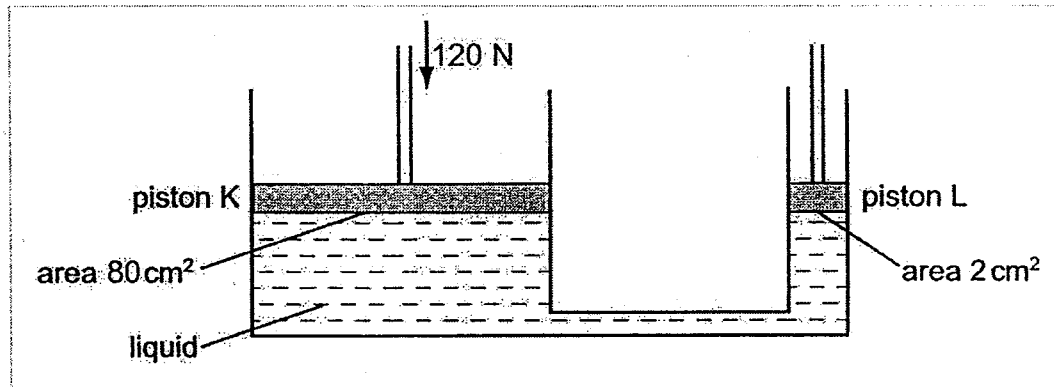


The density of water is 1000 kg/m^3.

How far below atmospheric pressure is the pressure in this chamber?

A 2000 Pa **B** 4000 Pa **C** 200 000 Pa **D** 400 000 Pa

10 The diagram below shows a hydraulic press.



A downward force of 120 N is exerted on piston K.

What is the force exerted on piston L?

A 0.75 N **B** 3.0 N **C** 120 N **D** 4800 N

11 A rocket of total mass M is travelling at a speed v. The engine of the rocket is fired and fuel is used up. The mass of the rocket decreases to $M/2$ and its speed increases to $2v$.

What happens to the kinetic energy of the rocket?

A The kinetic energy doubles.

B The kinetic energy halves.

C The kinetic energy increases by a factor of four.

D The kinetic energy remains the same.

12 A toy boat was propelled steadily from rest to reach a speed of 2.0 m/s in 10 seconds. During this time, there is an average water resistance of 3.0 N acting between the base of the boat and the water.

What is the rate of work done against water resistance?

A 3.0 W **B** 6.0 W **C** 30 W **D** 60 W

13 In a Brownian motion experiment involving smoke particles in air, large smoke particles settle quickly but very small smoke particles remain suspended for long periods of time.

Which of the following explains why small smoke particles do not settle quickly?

A The Earth's gravitational field does not act on small smoke particles.

B The small smoke particles have the same density as air.

C Random bombardments by air molecules keep the small smoke particles suspended.

D Air pressure has a greater effect on smaller particles.

14 Blowing across the surface of a bowl of hot soup will cause the soup to cool faster.

Which of the following statements is the correct explanation?

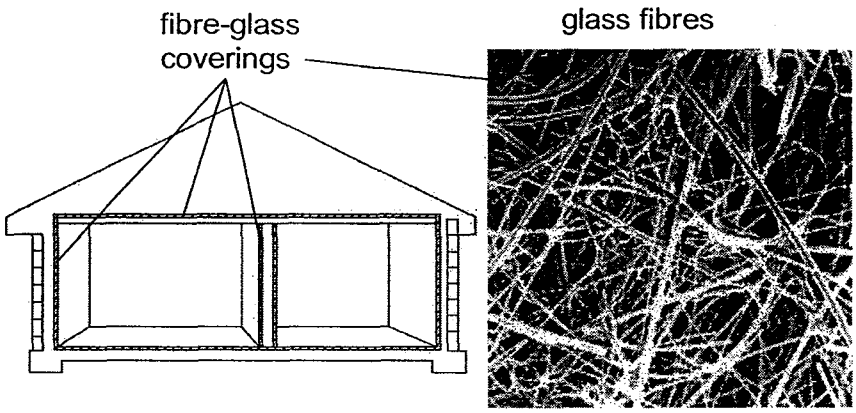
A Moving air is a better conductor of heat than still air.

B Convection currents cannot be set up without blowing.

C Blowing across the surface of the soup increases the rate of evaporation, hence more thermal energy will be lost from the soup.

D Blowing across the surface of the soup increases the surface area of the soup, hence more thermal energy will be lost through radiation.

15 Fibre-glass consists of a large amount of fine glass fibres. Fibre-glass coverings laid on the floor, walls and ceiling of a house can greatly reduce heat lost to the surroundings.



Three students attempt to explain this. Each student gives an explanation.

Student 1: Glass fibres have a low specific heat capacity.
Student 2: The glass fibres with trapped air are very poor conductors of heat.
Student 3: Fibre-glass coverings are good absorbers of infra-red radiation.

Which of the students is/are correct?

A 1 only B 2 only C 1 and 2 only D 2 and 3 only

16 A thermometer uses an electrical resistance of a piece of metal that varies with temperature. It is calibrated from resistance value of 20 Ω to 2000 Ω.

When the resistance is at 20 Ω, the temperature shows -10 °C. For resistance of 450 Ω, it shows 60 °C.

What is the highest temperature at which the thermometer can measure?

A 200 °C **B** 230 °C **C** 310 °C **D** 330 °C

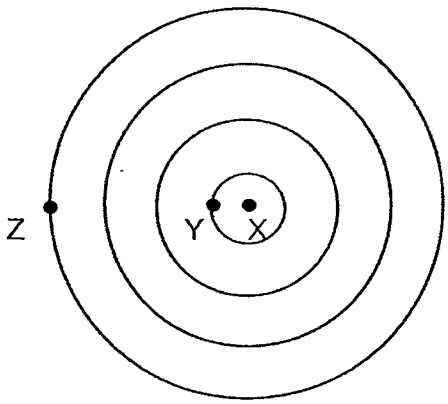
17 An ice machine removes heat at a rate of 3000 W.

The specific heat capacity of water is 4.2×10^3 J / kg °C and the specific latent heat of fusion of ice is 3.4×10^5 J / kg.

What is the time needed to freeze 2.5 kg of water at 30 °C?

A 280 s **B** 300 s **C** 390 s **D** 8600 s

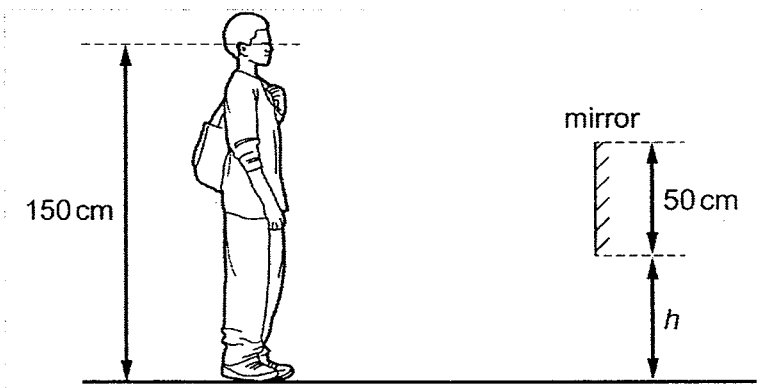
18 A spherical dipper of frequency 15 Hz is placed at X, and circular wavefronts radiate from X to Z as shown.



Give that the distance between Y and Z is 1.2 m, what is the speed of the wave?

A 4.5 m/s **B** 6.0 m/s **C** 13 m/s **D** 18 m/s

19 A shoe shop puts a mirror on the wall so that customers can look at their shoes.

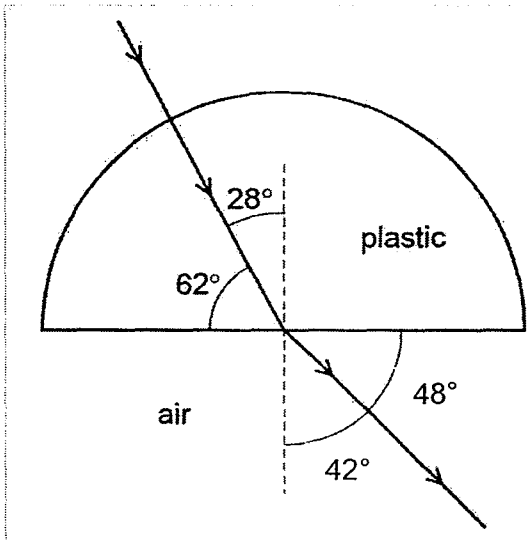


The length of the mirror is 50 cm. A customer has eyes 150 cm above ground level. The bottom of the mirror is at height *h* above the ground.

What is the smallest value of *h* that allows the customer to see an image of his shoes in the mirror?

A 10 cm **B** 25 cm **C** 50 cm **D** 75 cm

20 A semi-circular block is made from a plastic. A ray of light passes through it at the angles shown.



What is the refractive index of the plastic?

A 0.70 **B** 1.3 **C** 1.4 **D** 1.6

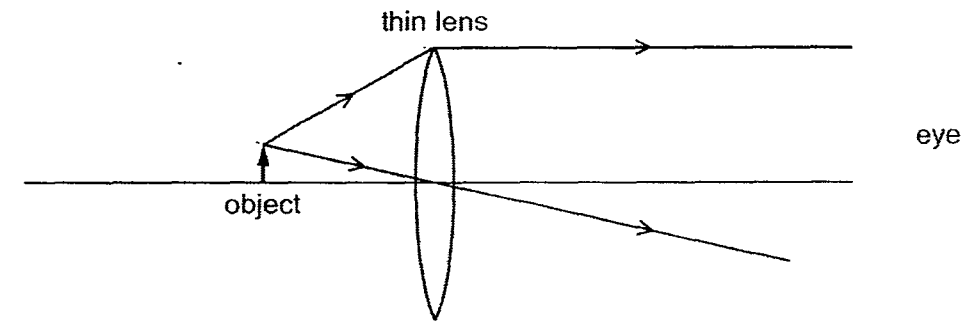
21 An X-ray travels from vacuum into a medium of refractive index 2.1.

What is the speed of the X-ray in the medium?

A 0.7×10^8 m/s **B** 1.4×10^8 m/s **C** 3.0×10^8 m/s **D** 6.3×10^8 m/s

22 An object is viewed through a converging lens.

The diagram shows the paths of two rays from the top of the object to an eye.



How does the image compare with the object?

A It is larger and inverted.

B It is larger and upright.

C It is smaller and inverted.

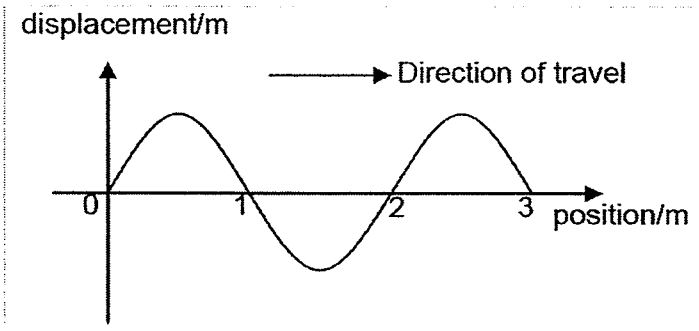
D It is smaller and upright.

23 When an object is placed 50 cm from a convex lens, a real image of the same size as the object is formed. The object is then moved 15 cm towards the lens.

Which of the following correctly describes the new image formed?

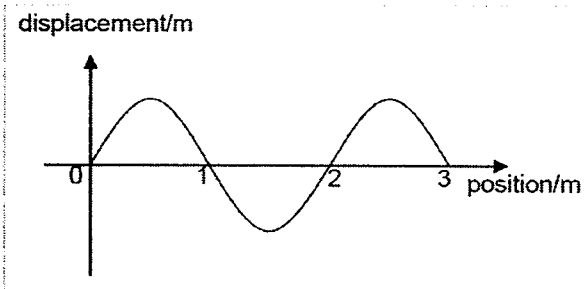
	image	image distance
A	diminished	less than 50 cm from the lens
B	magnified	less than 50 cm from the lens
C	diminished	more than 50 cm from the lens
D	magnified	more than 50 cm from the lens

24 The diagram shows the displacement-position graph of a transverse wave at t = 0 s as it travels from left to right. The wave has a period *T*.



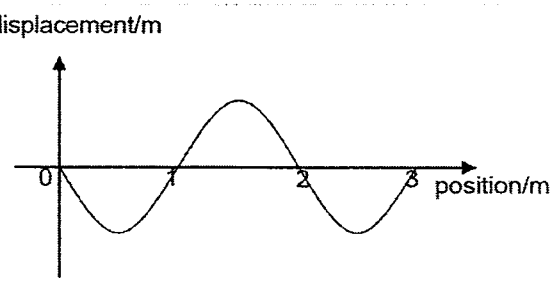
Which of the following graphs correctly shows how the transverse wave would look like at t = 0.25*T*?

A

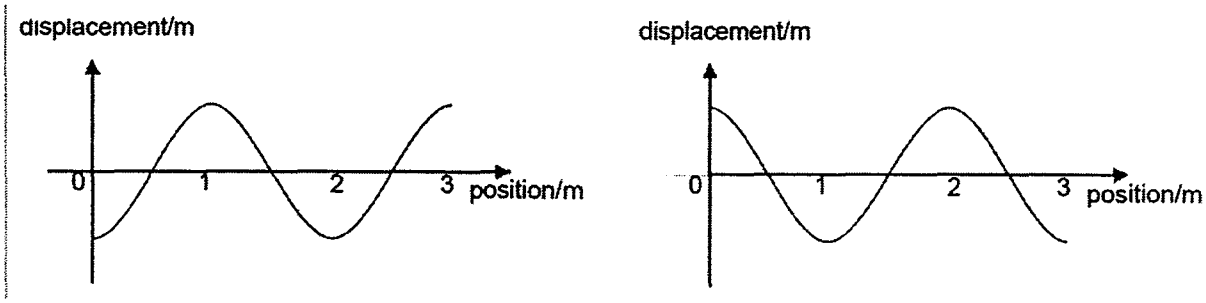


B

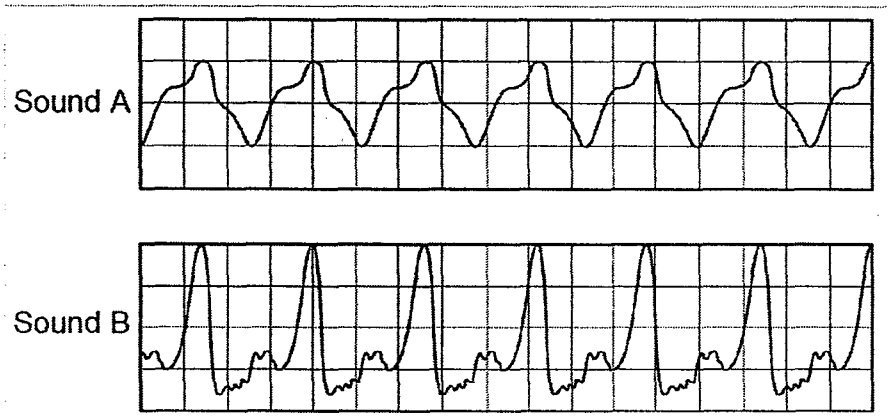
C



D



25 The sounds produced by two musical instruments are directed towards a microphone connected to a cathode ray oscilloscope (c.r.o.). The waveforms produced on the screen are shown. For both waveforms, the settings of the c.r.o. remain the same.



Which statement about the two sounds is correct?

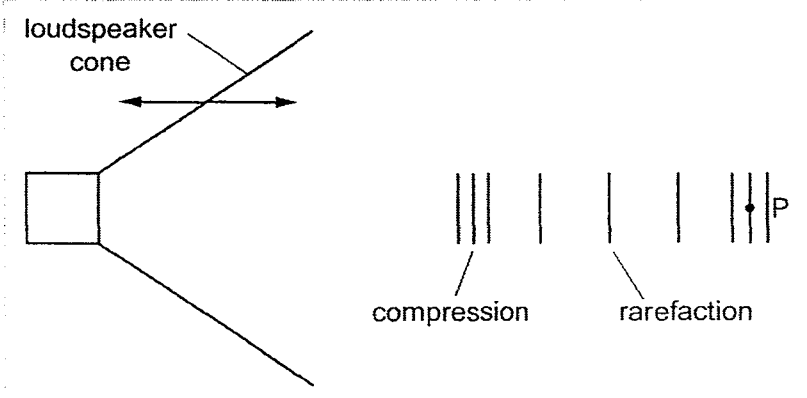
A Sound A travels slower than sound B.

B Sound B has a lower pitch than sound A.

C Sound B is louder than sound A.

D Sound B has a higher pitch and greater loudness than sound A.

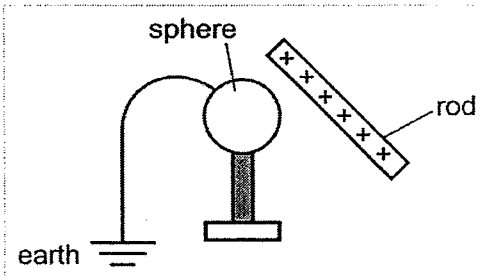
26 Compressions and rarefactions are sent out from a loudspeaker cone as it vibrates backwards and forwards. The frequency of vibration is 50 Hz.



A compression is at point P. How much time elapses before the next rarefaction arrives at P?

A 0.010 s **B** 0.020 s **C** 25 s **D** 50 s

27 A positively charged rod is held close to an earthed metal sphere.



Which of the following describes the charge on the metal sphere?

A It is negative because electrons are attracted towards the rod.

B It is neutral because electrons are attracted towards the rod and protons are repelled.

C It is neutral because it is earthed.

D It is positive because protons are repelled by the rod.

28 Which of the following is equivalent to one coulomb?

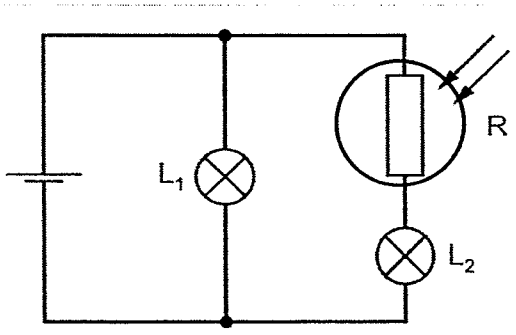
A one ampere per volt

B one ampere second

C one volt ampere

D one volt per ampere

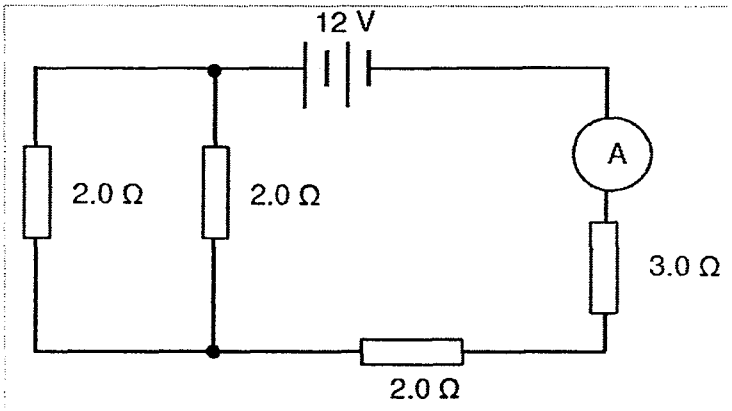
29 In the circuit shown, R is a light-dependent resistor.



The light intensity on R increases. What happens to the brightness of the two lamps L_1 and L_2?

	L_1	L_2
A	decreases	decreases
B	decreases	increases
C	stays the same	decreases
D	stays the same	increases

30 A circuit is set up in the diagram below.



What is the ammeter reading in the circuit?

A 0.50 A **B** 0.67 A **C** 1.5 A **D** 2.0 A

31 The diagram shows the label on an electric iron.

ELECTRIC IRON	
Operating Voltage	240 V
Power	2.8 kW
Fuse Rating	13 A

This iron is used for 12 hours every month.

The cost of 1 kWh of electrical energy is 25 cents.

Which of these statements is true about the electric iron?

A The fuse will blow because the fuse rating is too low.

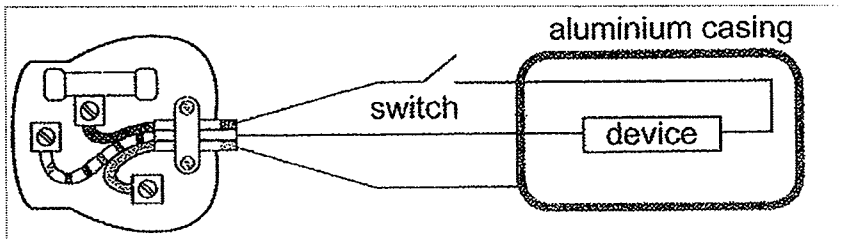
B The energy dissipated in the iron every month is 120 kJ.

C The iron is 90% efficient.

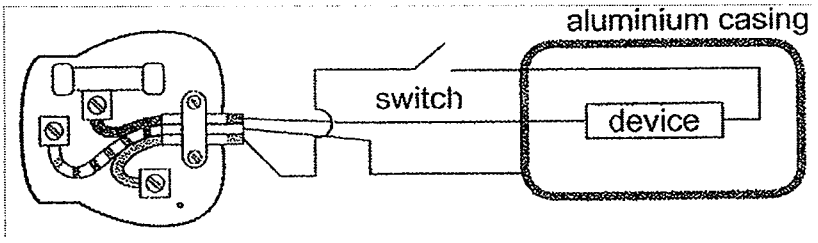
D It costs $8.40 every month to use the iron.

32 Which one of the following electrical appliances is correctly wired to a three-pin plug?

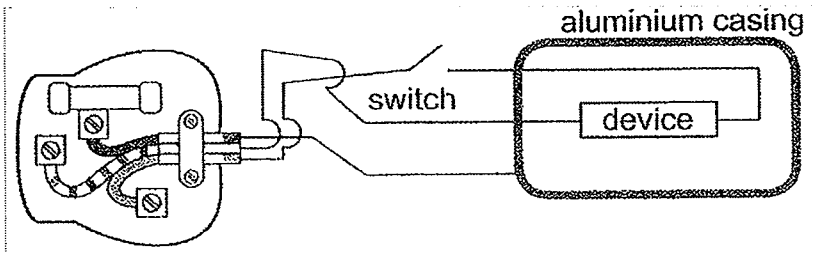
A



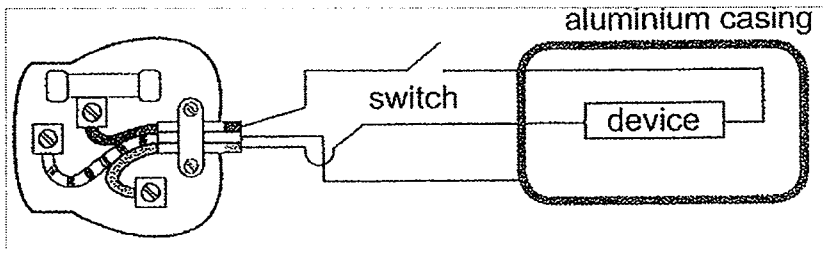
B



C



D



33 The bulb in a lamp is rated 2 V, 1 W, while the bulb in an oven is rated 220 V, 10 W.

What will happen when both the lamp and oven are connected in series across a 220 V operating supply?

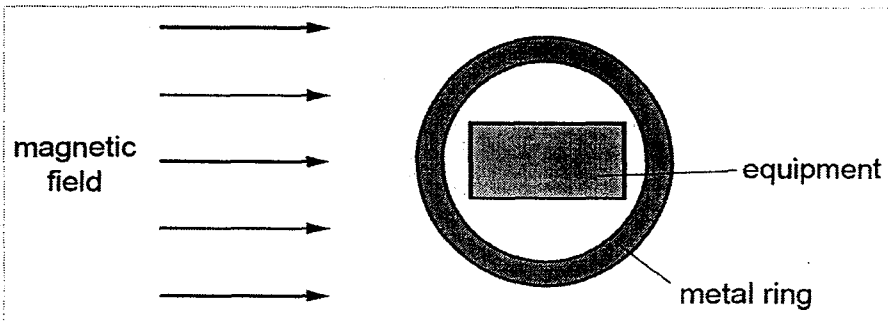
A The bulb in the lamp will blow immediately, and no current will flow in the circuit.

B The bulb in the lamp will appear to operate normally, while the bulb in the oven will emit a weak light.

C The bulb in the lamp will emit very little light, while the bulb in the oven will appear to operate normally.

D Both bulbs will operate at normal brightness.

34 A metal ring screens a piece of equipment from a magnetic field.

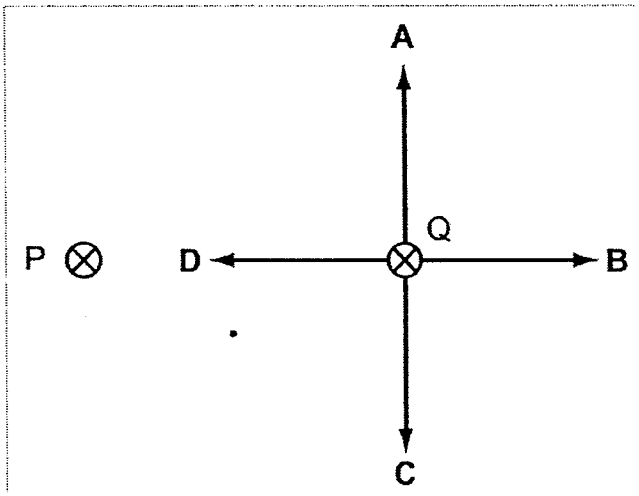


Which metal should be used for the ring, and why?

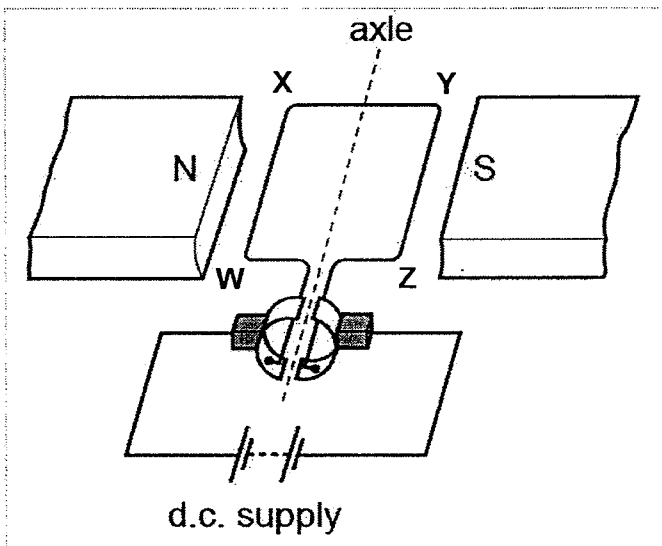
	metal	explanation
A	copper	the metal carries the field lines around the equipment
B	copper	the metal is non-magnetic
C	iron	the metal carries the field lines around the equipment
D	iron	the metal is non-magnetic

35 P and Q represent two, parallel, straight wires carrying currents into the plane of the paper. P and Q exert a force on each other.

Which arrow shows the force on Q?



36 The diagram below shows a simple d.c. motor.

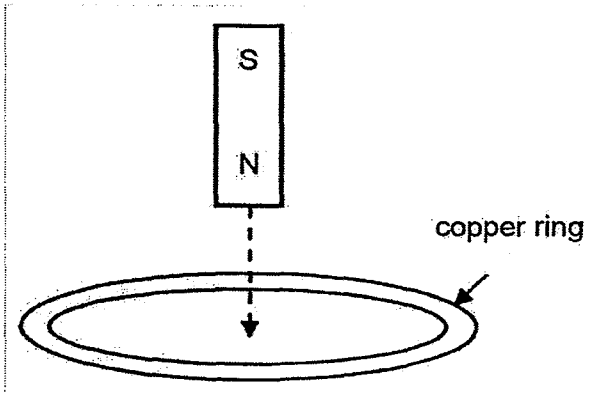


When the switch is closed, which of the following statements is/are correct?

I A current will flow round the coil in the direction **WXYZ**.
II The coil will rotate in a clockwise direction about the axle.
III The split-ring commutator will reverse the direction of the current every 360°.

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

37 A magnet is dropped vertically through a copper ring.



Which of the following statements is **incorrect**?

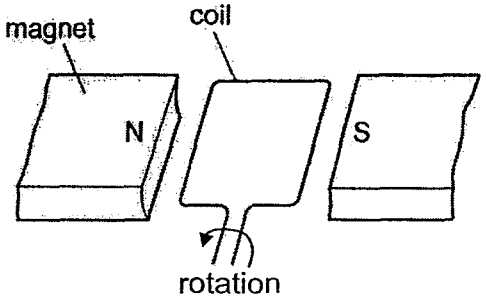
A A current flows in the ring just before the magnet passes through the ring.

B A current flows in the ring just after the magnet passes through the ring.

C The magnet slows down just before it passes through the ring.

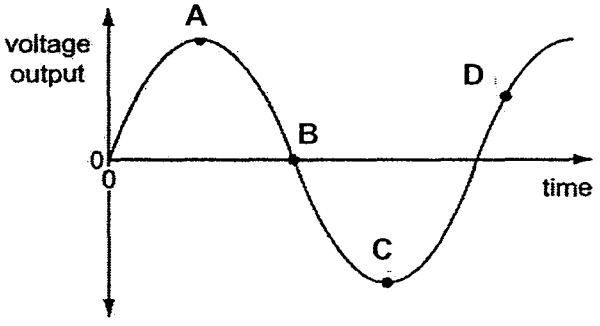
D The magnet accelerates just after it passes through the ring.

38 The diagram shows part of an a.c. generator when its coil is in a horizontal position.



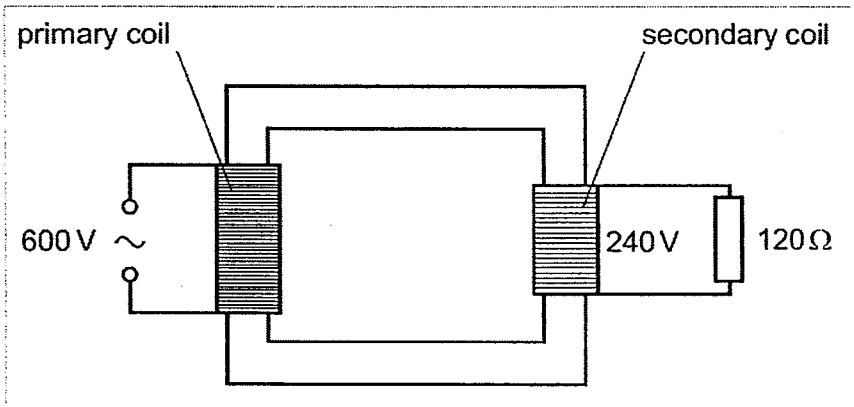
The graph below shows the voltage output plotted against time.

Which point on the graph shows the coil in a vertical position?



39 An ideal transformer has a primary voltage of 600 V and a secondary voltage of 240 V.

The secondary coil is attached to a resistor of resistance 120 Ω.



What is the power dissipated in the resistor and the current in the primary coil?

	power / W	current / A
A	120	0.20
B	120	5.0
C	480	0.80
D	480	1.3

40 An oscilloscope is used to display the waveforms of 2 alternating current (a.c.) input.

Diagram 1 shows the oscilloscope trace produced by the first input of voltage 2.0 V and frequency 50 Hz.

Diagram 2 shows the trace produced by the second input. The controls on the oscilloscope are set at the same values.

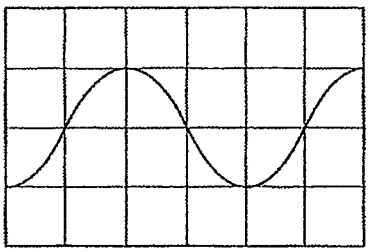


Diagram 1

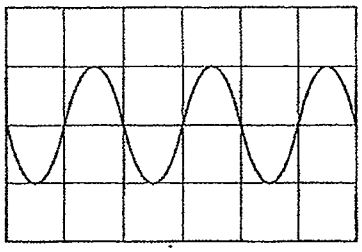


Diagram 2

What is the voltage and frequency of the second input?

	voltage / V	frequency / Hz
A	1.0	50
B	2.0	25
C	2.0	100
D	4.0	50

END OF PAPER

O

Preliminary Examination 2016
Secondary Four Express & Five Normal

CANDIDATE NAME:

CLASS: / INDEX NUMBER:

PHYSICS **5059/02**

Paper 2 Theory

29 August 2016

1 hour 45 minutes

1045 – 1230h

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.

Section B
Answer **all** questions. Question 11 has a choice of parts to answer.

Candidates are reminded that **all** quantitative answers should include appropriate units.
The use of an approved scientific calculator is expected, where appropriate.
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 together.
The number of marks is given in brackets [ ] at the end of each question or part question.

Section A	
Section B	
Total	

Section A

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

1 Fig. 1.1 shows a student doing a push-up. A total force F acts upwards on his hands. There is also a force R upwards on his toes.

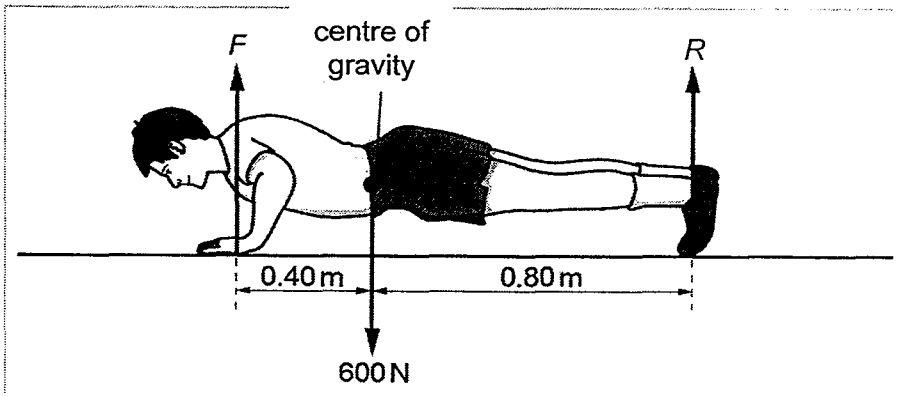


Fig. 1.1

The weight of the student is 600 N and this force acts downwards from his centre of gravity.

(a) **(i)** Describe how the student does work as his body rises from the ground.

.....

..... [1]

(ii) State the form of energy that the student uses to do this work.

..... [1]

(b) At the position shown in Fig. 1.1, the student is stationary. The weight of the student causes a moment about his toes.

(i) Calculate the moment of the weight of the student about his toes.

moment = ... [1]

(ii) Calculate the value of the forces F and R.

F = ...

R = ... [2]

(c) Describe the other force that forms a Newton's Third Law action-reaction pair with F, and state the body on which it acts.

.....

.....

..... [2]

2 In Fig. 2.1, a balloon is filled with air and is attached to a puck. Air is continuously released from the balloon through a hole at the bottom of the puck. The puck is given an initial push. It then moves on a horizontal table along a straight path formed by a pair of tracks.

Fig. 2.2 shows the speed-time graph of the puck.

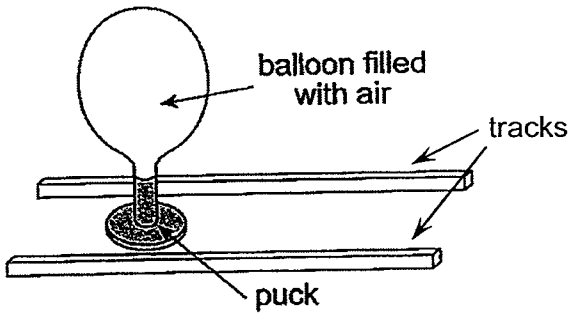


Fig. 2.1

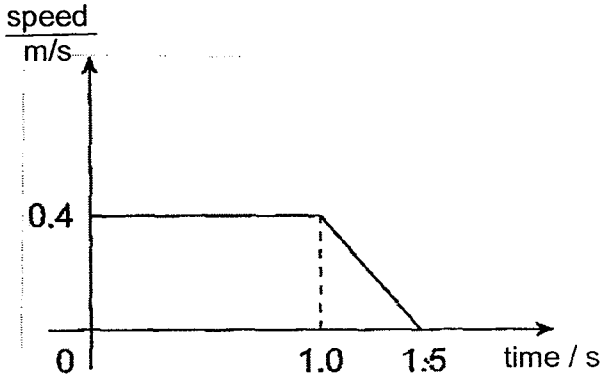


Fig. 2.2

(a) **(i)** Describe the motion of the puck from $t = 0$ to $t = 1.5$ s.

.....

.....

..... [2]

(ii) Explain the change in motion of the puck at $t = 1.0$ s.

.....

.....

..... [2]

(b) The experiment is repeated with less air in the balloon. The initial speed of the balloon remains at 0.4 m/s.

On Fig. 2.2, sketch the new speed-time graph of the puck. [1]

3 An experiment is carried out to find how the pressure of a fixed mass of air at room temperature varies with volume. Fig. 3.1 shows the apparatus used.

The syringe is sealed at one end and the piston is free to move up and down as different metal weights are used. The piston has a cross-sectional area of 30 cm^2.

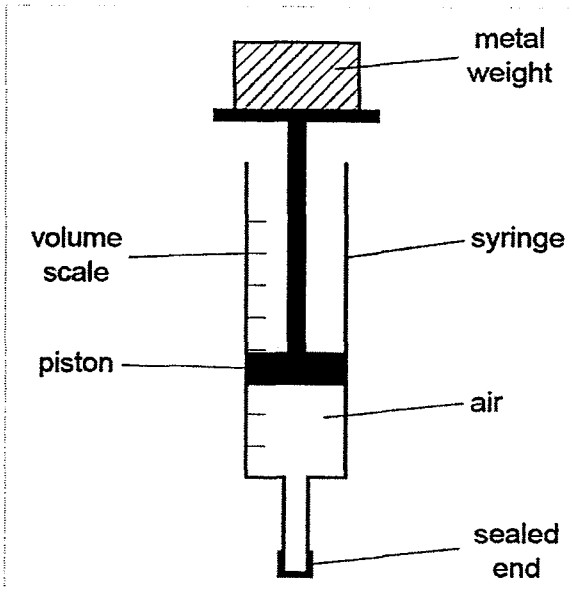


Fig. 3.1

(a) The metal weight in Fig. 3.1 has a mass of 400 g.
Calculate the pressure, in Pa, exerted on the air due to this metal weight.

pressure exerted = ... [2]

(b) More metal weights are placed on top of the syringe.

Describe how the air molecules inside the syringe are able to support the additional metal weights.

.....

.....

.....

.....

..... [3]

(c) Fig. 3.2 shows the axes for a graph of pressure against volume for the air in the syringe. One point is plotted on the graph at pressure of P_0 and volume V_0. The temperature of the air is kept constant.

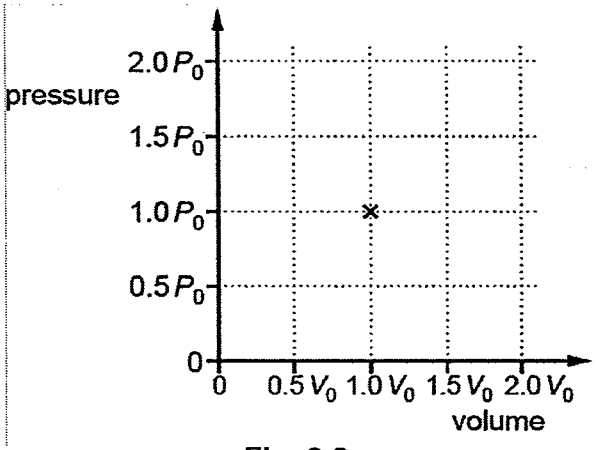


Fig. 3.2

By plotting appropriate points at volumes of 0.5 V_0 and 2.0 V_0, complete the graph on Fig. 3.2. [2]

4 Ultrasound is used in quality control to detect cracks in metal. Pulses of ultrasound are sent into the metal from a transmitter placed on the front surface of the metal. A detector placed next to the transmitter picks up the pulses reflected from the back surface of the metal.

Fig. 4.1 shows the oscilloscope trace of the ultrasound pulses produced for a piece of metal that contains no cracks. One division along the x-axis represents 1.0×10^{-6} s.

Pulses labelled **S** are the ones sent out from the transmitter. Each pulse labelled **R** is the reflection of **S** from the back surface of the metal.

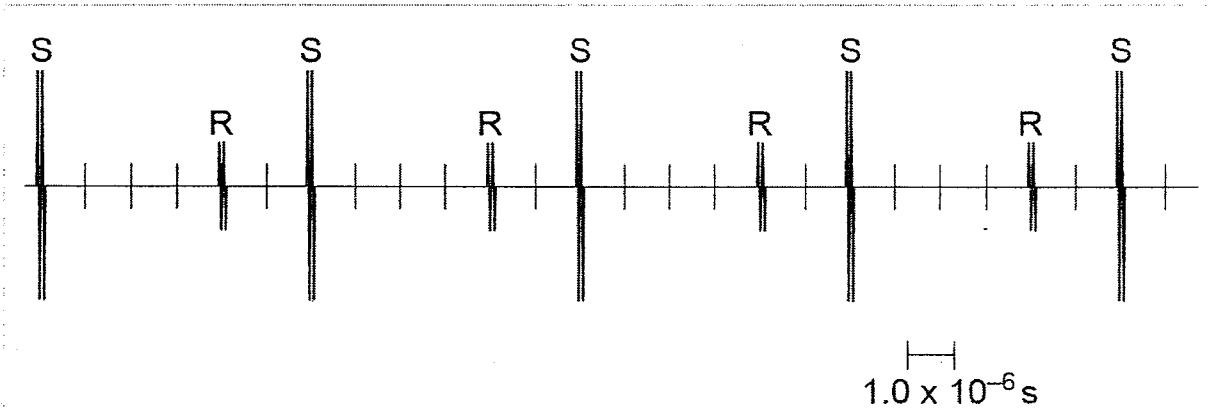


Fig. 4.1

(a) State what is meant by *ultrasound*.

.....

..... [1]

(b) Suggest one reason why the amplitude of **R** is less than the amplitude of **S**.

.....

..... [1]

(c) Use Fig. 4.1 to calculate the number of pulses sent out by the source in one second.

number of pulses = ... [1]

(d) The speed of ultrasound in the piece of metal in Fig. 4.1 is 5000 m/s.
Calculate the thickness of the piece of metal.

thickness = ... [2]

(e) A while later, the piece of metal is tested again. It now has a small crack half-way between the front surface and the back surface.

On Fig. 4.1, draw the position of the pulses produced by this crack. Label each of these pulses **C**. [1]

5 In a company that manufactures frying pans, a researcher wishes to select a new material that can be used for the base of the pan. Fig. 5.1 shows 4 possible materials and their properties.

Material	Melting point / °C	Specific heat capacity / J kg^{-1} $°C^{-1}$	Colour
A	2350	900	silver
B	950	480	silver
C	1600	480	black
D	7800	130	black

Fig. 5.1

(a) **(i)** Material A has a specific heat capacity of 900 J kg^{-1} $°C^{-1}$. State what is meant by this statement.

.....

..... [1]

(ii) The researcher carries out a series of experiments on the materials.

In one of the experiments, 2.0 kg of a sample of material A is heated by an electrical heater of power 450 W. The initial temperature of the sample is 25 °C.

Calculate the time taken for the temperature of the sample to rise to 100 °C.

time taken = ... [2]

(b) Based on the data in Fig. 5.1, discuss which material is the most suitable to be used for the base of the frying pan. Give reasons to support your choice.

.....

.....

.....

.....

.....

.....

..... [3]

6 Fig. 6.1 shows how fuel is pumped through a pipe from a tanker to an aeroplane at an airport.

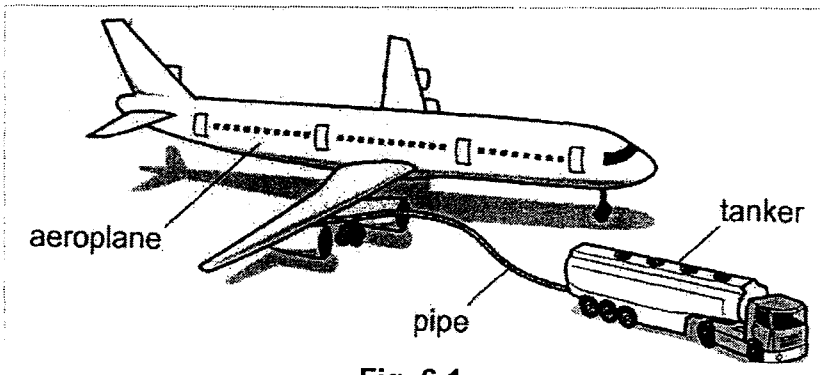


Fig. 6.1

As the fuel rubs against the pipe, it becomes negatively charged and this in turn charges the aeroplane.

(a) Explain, in terms of charges, how the fuel becomes negatively charged.

.....

.....

..... [2]

(b) **(i)** The aeroplane gains 2.4 nC of charge in 5.0 s.

Calculate the average current during this time.

average current = ... [1]

(ii) Describe a hazard that can arise when the aeroplane becomes charged.

.....

..... [1]

(iii) Suggest and explain how the aeroplane can be prevented from being charged.

.....

.....

..... [2]

7 Fig. 7.1 shows a workman using a cordless electric drill.

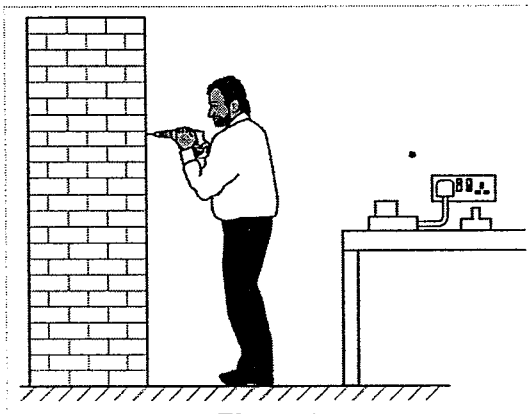


Fig. 7.1

The motor of the drill is powered by a rechargeable battery with an electromotive force (e.m.f.) of 18 V. When the drill is used, the current supplied to the motor is 25 A.

(a) **(i)** Explain what is meant by an *e.m.f. of 18 V*.

.....

..... [1]

(ii) Calculate the power supplied to the motor.

power = ... [1]

(b) After 90 minutes of use, the battery is flat. It is connected to a charger and is recharged.
The charger includes a transformer that produces a 23 V alternating current (a.c.) output from a 230 V a.c. mains supply.

(i) Draw a labelled diagram to show the structure of the transformer used in the charger.

[2]

(ii) State how the transformer ensures that the a.c. output has a value of 23 V when the input is the 230 V a.c. mains supply.

.....
[1]

(iii) State and explain **one** advantage of using an alternating current for long-distance transmission of electrical power.

.....

.....

..... [2]

8 Fig. 8.1 shows a wind-up torch which does not contain batteries.

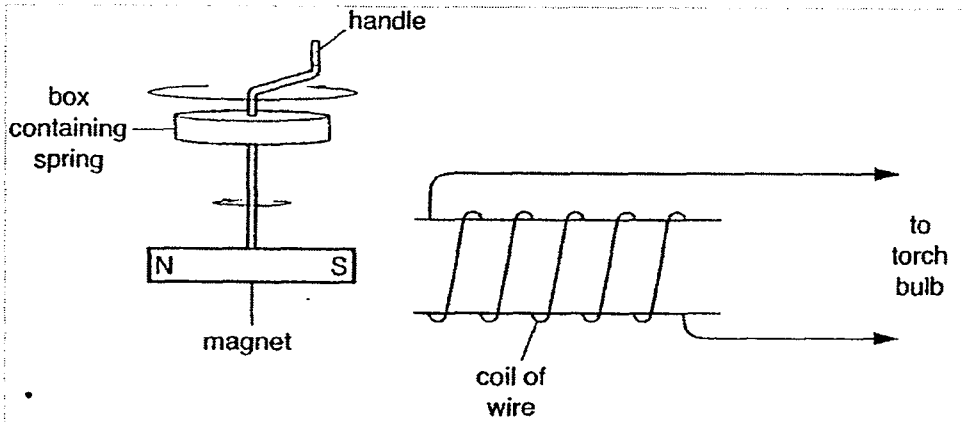


Fig. 8.1

To use the torch, the handle is first rotated to wind a spiral spring in a box. When the switch of the torch is turned on, the spring unwinds and a current is produced in the coil.

(a) Explain why there is a current in the coil.

.....

.....

..... [2]

(b) As the spring unwinds, the force in the spring decreases. Explain the effect on the intensity of the light produced.

.....

.....

..... [2]

(c) Suggest **two** modifications to the design of the torch in order to produce a larger current.

.....

.....

..... [2]

Section B

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

Answer only one of the two alternative questions in **Question 11**.

9 **(a)** An application of total internal reflection is the cutting of diamond to achieve a brilliant sparkle. A well-cut diamond has facets that reflect light instead of allowing light to refract out from its bottom.

Fig. 9.1a, 9.1b and 9.1c are **scaled diagrams** showing three diamonds in which light that is incident at the top of the diamond refracts out from the bottom of the diamond.

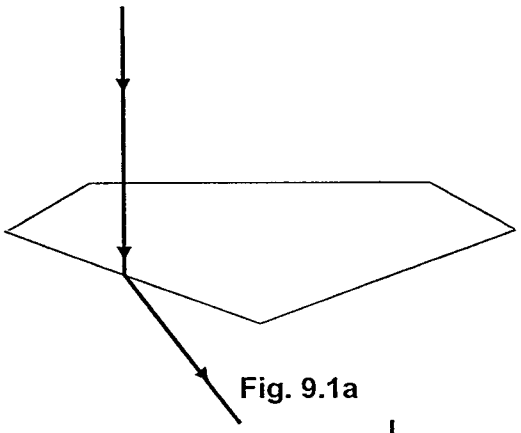


Fig. 9.1a

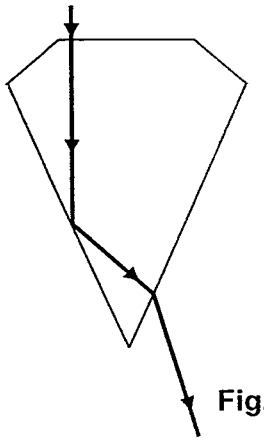


Fig. 9.1b

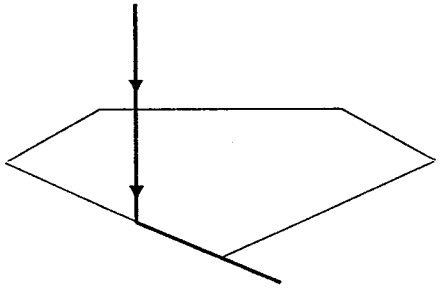


Fig. 9.1c

(i) Define *critical angle*.

.....

..... [1]

(ii) Using information from Fig. 9.1a to 9.1c, determine the critical angle of diamond. Hence, calculate the refractive index of diamond.

critical angle = ... [1]

refractive index = ... [1]

(iii) State and explain which diamond in Fig. 9.1 produces the brightest sparkle.

.....

.....

..... [2]

(b) Another application of total internal reflection is the use of optical fibres to transmit information over long distances.

A typical optical fibre comprises of a core encased in a cladding material as shown in Fig. 9.2.

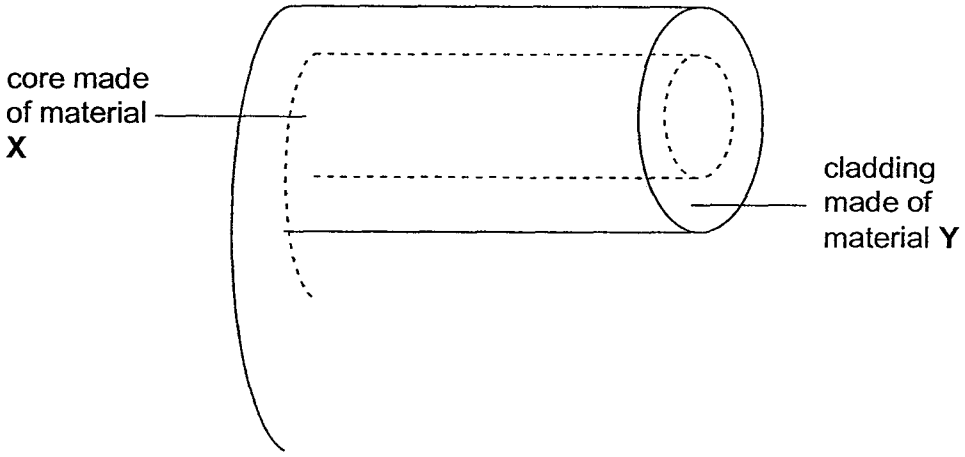


Fig. 9.2

Light rays are transmitted along the core. Rays incident on the core-cladding boundary at angles greater than the critical angle of core-cladding boundary will be reflected. The critical angle of this boundary can be determined using the formula

$$n_1 \sin\theta_1 = n_2 \sin\theta_2$$

where
n_1 = refractive index of core;
n_2 = refractive index of cladding;
θ_1 = angle of incidence in core; and
θ_2 = angle of refraction in cladding.

In a particular optical fibre, materials with refractive indices of 1.2 and 1.5 are used.

(i) Explain which material, **X** or **Y**, has a refractive index of 1.5.

.....

.....

..... [2]

(ii) Calculate the critical angle of the core-cladding boundary.

critical angle = ... [2]

(iii) The critical angle of the core-air boundary is 41°, lower than the critical angle of core-cladding boundary. Although the higher critical angle of the core-cladding boundary decreases the likelihood of total internal reflection, a cladded optic fibre is still preferred to one that is not cladded.

Suggest a reason why this is so.

.....

..... [1]

10 Fig. 10.1 shows the properties of 3 rods, **X**, **Y** and **Z**, which are made of different materials. These rods have an identical length of 0.40 m and a diameter of 1.0 cm.

Rod	Material	Density (kg/m^3)	Resistivity (Ω m)
X	copper	8960	1.7×10^{-8}
Y	lead	11 340	2.2×10^{-7}
Z	plastic	1200	1.6×10^{16}

Fig. 10.1

(a) Calculate the resistance of the copper rod.

resistance = ... [2]

(b) An experiment is carried out for each of these rods.
Fig. 10.2 shows the setup of the experiment where the copper rod **X** is used. **X** hangs from a spring balance and is connected to a circuit containing a battery supply.

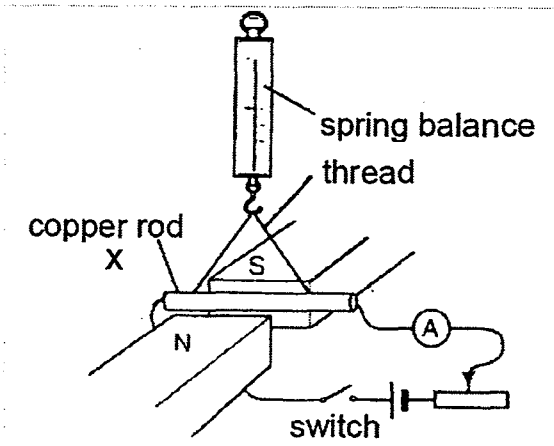


Fig. 10.2

The initial spring balance reading is recorded as N_1. The switch is then closed, and the new reading is recorded as N_2. The ammeter reading is recorded as I.

(i) Compare the value of N_1 and N_2 in Fig. 10.2. Explain your answer.

.....

.....

.....

.....

..... [2]

(ii) Rod **X** is replaced with **Y** and **Z**, and the experiment is repeated in each case.

For each of the following cases, identify the rod (**X**, **Y** or **Z**) that produces the observation and explain your answer.

1. Largest value of N_1 recorded,

.....

.....

..... [2]

2. No change in value of N_1 and N_2,

.....

.....

..... [2]

3. Largest ammeter reading I.

.....

.....

..... [2]

11 EITHER

Fig. 11.1a shows a relay connected to a cell and a switch.

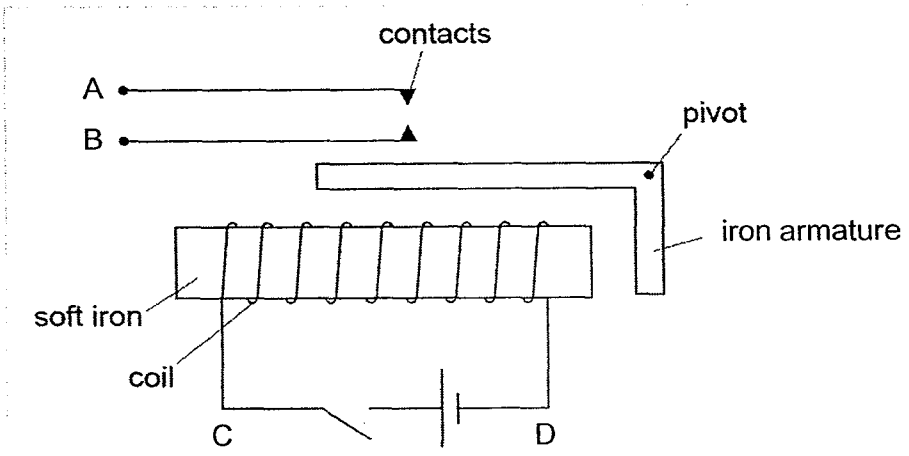


Fig. 11.1a

(a) When the switch is closed, the iron core is magnetised.

(i) Explain how this causes the contacts to close.

.....

.....

..... [2]

(ii) On Fig. 11.1a, mark

1. the S-pole of the iron core,

2. the N-pole and the S-pole of the iron armature. [2]

(b) Fig. 11.1b shows the relay connected in a circuit to a 12 V battery and a thermistor. The bell is initially not ringing.

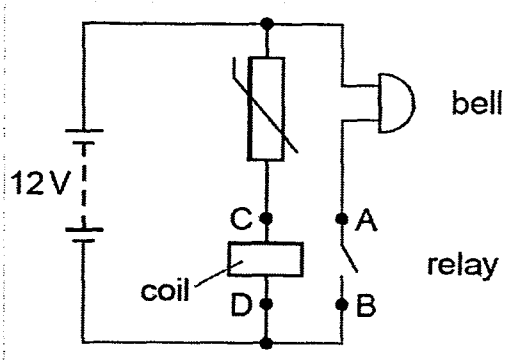


Fig. 11.1b

(i) Explain why the bell rings when the temperature of the thermistor rises.

.....

.....

.....

..... [2]

(ii) When the resistance of the thermistor is 2000 Ω, the current in the coil is 1.5 mA. This causes the contacts in the relay to close.
The resistance of the bell is 200 Ω.

Calculate

1. the current passing through the bell,

current = ... [1]

2. the potential difference (p.d.) across the coil.

p.d. across coil = ... [2]

(iii) Suggest an advantage of using a relay in this circuit.

.....

..... [1]

11 OR

Fig. 11.2a shows part of the mains electrical circuit in a house. The mains supply is 240 V.

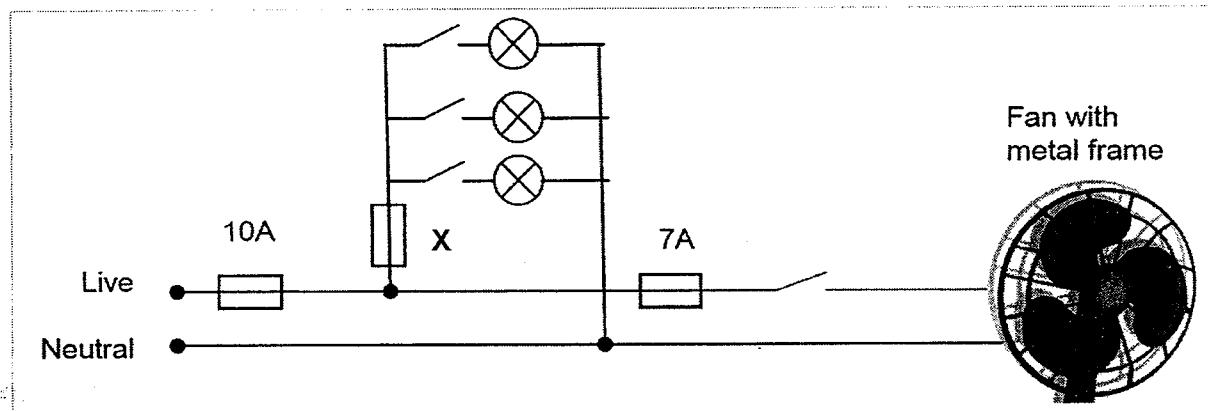


Fig. 11.2a

Three identical lamps are connected to the live wire through a fuse labelled **X**.

An electrical fan is connected to the live wire through a 7 A fuse.

There is a 10 A fuse to protect the whole circuit.

(a) Explain what is meant by

(i) *live wire*,

.....

..... [1]

(ii) *neutral wire*.

.....

..... [1]

(b) Each of the lamps is rated 100 W, 240 V.

(i) Calculate the amount of current drawn by each lamp.

current drawn = ... [1]

(ii) Suggest a suitable fuse rating for **X**. Support your answer with appropriate calculations.

fuse rating = ... [2]

(c) The electrical fan is not connected to an earth wire. Explain how this will affect the safety of the user.

.....

.....

.....

..... [2]

(d) If the live wire touches the neutral wire inside the fan, state and explain what will happen to the fan, the lamps and the fuses.

.....

.....

.....

.....

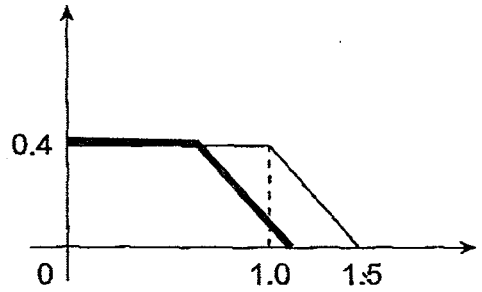
.....

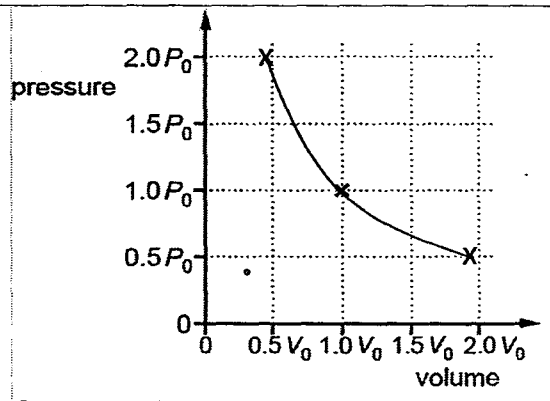
..... [3]

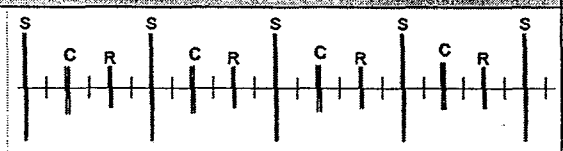
END OF PAPER

2016 Secondary 4 Express Preliminary Examination
Physics (5059/2) Mark Scheme

Overall 1 mark penalty each for missing unit and sig fig ***unless otherwise stated.***

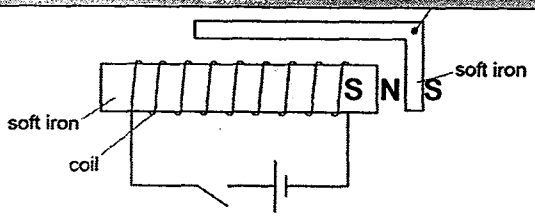
Question	Solution	Marks	Remarks
1 (a) (i)	When he pushes the floor, his body rises and moves through a distance in the same direction as the force, hence work is done.	[1]	
(ii)	Chemical (potential) energy	[1]	
1 (b) (i)	Moment = F x d = 600 x 0.80 = 480 Nm	[1]	**No credit for wrong/ missing unit.**
(ii)	By Principle of Moments, F x 1.2 = 480 F = 400 N ∑ upward forces = ∑ downward forces F + R = 600 R = 200 N	[1] [1]	Alternatively, Principle of Moments can be used to solve for R. Max [1] ecf if F is wrongly calculated.
1 (c)	The other force that forms an action-reaction pair with *F* is the force exerted by the boy on the floor. It has an equal magnitude but acting in the opposite direction to *F*.	[1] [1]	
2 (a) (i)	From t = 0 to 1.0 s, the puck moves at a constant speed of 0.4 m/s. From t = 1.0 to 1.5s, it moves with a constant deceleration / speed decreases constantly (uniformly / linearly) until it comes to rest.	[1] [1]	
(ii)	After t = 1.0 s, no more air can be released from the balloon, so the puck will come into contact with the table. It will experience friction which opposes the motion of the puck, hence the puck begins to decelerate.	[1] [1]	
2 (b)	Deceleration begins before 1.0 s Same value of deceleration  	[1]	

Question	Solution	Marks	Remarks
3 (a)	Pressure = F / A = (0.4 x 10) / (30 x 10^{-4}) = 1300 Pa	 [1] [1]	**Deduct [1] if pressure is not in Pa.**
3 (b)	When more metal weights are placed on top of the syringe, the piston is pushed downwards, and the air molecules will occupy a smaller volume / the number of air molecules per unit volume increases. This results in a higher frequency of collision by the air molecules on the inner walls of the piston, and a larger pressure is exerted. Since force = pressure x area, the force exerted by the air molecules increases, and this will balance the additional weights added.	[1] [1] [1]	Do not accept 'collide with more force'; *increase in frequency of collision* and *inner wall* must be mentioned. Accept alternative: pressure increases to be equal to the pressure exerted by the additional weights
3 (c)	 Correct points at 0.5 V_0 and 2.0 V_0 Smooth, decreasing curve through points	 [1] [1]	
4 (a)	Ultrasound is sound that has a frequency of above 20 kHz / above human audible frequency range.	[1]	
4 (b)	Not all sound is reflected from back surface as some passes through the back surface. / Some energy/sound is absorbed by the metal. / Sound/energy spreads out/scattered/reflected in other directions. (any one)	[1]	Do not accept 'sound energy is lost' without any elaboration.
4 (c)	No of pulses = 1/ (6.0 x 10^{-6}) = 1.7 x 10^5	 [1]	
4 (d)	Thickness = ½ x v x t = ½ x 5000 x (4.0 x 10^{-6}) = 0.010 m	 [1] [1]	Max [1] awarded if factor of '1/2' is missing.

Question	Solution	Marks	Remarks
4 (e)		[1]	All four 'C' must be drawn and labelled.
5 (a) (i)	900 J of (thermal) energy is required to raise the temperature of 1 kg of material A by 1 °C.	[1]	
(ii)	$Q = mc\Delta\theta$ $= 2.0 \times 900 \times (100 - 25)$ $= 1.35 \times 10^5$ J Time taken = Energy / power $= 1.35 \times 10^5 / 450$ = 300 s	[1] [1]	
5 (b)	Material D is the most suitable. ***(Any two of the following)*** • D has the highest melting point of 7800 °C which ensures that it remains a solid upon heating. • It has the lowest specific heat capacity of 130 J kg^{-1} $°C^{-1}$ and hence, it heats up the fastest / requires the least energy to heat up. • It is a good absorber of heat due to its black appearance.	[1] [2]	No credit awarded if: - material is chosen without any explanation; - candidate quotes data from the table without discussing the relevance of the data. **Deduct [1] if candidate did not quote any value in the explanation.**
6 (a)	When the fuel rubs against the pipe, friction causes electrons to move/ transfer from the pipe to the fuel. The fuel gains electrons and becomes negatively charged.	[1] [1]	
6 (b) (i)	Current = Q / t $= 2.4 \times 10^{-9} / 5.0$ $= 4.8 \times 10^{-10}$ A	[1]	
(ii)	Discharge/Sparks in air may occur which can ignite the fuel (vapour) and cause a fire/explosion. / Workers may get an electric shock when they come into contact with the plane. (any one)	[1]	
(iii)	A metal cable can be connected from the aeroplane to the ground. Charges accumulated on the plane can flow along the cable to earth and the plane will be earthed.	[1] [1]	
7 (a) (i)	18 J of work is done to drive a unit charge around the circuit.	[1]	
(ii)	P = IV = 25 x 18 = 450 W	[1]	

Question	Solution	Marks	Remarks
7 (b) (i)	A transformer with the following labels: laminated (soft) iron core; primary coil connected to a 230 V a.c. supply and the secondary coil connected to a 23 V a.c. output. There should be more turns in the primary coil.	[1] [1]	
(ii)	The ratio of the primary to secondary coil of the transformer is maintained at 10:1.	[1]	
(iii)	An alternating current allows voltage to be stepped up with the use of a transformer. This lowers the transmission current and hence reduces energy loss due to Joule heating.	[1] [1]	
8 (a)	When the spring unwinds, the magnet rotates and produces a changing magnetic field/flux linking the coil. This induces an emf and hence drives a current in the coil.	[1] [1]	
8 (b)	When the force in the spring decreases, the speed of rotation of the magnet decreases, causing the rate of change of magnetic field/flux linking the coil to decrease as well. A smaller current will be induced and this decreases the light intensity.	[1] [1]	
8 (c)	Increase the number of turns of the coil / Use a stronger magnet / Insert a soft iron core in the coil / Bring the magnet closer to the coil. (any two)	[2]	
9 (a) (i)	Critical angle is the incident angle in the **optically** denser medium which produces an angle of refraction of 90° in the **optically** less dense medium.	[1]	No credit awarded if "optically" is omitted.
(ii)	From Fig. 9.1c, Critical angle = 24° Refractive index = 1 / sin c = 1 / sin 24° = 2.5 (2 s.f.)	[1] [1]	Accept range 23° to 25°. No ecf for calculation of refractive index.
(iii)	The diamond in Fig. 9.1c produces the brightest sparkle. It is cut in such a way that most of the light rays are incident at angles greater than the critical angle of diamond, hence total internal reflection will occur easily/ more frequently.	[1] [1]	

Question	Solution	Marks	Remarks
9 (b) (i)	X has a refractive index of 1.5. Light should travel from an **optically** denser to an **optically** less dense medium in order for total internal reflection to occur. Hence the core must be made of a material with a higher refractive index.	[1] [1]	No credit awarded if "optically" is omitted.
(ii)	Using $n_1 \sin\theta_1 = n_2 \sin\theta_2$, $1.5 \sin c = 1.2 \sin 90°$ $c = 53°$ (2 s.f.)	 [1] [1]	Max [1] for application of formula if the wrong value of refractive index is identified in (i).
(iii)	The cladding protects the inner core from damage.	[1]	
10 (a)	$R = \rho l / A$ $= 1.7 \times 10^{-8} \times 0.40 / (\pi \times 0.005^2)$ $= 8.7 \times 10^{-5}\ \Omega$ (2 s.f.)	 [1] [1]	**Deduct [1] if wrong sig fig or unit.** Max [1] for application of formula if area is incorrectly calculated.
10 (b) (i)	N_2 has a lower value than N_1. When the switch is closed, a current flows in the copper rod. By Fleming's Left-Hand Rule, where the thumb, index finger and second finger represents the direction of the force, magnetic field and current respectively, an upward force will act on the rod. This decreases the spring balance reading.	[1] [1]	Accept: Interaction of the magnetic field of the current and that of the magnet produces an upward force.
(ii)	1. Rod Y. It has the highest density of 11340 kg/m^3 and hence the largest mass and weight.	[1] [1]	**No credit if each rod is identified without any explanation.** Accept: Plastic is a poor conductor of electricity if low resistivity is mentioned in 3.
	2. Rod Z. Plastic has the highest resistivity of $1.6 \times 10^{16}\ \Omega m$. When the switch is closed, no current flows through it and it will not experience any force.	[1] [1]	
	3. Rod X. Copper has the lowest resistivity of $1.7 \times 10^{-8}\ \Omega m$ and hence the lowest resistance. It will produce the largest current.	[1] [1]	**Deduct [1] from whole of part (ii) if candidate did not quote any value from table in the explanation.**
EITHER			
11 (a) (i)	The magnetised iron core attracts the iron armature, which will rotate clockwise about the pivot. The horizontal arm of the armature will then close the contacts.	 [1] [1]	

Question	Solution	Marks	Remarks
11 (a) (ii)		[2]	Accept if the S-pole of the iron armature is drawn on the horizontal arm, either at the pivot or the far end of the armature.
11 (b) (i)	When the temperature of the thermistor rises, its resistance decreases. This will cause a larger current to flow through the coil. The soft iron will be magnetised and the relay switch will be closed, causing the bell to ring.	[1] [1]	
(ii)	1. I = V / R = 12 / 200 = 0.060 A	[1]	
	2. p.d. of thermistor = RI = 2000 x 1.5 x 10^{-3} = 3.0 V p.d. across coil = 12 – 3.0 = 9.0 V	[1] [1]	
(iii)	Only a small current of 1.5 mA is required to switch on the bell using the relay. Without the relay, the user needs to handle a higher and more dangerous current of 60 mA.	[1]	Candidate is required to relate to the context of the question.
OR			
11 (a) (i)	The live wire is connected to a high potential and delivers current to the appliance.	[1]	
(ii)	The neutral wire is connected to zero potential and provides a return path for the current back to the supply.	[1]	
11 (b) (i)	Current drawn = P / V = 100 / 240 = 0.42 A (2 s.f.)	[1]	
(ii)	Total current drawn by 3 lamps = 0.416 x 3 = 1.25 A Hence fuse rating = 2 A	[1] [1]	Max [1] ecf if current drawn in (i) is wrongly calculated.
11 (c)	If the live wire touches the metal frame of the fan, the fan will become live/be at a high voltage/potential. The user will get an electric shock if he touches the fan.	[1] [1]	
11 (d)	The fan will not work as it will be short-	[1]	

Question	Solution	Marks	Remarks
	circuited. The 7 A and 10 A fuses will blow due to the large current. Fuse X (2A fuse) will not blow because it is in a parallel connection. The lamps will not light up because the 10 A fuse has blown, hence the circuit becomes an open circuit/electrical supply is cut off.	[1] [1]	

2016 Secondary 4 Express Preliminary Examination
Physics (5059/1) Answers

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