St. Margaret's Secondary School

Preliminary Examinations 2010

Founded 1842

PHYSICS 5058/01

Secondary 4 Express

17th September 2010
Duration : 1 hour
Total Marks : 40

READ THESE INSTRUCTIONS FIRST

Do not open this Booklet until you are told to do so.

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

There are **forty** questions on 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 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.

When necessary, assume the acceleration due to gravity, g to be 10 m/s^2.

1 The dimension of a rectangular block of wood is measure as 130 mm, 4.0 mm and 3.21 mm.

What are the measuring instruments used to obtain such readings?

(i) metre rule
(ii) vernier calipers
(iii) micrometer screw gauge

A (i) and (ii) only

B (i) and (iii) only

C (ii) and (iii) only

D (i), (ii) and (iii)

2 Given that Newton's Law of Gravitation is given by $F = \frac{Gm_1m_2}{r^2}$ where m_1 is the mass of particle 1, m_2 is the mass of particle 2, F is the gravitational force, r is the distance between the two particles and G is the universal gravitational constant.

Which of the following is the unit for G?

A $kg^3m^3s^2$ **B** kgs^2/m^3 **C** m^3/kgs^2 **D** kg^3m^3/s^2

Answer Question 3 and 4 based on the information given below.

A stream is 30 m wide and its current flows southward at 1.5 m/s. A toy boat is launched with a velocity of 2.0 m/s eastward from the west bank of the stream.

3 What is the magnitude of the boat's resultant velocity as it crosses the stream?

A 0.5 m/s **B** 2.1 m/s **C** 2.5 m/s **D** 3.5 m/s

4 How far southward will the boat have traveled upon reaching the opposite bank?

A 18.0 m **B** 22.5 m **C** 30.0 m **D** 37.5 m

5 Two stones, *A* and *B*, are thrown horizontally from the top of a cliff. Stone *A* has an initial speed of 15 m/s and stone *B* has an initial speed of 30 m/s. There is negligible air resistance.

Compared to the time it takes stone *A* to reach the ground, the time it takes stone *B* to reach the ground is

A half as great.

B the same. Both fell at a constant acceleration due to gravity of 10 ms^{-2}

C twice as great.

D four times as great.

6 An object is pulled at a constant speed across a rough surface. Which of the following statements about friction is true?

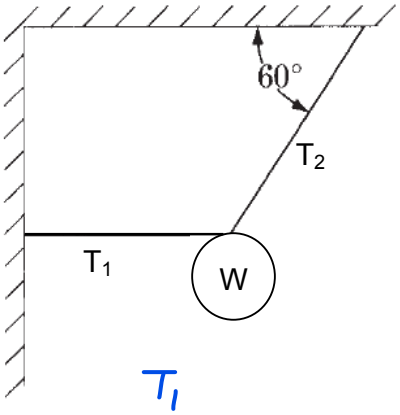
A The magnitude of the frictional force is greater than the driving force.

B The magnitude of the frictional force is less than the driving force.

C The magnitude of frictional force is equal to the driving force. No resultant force

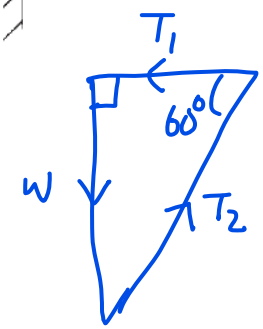
D The magnitude of the frictional force is equal to the resultant force.

7 The diagram shows a system in equilibrium consisting of an object of weight *W* that hangs from two ropes. The tensions in the ropes are T_1 and T_2.

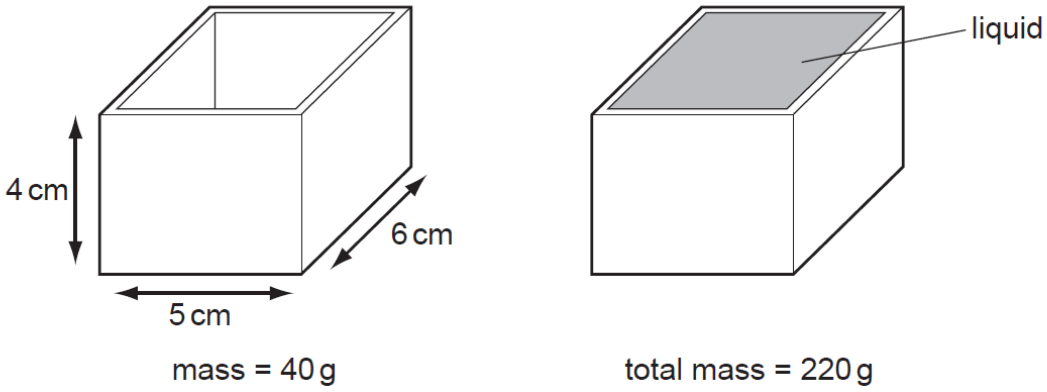


Which of the following are correct values of T_1 and T_2?

	T_1	T_2
A	$T_2 \sin 60°$	$\frac{W}{\cos 60°}$
B	$T_2 \sin 60°$	$\frac{W}{\sin 60°}$
C	$\frac{W}{\tan 60°}$	$\frac{W}{\cos 60°}$
D	$\frac{W}{\tan 60°}$	$\frac{W}{\sin 60°}$



8 The diagrams show a rectangular box with inside measurements of 5 cm × 6 cm × 4 cm. The box has a mass of 40 g when empty. When filled with a liquid, it has a total mass of 220 g.



What is the density of the liquid?

A $\frac{220}{(5\times6\times4)}\text{g/cm}^3$

B $\frac{220-40}{(5\times6\times4)}\text{g/cm}^3$

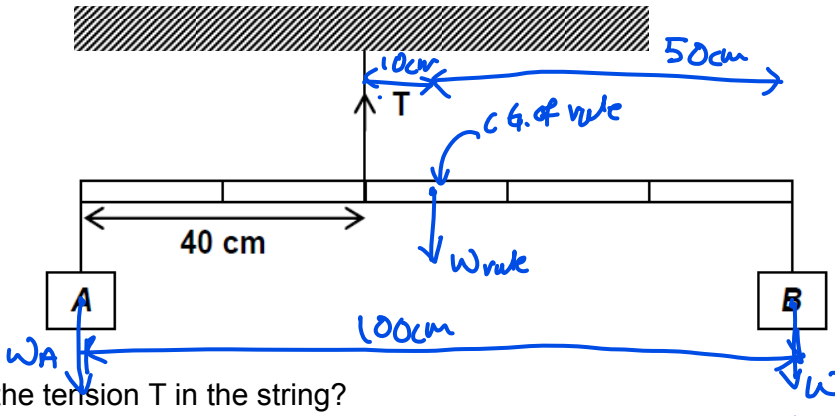
C $\frac{(5\times6\times4)}{220}\text{g/cm}^3$

D $\frac{(5\times6\times4)}{220-40}\text{g/cm}^3$

$\rho = \frac{m}{V}$

$= \frac{220-40}{4\times5\times6}\ \text{g/cm}^3$

9 The diagram shows a uniform metre rule of mass 0.60 kg balanced horizontally. The mass of A is 0.40 kg.



What is the tension T in the string?

A 6.7 N

B 10.0 N

C 11.7 N

D 14.0 N

By the Principle of Moments, taking moments about B,

Σ AC/ACW $= \Sigma$ C.C.W

$F_1d_1 + F_2d_2 = F_3d_3$

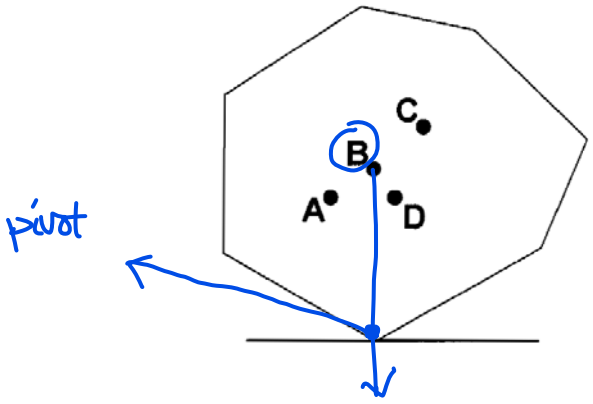
$W_A d_1 + W_{rule} d_2 = T d_3$

$(0.4\times10)(100) + (0.6\times10)(50) = T\times60$

$\therefore T = 11.6667 = 11.7\text{ N}$ (3 s.f.)

10 The diagram below shows an object tilted such that it is at the point of falling over.

Where would be the likely position of the centre of gravity of the object?



When the centre of gravity is at B, the vertical line of action of the weight of the object through its centre of gravity will pass through the pivot. Since there is no perpendicular distance between the line of action and the pivot, there will be no resultant moment. The object will be in equilibrium, balanced and not topple

11 Water of density 1000 kg/m^3 fills up to 30 cm in a container. The base of the container is broken accidentally and water starts to leak from a tiny hole of area 1.0 mm^2. To prevent water from leaking, a sticky tape is used to cover the tiny hole.

Determine the minimum force that the tape must be able to withstand.

1 m = 1000 mm
$(1\text{m})^2 = (1000\text{mm})^2$
$= 1000000\text{mm}^2$

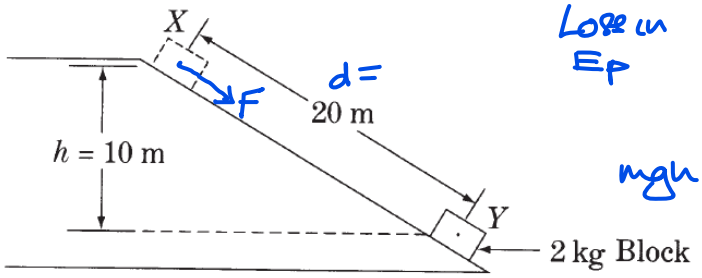
A 0.003 N **B** 0.3 N **C** 30 N **D** 3000 N

$P = \frac{F}{A}$
$F = pA$

$p = \rho gh$
$= 1000 \times 10 \times \frac{30}{1000} = 3000\text{Pa}$

$F = 3000 \times \frac{1}{1000000}$
$= 0.003\text{N}$

12 The diagram shows a 2 kg block, starting from rest, slides 20 m down a frictionless inclined plane from *X* to *Y*, dropping a vertical distance of 10 m.



Loss in E_P = work done by gravity in direction of sliding block

$mgh = Fd$

$2 \times 10 \times 10 = F \times 20$

$\therefore F = 10\text{N}$

Determine the magnitude of the net force on the block while it is sliding.

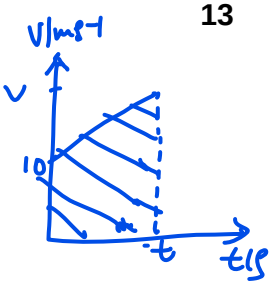
A 1 N **B** 5 N **C** 10 N **D** 20 N

13 An object is thrown downwards with a speed of 10 m/s from a cliff that is 120 m above ground.

$g = 10\text{ms}^{-2}$ constant

If air resistance is negligible, determine the time taken for the object to fall to the ground from the cliff.

Equate ① & ②



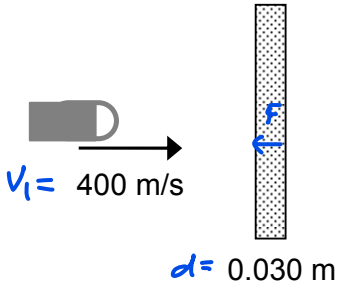
A 4.0 s **B** 4.1 s **C** 4.8 s **D** 6.0 s

$a = \frac{v-u}{t_v - t_u}$
$10 = \frac{v-0}{t}$
$\therefore v = 10t + 10$ — ①

Area $= \frac{1}{2}h(l_1 + l_2)$
$120 = \frac{1}{2}(t)(10+v)$
$240 = 10t + vt$
$\therefore v = \frac{240 - 10t}{t}$ — ②

$10t + 10 = \frac{240 - 10t}{t}$
$t^2 + 2t - 24 = 0$
$t = -6$ or $t = 4$
(reject) (accept)

14 When a bullet of mass 20 g moving at 400 m/s strikes a fixed wooden block of thickness 0.030 m, it emerges with a speed of 200 m/s as shown in the diagram.



Loss of E_k = work done against friction

$E_{k_1} - E_{k_2} = Fd$

$\frac{1}{2}mv_1^2 - \frac{1}{2}mv_2^2 = Fd$

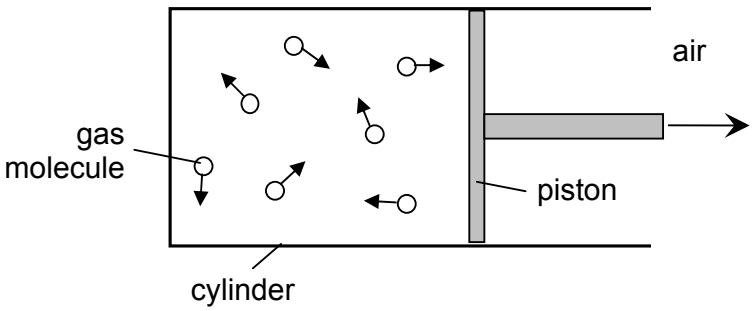
$\frac{1}{2} \times \frac{20}{1000}(400^2 - 200^2) = F \times 0.030$

$F = 40000\,N$

What is the retarding force of the wood?

A 66.7 N **B** 13300 N **C** 40000 N **D** 53300000 N

15 Gas inside a cylinder is heated slowly to a higher temperature. The pressure inside the cylinder remains constant as the piston moves outwards.



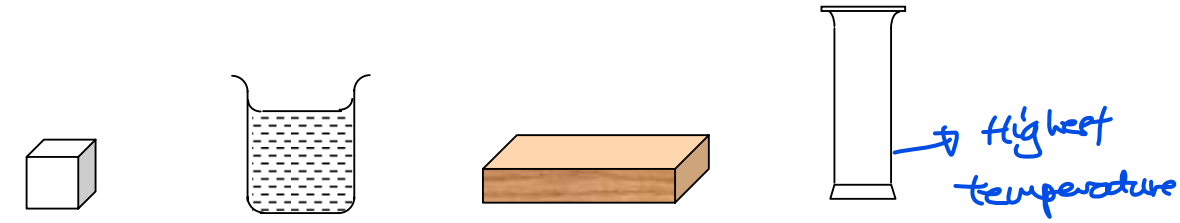
How do the speed of the gas molecules and their rate of collision with the piston compare with their initial values at the lower temperature?

	speed of molecules	*rate of collision*
A	greater	greater
B	greater	reduced
C	greater	same
D	same	greater

When the gas is heated, the gas molecules gained kinetic energy and increased in speed. They collided with the piston more vigorously and more frequently.

In order for the pressure inside the cylinder to remain constant as the piston moves outwards, the rate of collision (frequency) has to be reduced

16 Which of the following contains the molecules with the highest average speed?



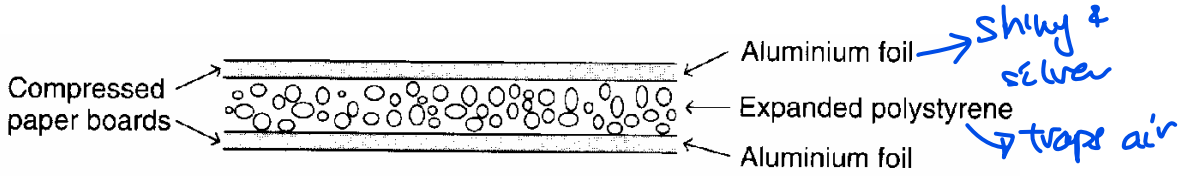
ice cube at –10°C **A**

water at room temperature **B**

wood at room temperature **C**

steam at 110°C **D**

17 The diagram shows a section through a particular type of building board.



Which statement best explains why such a board provides good thermal insulation?

	Aluminium foil is a	*Expanded polystyrene is a*
A	good conductor	poor reflector
B	poor reflector	poor conductor
C	good conductor	good reflector
D	good reflector	poor conductor

18 Fang Fang tried to use a thermistor as a thermometer. She found that when the temperature was 200 °C, the resistance of the thermometer was 250 Ω and when the temperature was 50 °C, the resistance of the thermometer increased to 500 Ω.

What would be the temperature when the resistance of the thermistor is 600 Ω?

A -60 °C **B** -40 °C **C** -10 °C **D** 10 °C

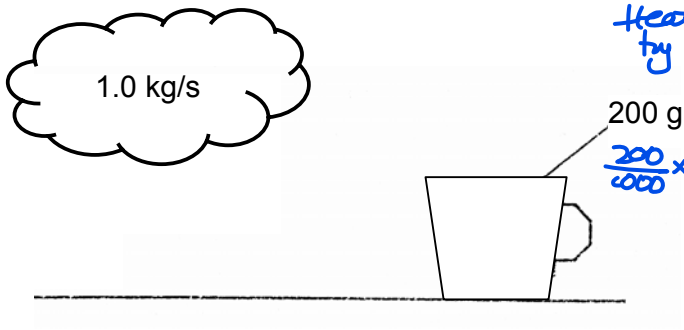
$$\frac{T\theta - T_L}{T_U - T_L} = \frac{R\theta - R_L}{R_U - R_L}$$

$$\frac{T\theta - 50}{200 - 50} = \frac{600 - 500}{250 - 500}$$

$$T\theta - 50 = -60$$

$$T\theta = -10\,^{\circ}C$$

19 A cup of hot coffee of mass 200 g is at an initial temperature of 80 °C. Given that wind, at an initial temperature of 20 °C, is blowing across the cup at a rate of 1.0 kg/s. After moving over the cup, the temperature of the wind increases to 25 °C.



Heat lost by coffee = Heat gained by air

$mc\Delta\theta = mc\Delta\theta$

$\frac{200}{1000} \times 4000 \times (80-50) = (1 \times t) \times 200 \times (25-20)$

$t = 24$ s

If the specific heat capacity of coffee is 4.0 kJ/kg°C and that of air is 200 J/kg°C, compute the time necessary to cool the cup of coffee to 50 °C.

A 0.024 s **B** 4.8 s **C** 24 s **D** 40 s

20 Which of the following increases when a liquid becomes a gas at its boiling point?

constant temperature

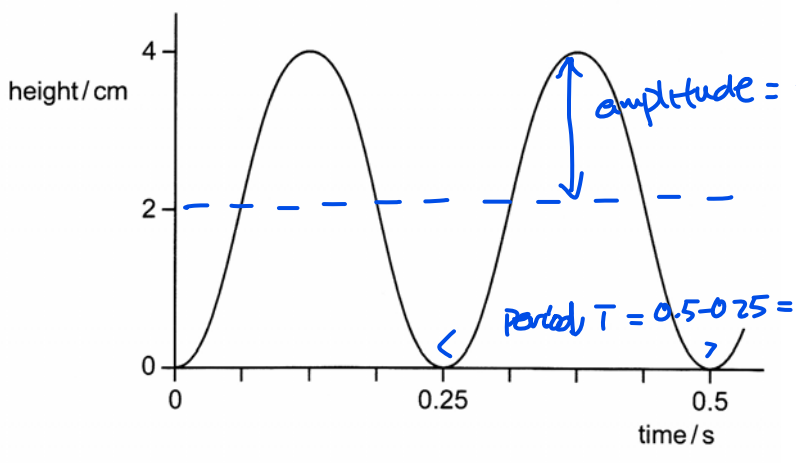
A the average kinetic energy of the molecules → only when temperature of substance increases

B the molecular size

C the molecular spacing

D the total number of molecules

21 The diagram shows the motion of a wave in a ripple tank.



What are the amplitude and frequency of this wave?

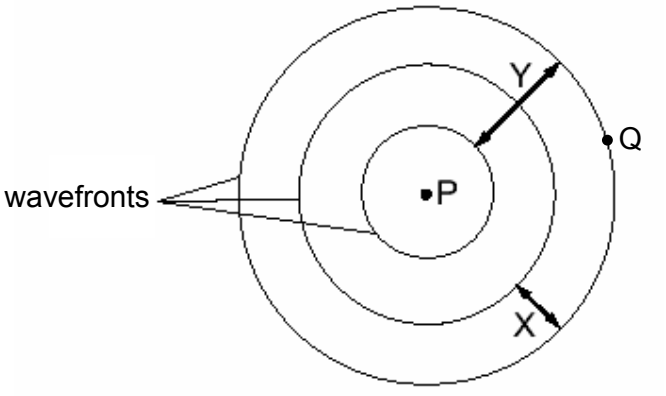
$f = \frac{1}{T}$

$= \frac{1}{0.25}$

$= 4\,Hz$

	amplitude / cm	*frequency / Hz*
A	2	2
B	2	4
C	4	2
D	4	4

22 A vertical stick is dipped in and out of the water at P. It takes two seconds to travel from P to Q.



P → Q = 3 completed waves in 2s

$3T = 2$

$T = \frac{2}{3}s$

$f = \frac{1}{T}$

$= \frac{1}{(\frac{2}{3})}$

$= 1.5\,Hz$

Which of the following statement is true?

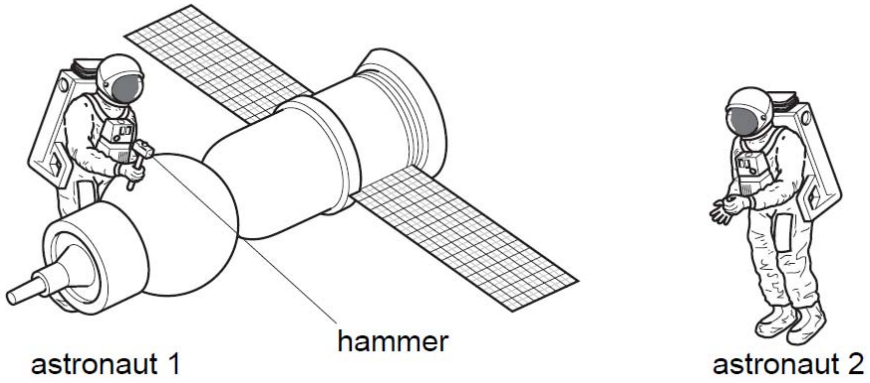
A The frequency of the waves is 1.5 Hz.

B Distance X is the amplitude of the waves.

C Distance Y is the wavelength of the waves.

D The wave formed is a longitudinal wave.

23 Astronaut 1 uses a hammer to mend a satellite in space. Astronaut 2 is nearby. There is no air in space.



Compared with the sound heard if they were working on Earth, what does astronaut 2 hear?

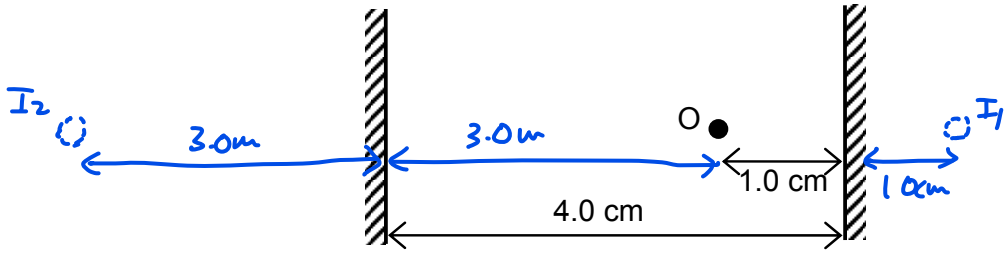
A A louder sound.

B A quieter sound.

C A sound of the same loudness.

D No sound at all. Sound requires a medium to travel. Space is vacuum.

24 Two plane mirrors are placed facing each other with a pin O held upright between them as shown in the diagram.



Distance between I_1 & I_2 = 10 + 10 + 30 + 3.0 = 8.0cm

Determine the separation between the two images formed in the mirrors.

A 6.0 cm **B** 8.0 cm **C** 10.0 cm **D** 12.0 cm

25 The wavelength of yellow sodium light in vacuum is 5.89×10^{-7} m. The speed of this light in glass with an index of refraction of 1.5 is

A 4×10^{-7} m/s **B** 9×10^{-7} m/s **C** 2×10^{8} m/s **D** 3×10^{8} m/s

$n = \frac{\text{speed in vacuum}}{\text{speed in glass}}$

$\text{Speed in glass} = \frac{3 \times 10^8}{1.5} = 2 \times 10^8 \text{ ms}^{-1}$

26 The image of an object formed is smaller than object when the object is placed 19 cm from a converging lens. Placed at a distance of 17 cm, the image of the object becomes slightly bigger than the object.

What is the approximate focal length of the lens?

A 9 cm **B** 10 cm **C** 16 cm **D** 18 cm

when O = 19cm → diminished image
when O = 17cm → magnified image
So when O = 18cm → same size
Hence, 2f = 18cm
f = 9cm

27 A microwave and an X-ray are traveling in a vacuum.

Compared to the wavelength and period of the microwave, the X-ray has a wavelength that is

A longer and a period that is shorter.

B longer and a period that is longer.

C shorter and a period that is longer.

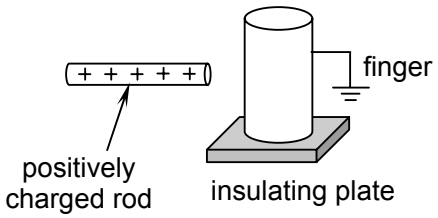
D shorter and a period that is shorter.
↓ higher frequency

28 In the table shown, which region A, B, C or D is used in dental inspection?

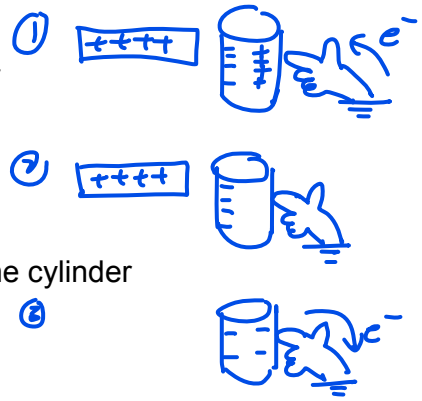
Gamma	A	B	C	D	Microwave	Radio wave

X-rays

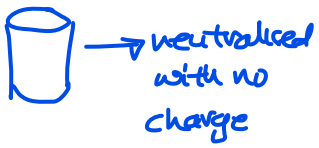
29 A student tries to charge a metal cylinder in the following ways:



(i) bring a positively charged rod near the cylinder
(ii) touch the cylinder with a finger
(iii) remove the rod
(iv) remove the finger.



After this process, the cylinder would most likely be



A uncharged.

B positively charged.

C negatively charged

D negatively charged on one side and positively charged on the other.

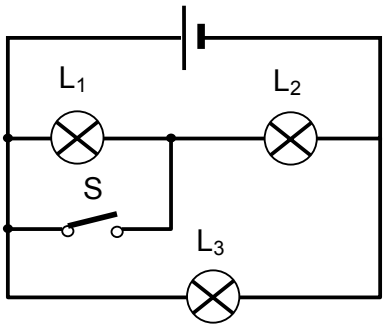
30 A potential difference of 10 V exists between two points, *A* and *B*, within an electric field.

$V = \frac{W}{Q}$ | $Q = \frac{W}{V} = \frac{2.0 \times 10^{-2}}{10} = 2.0 \times 10^{-3}\,C$

What is the magnitude of charge that requires 2.0×10^{-2} J of work to move it from *A* to *B*?

A 5.0×10^{2} C **B** 2.0×10^{-1} C **C** 5.0×10^{-2} C **D** 2.0×10^{-3} C

31 In the circuit shown, all the lamps are identical.



When switch S is closed, lamp L_1 is bypassed. Since effective resistance across L_1 and L_2 has decreased, current flowing into L_2 will increase and brightness of L_2 also increases. Since current flowing through L_3 remains constant, brightness of L_3 remains unchanged

What will happen to their brightness if switch S is closed?

	L_1	L_2	L_3
A	decreases	increases	decreases
B	goes off	increases	decreases
C	goes off	increases	remains unchanged
D	increases	decreases	remains unchanged

32 The resistance of wire A is 4 Ω. Wire B, made of the same material, has twice the length and half the radius of Wire A.

Determine the resistance of Wire B.

$R = \frac{\rho l}{A}$ | $l_2 = 2l_1$ | $A_1 = \pi r^2$, $A_2 = \pi\left(\frac{r}{2}\right)^2$, $A_2 = \frac{1}{4}\pi r_1^2 = \frac{1}{4}A_1$

A 32 Ω **B** 16 Ω **C** 8 Ω **D** 4 Ω

$R_2 = \frac{\rho l_2}{A_2} = \frac{\rho(2l_1)}{\frac{1}{4}A_1} = \frac{8\rho l_1}{A_1} = 8R_1 = 8 \times 4 = 32\,\Omega$

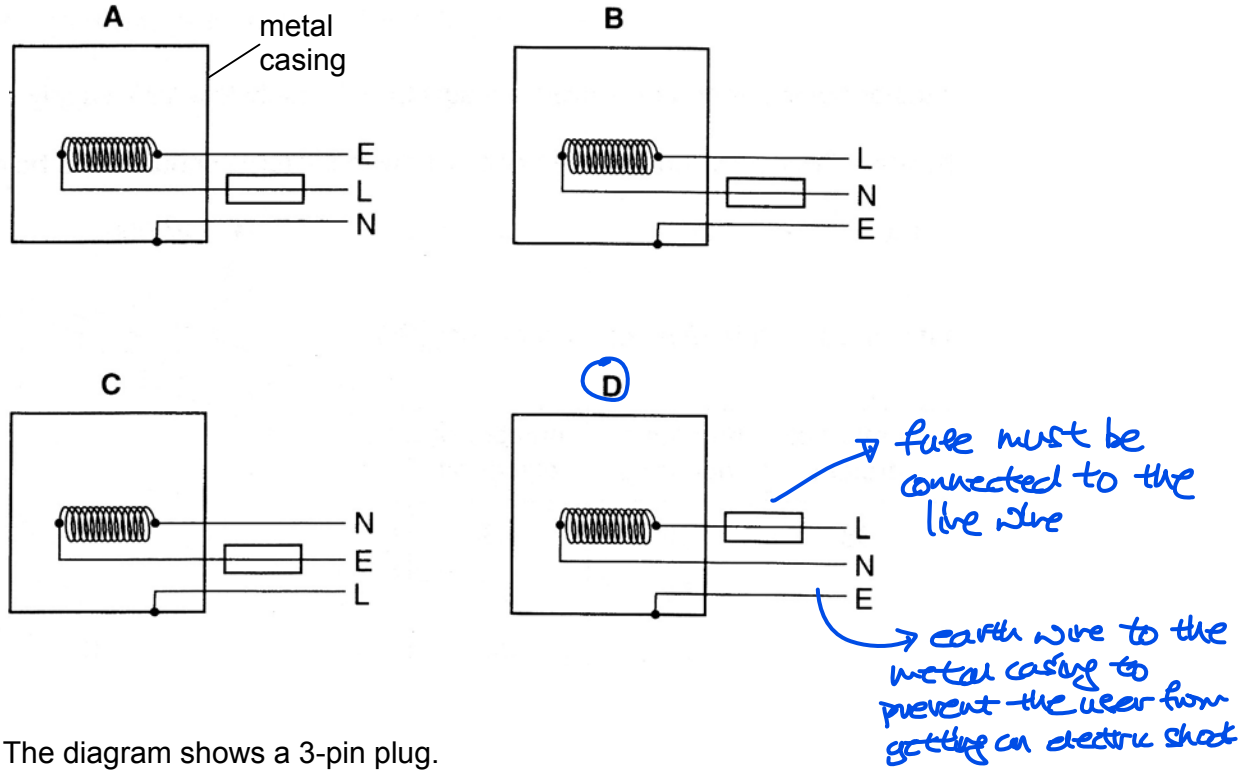
33 Which device is designed to allow a small direct current (d.c.) to control a large direct current (d.c.)?

A a relay
B a transformer
C a generator
D a motor

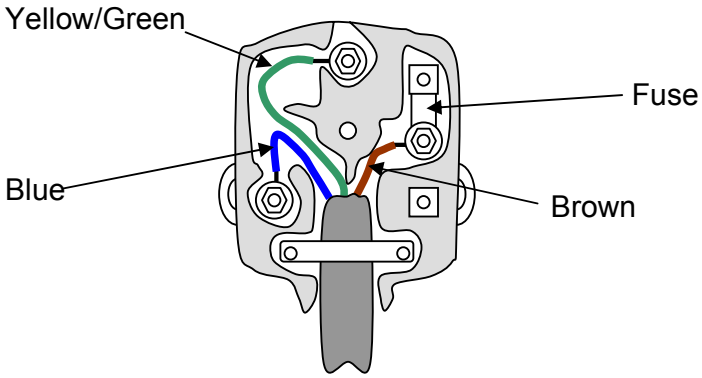
A relay is usually used to switch on or off the high current circuit as high current is extremely dangerous

34 The diagrams show the possible wiring to a heating element.

Which one shows the correct arrangement of wires?



35 The diagram shows a 3-pin plug.



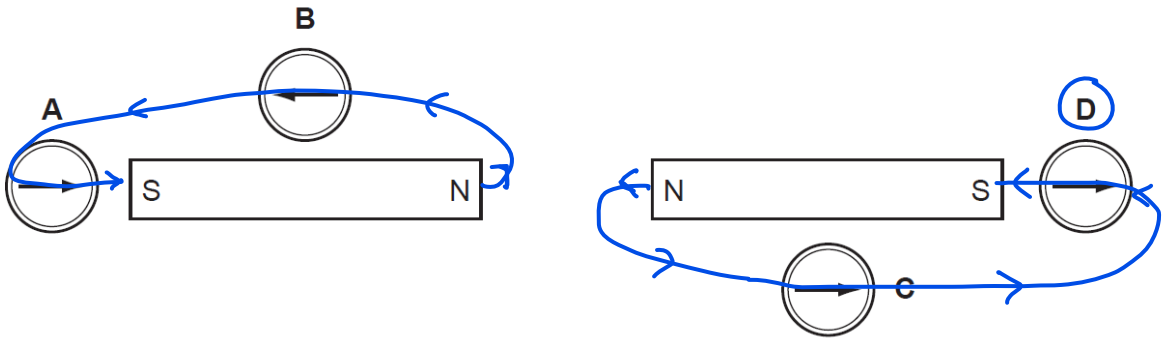
If the brown wire carries a current of 4 A when the appliance is switched on, what would be the currents in the yellow/green and blue wires?

	yellow and green / A	*blue / A*
A	4	4
B	0	4
C	4	0
D	0	0

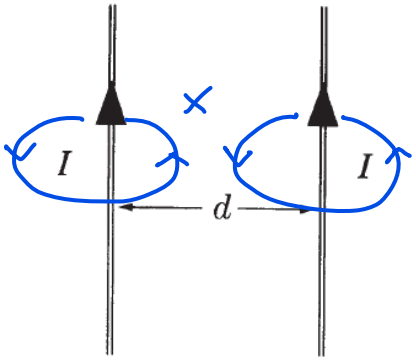
E – Y (green & yellow)
L – O (brown)
N – U (blue)

36 Four plotting compasses are placed in the magnetic field of two identical bar magnets as shown in the diagram.

Which compass is shown pointing in the wrong direction?



37 Two long parallel wires, separated by a distance *d*, carry equal currents *I* toward the top of the page, as shown in the diagram.



Direction of magnetic field lines in both wires determined using right hand grip rule

At half-way point X, the magnetic field lines are acting in opposite directions and will cancel away one another. Hence, the magnitude is zero.

The magnetic field due to the wires at a point halfway between them is

A directed into the page.

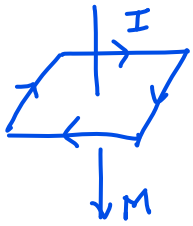
B directed out of the page.

C zero in magnitude.

D directed to the right.

Qn 37-40. not examinable for 2020 O-level exam

38 A square loop of wire lies in the plane of the page. A decreasing magnetic field is directed into the page. The induced current in the loop is



Determine using right-hand grip rule

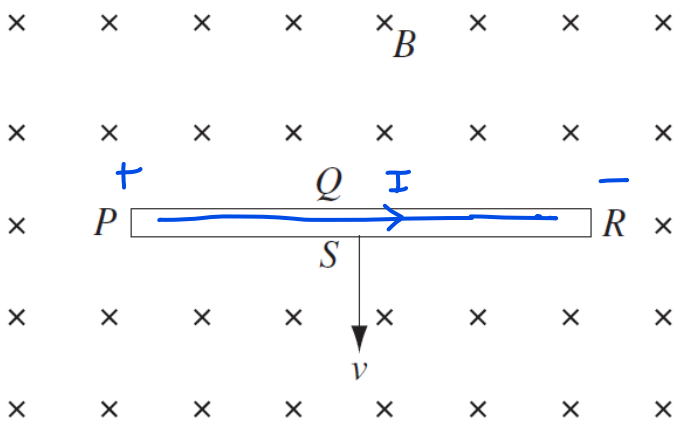
A clockwise.

B anti clockwise.

C out of the page.

D not present.

39 A thin solid conductor with sides *PQRS* is moving at constant velocity *v*, at right angles to a uniform magnetic field *B*, directed into the page as shown.



Using Fleming's right-hand rule

Magnetic field (into the paper)

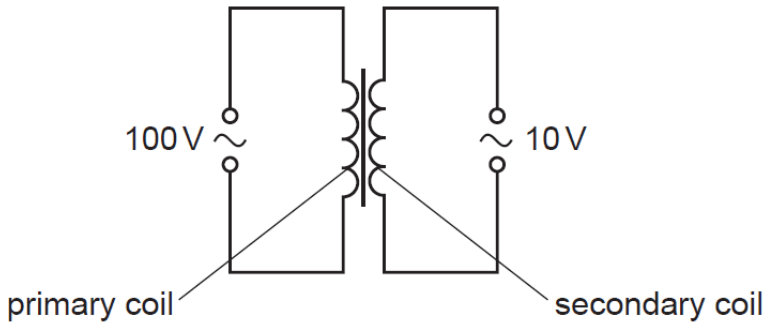
Current (to right of paper)

Force (to bottom of paper)

Which side of the conductor has the greatest concentration of electrons?

A P **B** Q **C** R **D** S

40 A transformer is to be used to provide a 10 V output from a 100 V supply.



What are suitable numbers of turns for the primary coil and for the secondary coil?

	number of turns on the primary coil	*number of turns on the secondary coil*
A	100	1000
B	200	110
C	400	490
D	800	80

$\frac{N_P}{N_S} = \frac{V_P}{V_S} = \frac{100}{10} = \frac{10}{1}$

**** END OF PAPER ****