COMMONWEALTH SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2014

PHYSICS (5059/1)

PAPER 1

Name: _____ ( ) Class: _____

SECONDARY FOUR EXPRESS

2 September 2014
0800h – 0900h
1 h

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the question paper and any separate answer sheets used.

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 OTAS.

Read very carefully the instructions on the OTAS.

INFORMATION FOR CANDIDATES

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.

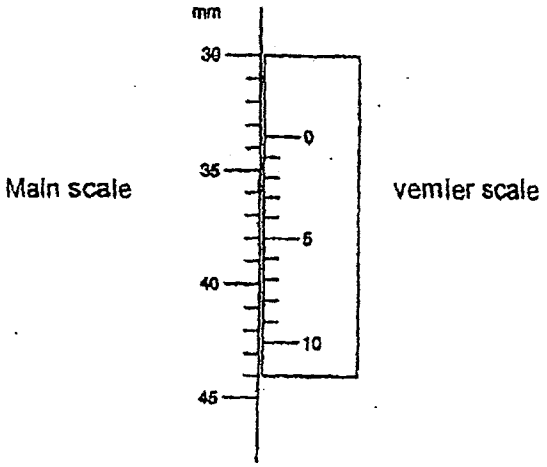
Take the gravitational field strength on Earth, g to be 10 Nkg^{-1}.

Name of setter: Mdm Quek Lay Hong

This paper consists of **18** printed pages including the cover page.

[Turn over

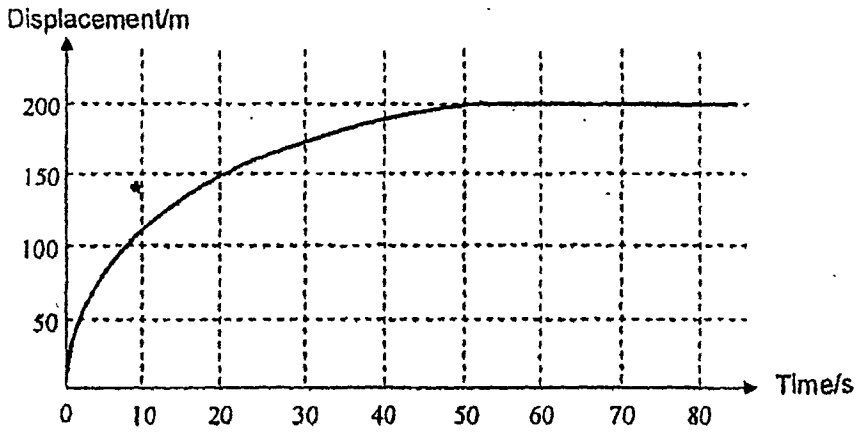
1 The following diagram shows part of a vernier scale.



What is the correct reading?

A 30,5 mm B 33.5 mm C 38.0 mm D 42.5 mm

Refer to the graph for questions 2 and 3.



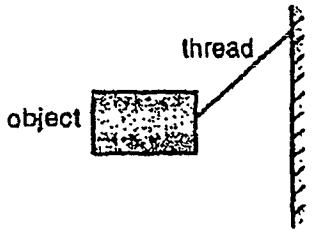
2 Determine the average velocity for the period 0 s to 80 s from the displacement–time graph.

A 2.5 m s^{-1} B 4.0 m s^{-1}
C 7.5 m s^{-1} D 10.0 m s^{-1}

3 At which of the following times is the instantaneous velocity the greatest?

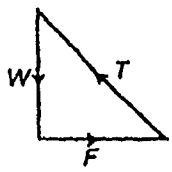
A 10 s B 20 s
C 30 s D 50 s

4 The diagram shows an object of weight W is attached to a thread of tension T. The object is pulled to the left with a force F and it remains stationary.

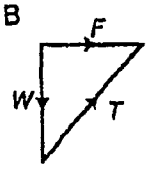


Choose the vector diagram that represents the system shown above.

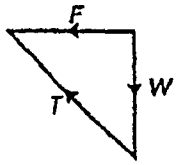
A



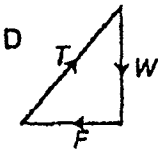
B



C



D



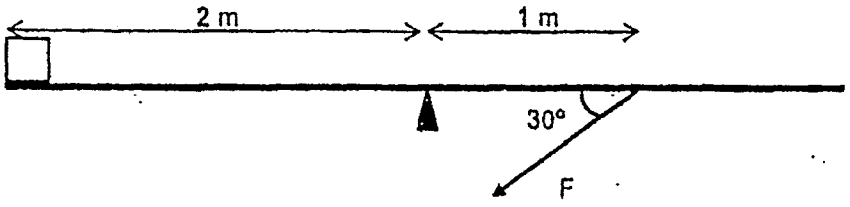
5 A rocket has a mass of 100 kg. The force produced by the engine of the rocket is 3000 N in the direction against the force of gravity.

What is the acceleration of the rocket?

A $10\ ms^{-2}$
B $20\ ms^{-2}$
C $30\ ms^{-2}$
D $40\ ms^{-2}$

6 The diagram shows a cubic box with uniform mass of 2 kg and sides 30 cm placed on one end of a uniform plank. The plank is pivoted at its centre. A force F is applied on the other side of the plank to balance the box.

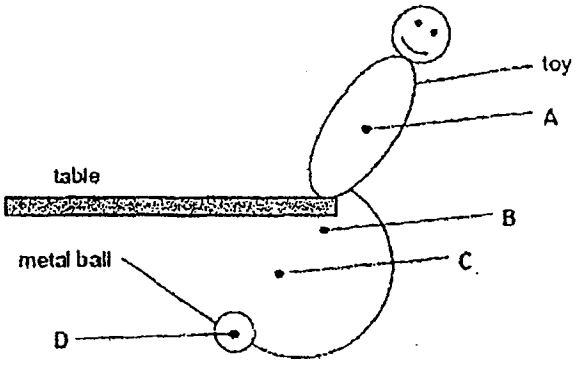
What is the magnitude of the force F?



A 37 N B 40 N C 74 N D 80 N

7 The diagram shows a toy balanced on the edge of a table and at rest. The toy has a metal ball attached to it.

Where is the likely centre of gravity of the toy?

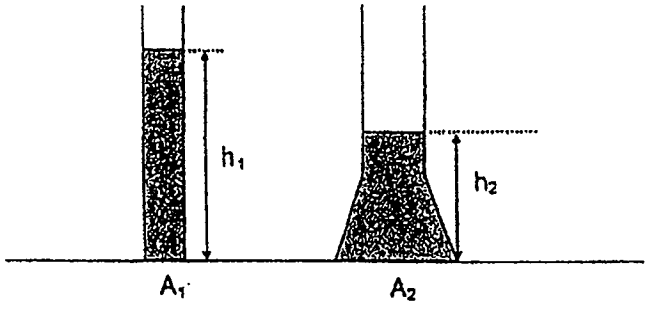


8 A force of 5 N exerted on an object causes it to accelerate from a velocity of 0 m s^{-1} to 8 m s^{-1} in 10 s.

Determine the power of this force.

A 0.4 W
B 2 W
C 20 W
D 40 W

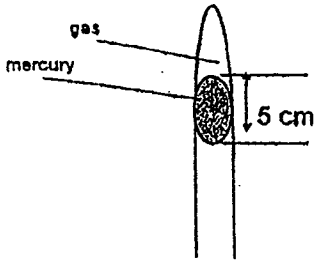
9 Water is contained in a container of base area A_1 up to height h_1. Some water is contained in a second container of bigger base area A_2, but up to a smaller height h_2. The pressure exerted on base A_1 is P_1 while that exerted on base A_2 is P_2.



Which of the following statements is correct?

A $P_1 > P_2$ since $h_1 > h_2$
B $P_1 < P_2$ because $A_2 > A_1$
C $P_1 > P_2$ because $A_2 > A_1$
D It is possible that $P_1 = P_2$ since $A_2 > A_1$ and $h_1 > h_2$

10 The diagram shows a capillary tube with a 5 cm column of mercury.



Calculate the pressure of the gas in Pa given that the atmospheric pressure is 760 mm Hg. The density of mercury is 13600 kgm^{-3}.

A 96600 Pa B 103000 Pa C 104000 Pa D 110000 Pa

11 When a hydrogen balloon sinks from an altitude of 300 m to ground level, its volume decreases.

What pressure changes have occurred within the balloon and the air outside the balloon?

	Pressure change within the balloon	Pressure change outside the balloon
A	Decrease	Decrease
B	Decrease	Increase
C	Increase	Decrease
D	Increase	Increase

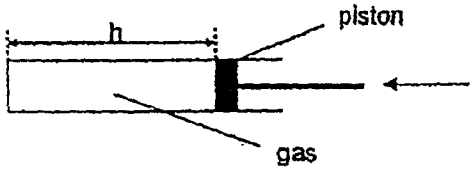
12 A diver deep underwater exhales an air bubble. The air bubble is observed to increase in size as it rises to the surface.

Which of the following explanations may be used to describe this phenomenon?

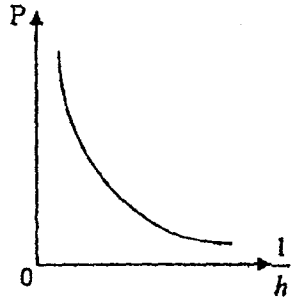
1 The volume increases because the pressure underwater decreases with decreasing depth.
2 The volume increases because while there is no pressure underwater, there is atmospheric pressure at the surface of the water.
3 The volume increases because while the pressure underwater remains the same, the temperature of the water is lower (i.e. colder) with greater depth

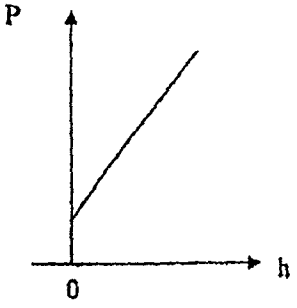
A 1 only
B 3 only
C 1 and 2 only
D 2 and 3 only

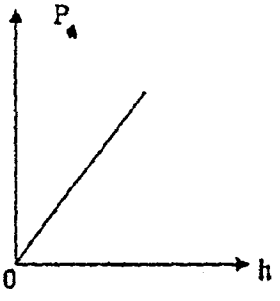
13 A column of gas is slowly compressed as shown in the diagram.

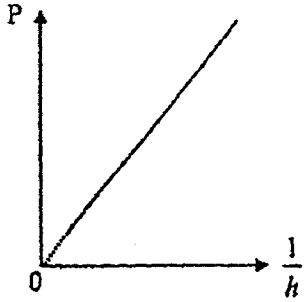


Which of the following graphs correctly shows the relation between the gas pressure P and the length of the gas column h?

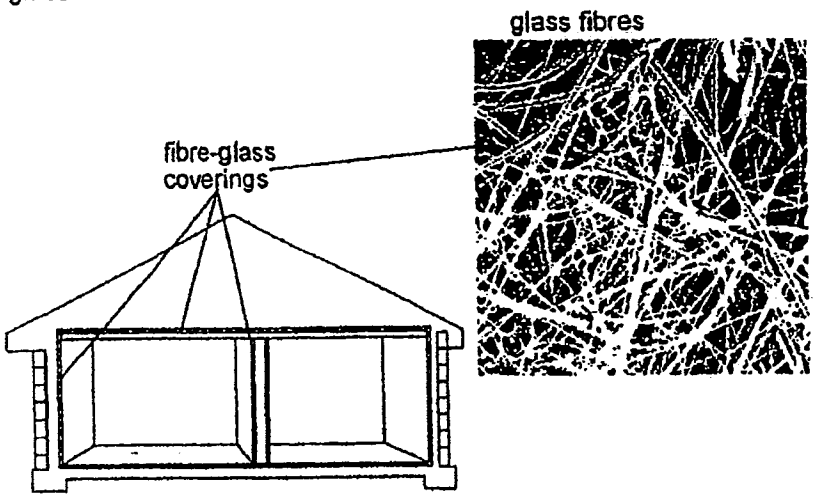
A


B


C


D


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



Which of the following is/are the reason(s) for this?

(i) Fibre-glass reflects radiation.
(ii) The specific heat capacity of glass fibres is small.
(iii) The glass fibres with trapped air are very poor conductors of heat.

A (ii) only
B (iii) only
C (i) and (ii) only
D (ii) and (iii) only

15 The distance between the 10°C mark and the 90°C mark on a mercury thermometer is 25 cm.

When the mercury level is 5 cm below the 90°C the temperature is approximately

A 16°C
B 26°C
C 74°C
D 106°C

Refer to the following description for Questions 16 and 17.

A 300 g block of lead, with a specific heat capacity of 130 $Jkg^{-1}K^{-1}$, is heated to a temperature of 50°C. It is then dropped into a well-insulated beaker of water at 30°C.

Take the heat capacity of the water and beaker to be 300 JK^{-1}, and assume that there is no heat loss to the surroundings.

16 Determine the heat capacity of this block of lead.

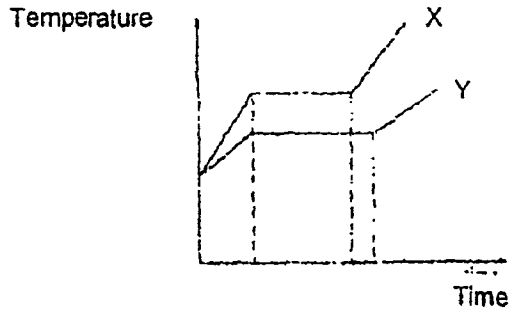
A $39\ J\ K^{-1}$ B $130\ J\ K^{-1}$
C $1170\ J\ K^{-1}$ D $39000\ J\ K^{-1}$

17 When the block of lead is dropped into the water, its temperature decreases, while that of water (and the beaker) increases until they are at the same temperature.

Determine the final temperature of the block of lead and the water.

A 27°C B 32°C
C 40°C D 42°C

18 Two solids, X and Y, of equal masses are melted by heaters of same power rating at the same time. The variation of their temperatures with time is given in the graph.



Which of the following statements is/are true?

(i) The melting point of solid X is higher than that of solid Y.
(ii) The specific heat capacity of solid X is smaller than that of solid Y.
(iii) The specific latent heat of fusion of solid X is smaller than that of solid Y.

A (ii) only
B (i), (ii) and (iii)
C (i) and (ii) only
D (i) and (iii) only

19 A thermocouple shows a voltage of 3.0 mV when one end of the junction is placed in ice at 0°C, and the other junction in boiling water at 100°C. When the junction in the boiling water is removed and placed in a liquid of unknown temperature, the voltage reading is 5.2 mV.

Determine the temperature of this liquid.

A 45°C
B 145°C
C 173°C
D 273°C

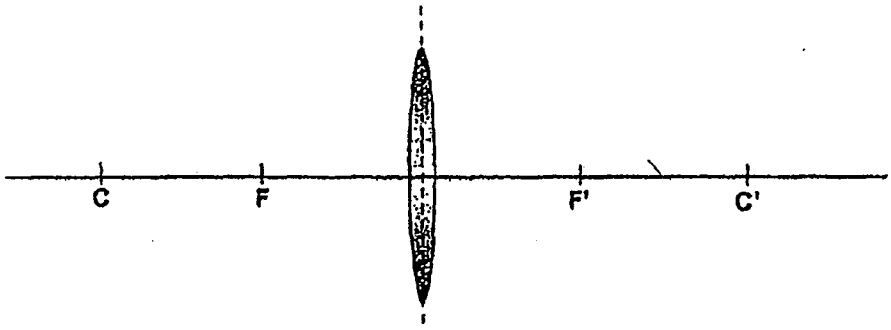
20 Students A and B heat up a beaker of water using an immersion heater. The water in student A's beaker becomes hotter after some time.

Which of the following reasons is/are probable?

(ii) Student A uses a larger beaker.
(i) Student A has more water in his beaker.
(iii) Student A has an immersion heater with higher power rating.

A (i) only
B (ii) only
C (iii) only
D (i) and (ii) only

21 F and F' are the foci of the converging lens. C and C' are both at a distance of two times the focal length from the lens.

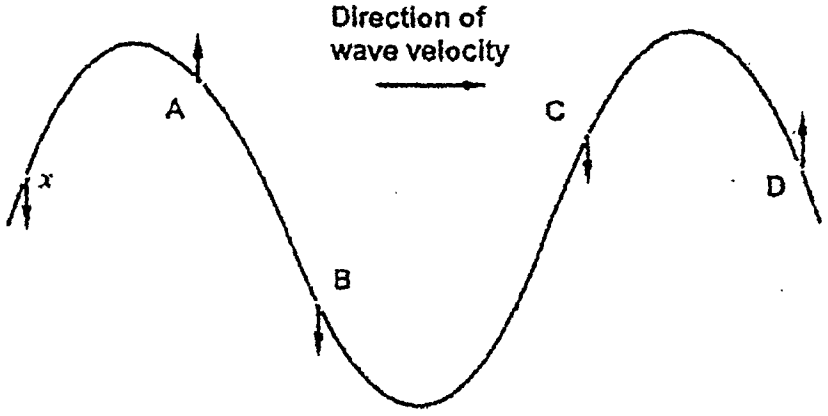


In order for the converging lens to be used in a photocopier, where should the original document and the photocopied paper be placed?

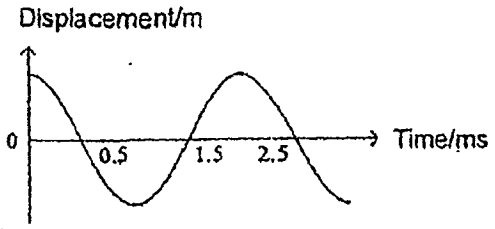
	Position of Original Document	Position of Photocopied Paper
A	Less than F	Between F and C
B	At F	At F'
C	Between F and C	At F'
D	At C	At C'

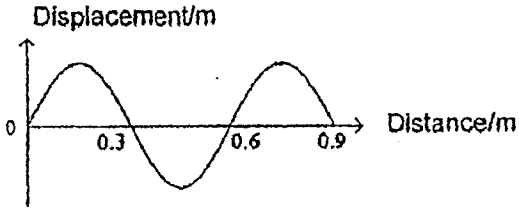
22 The diagram shows a section of a wave motion. The particle at position x moves in the direction of the arrow shown.

Which of the following particles at the labelled positions, A, B, C and D is *incorrect*?



23 The two graphs shown below refer to the same wave.





What is the speed of the wave?

A $0.3\ ms^{-1}$
B $1.2\ ms^{-1}$
C $150\ ms^{-1}$
D $300\ ms^{-1}$

24 Which of the following statements is **false**?

A X-rays are used in luggage scanners.
B Infrared radiation is used in sun beds.
C Gamma rays are used in cancer treatments.
D Microwaves are used for the transmission of cell phone data.

25 The speed of a sound wave is reduced by half when it passes from medium A to medium B.

Which statement below describes the change in the sound wave correctly?

A The frequency is reduced by half.
B The wavelength is reduced by half.
C The frequency becomes twice its initial value.
D The wavelength becomes twice its initial value.

26 Ships use ultrasound waves to find the depth of the sea. Pulses of the ultrasound waves are sent out and echoes are detected. A ship emits a pulse of ultrasound waves lasting 0.50 s. The ultrasound waves have a frequency of 30 000 Hz.

How many complete ultrasound waves does the pulse contain? (Take the speed of sound in water to be 1500 m s^{-1}.)

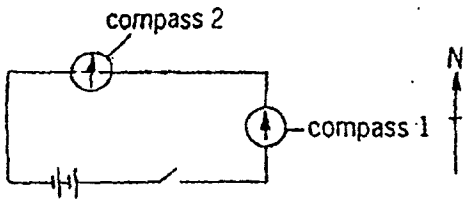
A 15 000 B 30 000
C 70 000 D 140 000

27 Sam plays a note on the guitar. He then plays a louder sound of the same pitch.

Which of the following correctly compares the speed and wavelength of the second note with the first note?

	Speed of second sound	*Wavelength of second sound*
A	Same	Same
B	Same	Different
C	Different	Same
D	Different	Different

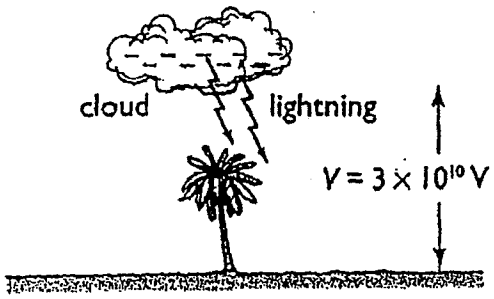
28 The diagram shows compass 1 placed **on top** of a current-carrying wire and compass 2 placed **below** the wire.



What happens to the needles of the compasses when the circuit is closed?

A Both compass needles are deflected to the east.
B Both compass needles are deflected to the west.
C The needle in compass 1 is not deflected but the needle in compass 2 is deflected to the east.
D The needle in compass 1 is deflected to the east but the needle in compass 2 is deflected to the south.

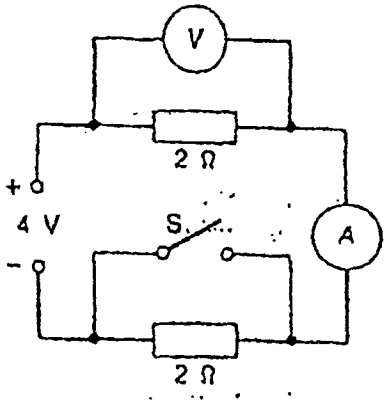
29 During a thunderstorm, lightning sent an electric charge of 90 C from a thundercloud to the earth. The potential difference between the thundercloud and the earth was 3×10^{10} V during the discharge.



How much energy was produced during the lightning?

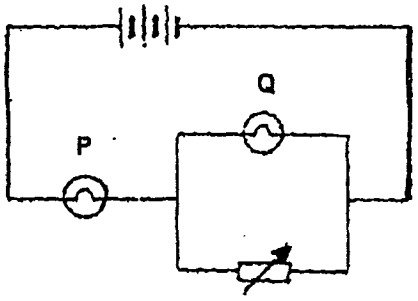
A 2.7×10^{10} J
B 2.7×10^{12} J
C 3.0×10^{12} J
D 1.3×10^{13} J

30 In the diagram, how do the voltmeter and ammeter readings change when the switch S is closed?



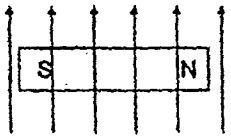
	Voltmeter reading changes from	*Ammeter reading changes from*
A	2.0 V to 4.0 V	0.50 A to 1.0 A
B	2.0 V to 4.0 V	1.0 A to 2.0 A
C	4.0 V to 2.0 V	1.0 A to 2.0 A
D	4.0 V to 2.0 V	0.50 A to 1.0 A

31 In the diagram, what will happen to the brightness of the lamps if the resistance of the rheostat is increased?



	P	Q
A	Dimmer	Brighter
B	Dimmer	Dimmer
C	Brighter	Dimmer
D	Brighter	Brighter

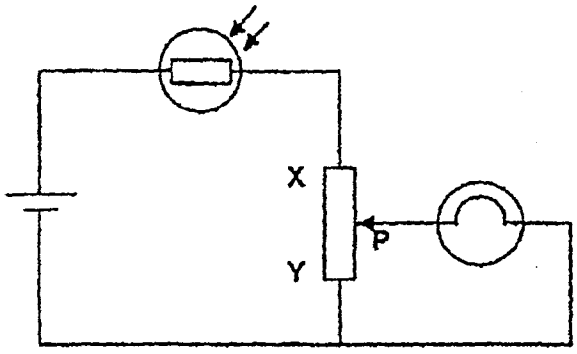
32 A bar magnet is placed in a uniform magnetic field as shown.



The magnet will

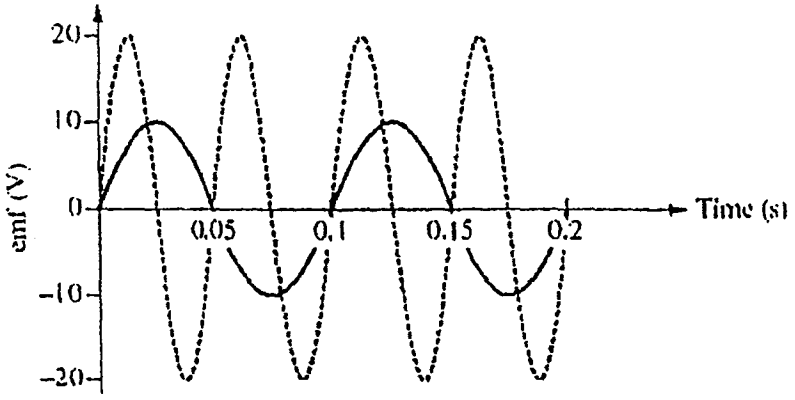
A remain stationary
B turn 90° clockwise
C turn 90° anti-clockwise
D turn 180° anti-clockwise

33 In the diagram, when is the lamp brightest?



A the LDR is covered and P is moved to Y
B the LDR is covered and P is moved to X
C light is incident on the LDR and P is moved to Y
D light is incident on the LDR and P is moved to X

34 In the graph, the solid curve shows how the emf produced by a simple generator varies with time. The dashed curve is the output from the same generator after a modification has been made to it.



Which modification was made to produce the result shown?

A The area of the coil was doubled.
B The strength of the magnet was doubled.
C The number of turns in the coil was doubled.
D The speed of rotation of the coil was doubled.

35 The diagram shows a tea spoon and a table spoon that are made of pure silver.

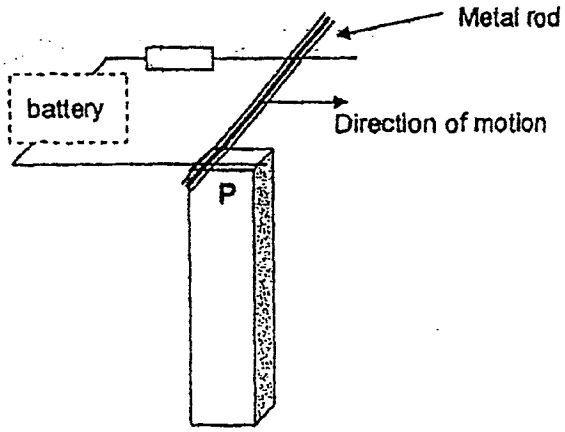
Tea spoon weighs 20 g

Table spoon weighs 50 g

Which of the following statements is correct about the densities of the two types of spoons?

A Both spoons have the same density.
B The tea spoon has a higher density than the table spoon.
C The table spoon has a higher density than the tea spoon.
D The densities for the tea spoon and the table spoon are 20 gcm^{-3} and 50 gcm^{-3} respectively.

36 A metal rod is placed on stiff wires as shown in the following diagram. A permanent magnet is placed under the centre of the rod with the end P nearest to it.



If the rod moves in the direction shown, which of the following option(s) is/are possible?

	Orientation of battery	Polarity of P
I		South
II		North
III		South
IV		North

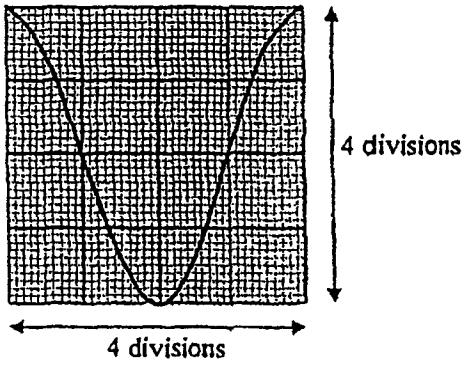
A I only

B II and III only

C II only

D I and IV only

37 The diagram illustrates the trace obtained on the screen of an oscilloscope when a given signal is applied to the input terminals.



The time-base is set to 2.0 ms/div and the voltage sensitivity is 2.0 V/div.

Which of the following correctly represents the peak voltage and frequency of the signal?

	Peak voltage	*Frequency*
A	4.0 V	83.3 Hz
B	4.0 V	125 Hz
C	8.0 V	83.3 Hz
D	8.0 V	125 Hz

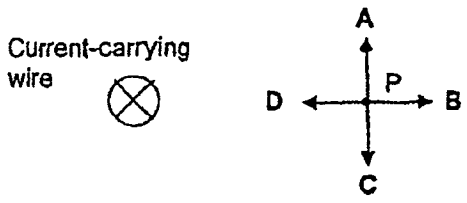
38 The cost of electricity is 27 cents per kWh.

What is the cost of using a 1000 – 1200 W iron at maximum power for 45 minutes?

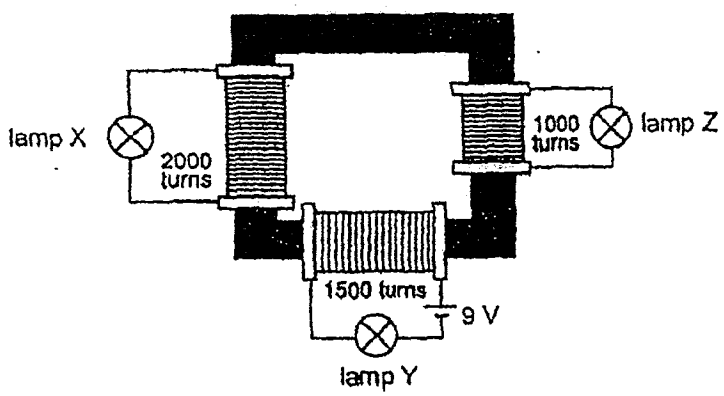
A 12.2 cents
B 14.6 cents
C 24.3 cents
D 1458 cents

39 The diagram shows a wire carrying current into the plane of the page.

What is the direction of the magnetic field at point P?



40 Three identical filament lamps, X, Y and Z, are connected to a transformer with multiple coils. The resistance of each lamp is 4.5 Ω and each requires a current of 2.0 A to light up normally.



What can be observed about the brightness of the three lamps?

	Lamp X	Lamp Y	Lamp Z
A	Dimmer than normal	Normal brightness	Brighter than normal
B	Brighter than normal	Normal brightness	Dimmer than normal
C	Not lit	Normal brightness	Not lit
D	Not lit	Not lit	Not lit

Commonwealth Sec. ANS KEY

Paper 1

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

COMMONWEALTH SECONDARY SCHOOL

PRELIMINARY EXAMINATION 2014

PHYSICS (5059/2)

PAPER 2

Name: _____ ( ) Class: _____

SECONDARY FOUR EXPRESS

27 August 2014
0800 h – 0945 h
1 h and 45 minutes

READ THESE INSTRUCTIONS FIRST

Write your name, index number and class on the question paper and any separate answer sheets used.
Write in dark blue or black pen.

Section A (50 marks)
Answer all questions.
Write your answers in the spaces provided on the question paper.

Section B (30 marks)
Answer all three questions.
Question 12 has a choice of parts to answer.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.
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.

Take the gravitational field strength g on Earth to be 10 Nkg^{-1}.

At the end of the examination, ensure that you have submitted all your work.

For Examiner's Use	
Paper 1	/40
Paper 2 Section A	/50
Paper 2 Section B	/30
Total	/120

Name of setter: Mr Jensen Ong

Parents'/Guardian's Signature

Section A

Answer all the questions in this section.

1 Fig 1.1 shows how the vertical velocity of a parachutist changes from the moment parachutist jumps from the aircraft until landing on the ground.

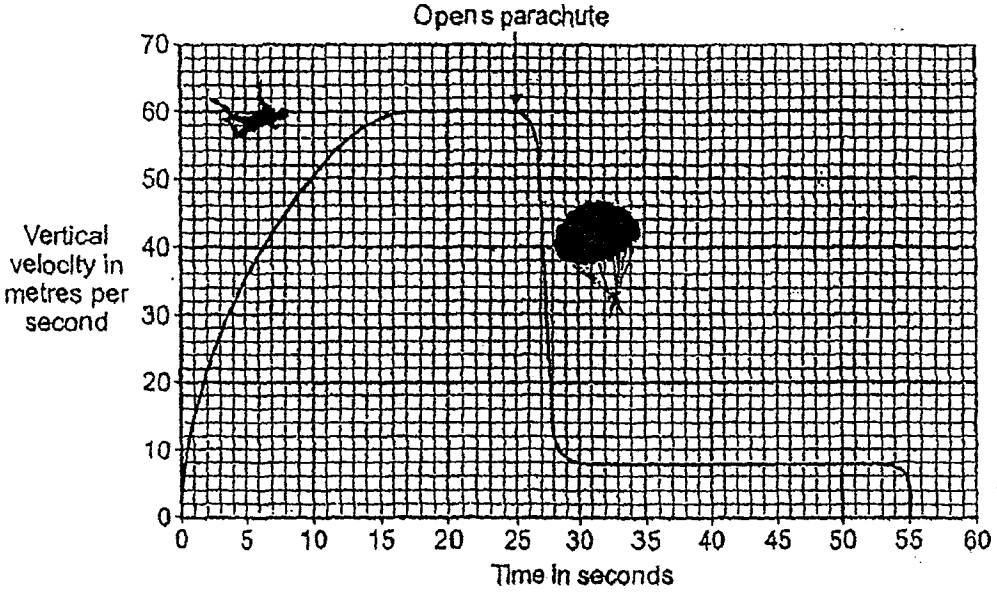


Fig. 1.1

(a) Use Newton's laws of motion to explain why the parachutist reaches terminal velocity before the parachute is opened. [

(b) When the parachutist jumps off the plane, the weight of the parachutist is one of the tw forces that form an action-reaction pair of forces. Describe the other force of the pair. [1

(c) Suggest the changes to the graph, if any, if the skydiver uses a parachute of a larger surface area. Assume that the parachutist opens the parachute at the same instant as indicated on the graph. [2]

Fig 2.1 below shows a kitchen cupboard securely mounted to a vertical wall. The cupboard rests on a support at A.

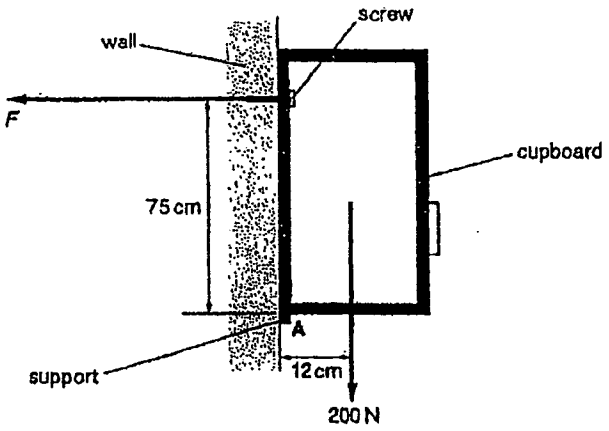


Fig. 2.1

The total weight of the cupboard and its content is 200 N. The line of action of its weight is at a distance of 12 cm from A. The screw securing the cupboard to the wall is at a vertical distance of 75 cm from A.

(a) State the principle of moments. [2]

(b) The direction of *F* provided by the screw on the cupboard is horizontal as shown in Fig. 2.1. Determine the magnitude of *F*. [2]

magnitude of *F* = ...

(c) The cross sectional area under the head of the screw in contact with the cupboard is 0.60 cm^2. Calculate the pressure on the cupboard under the screw head. [2]

pressure = ...

(d) State and explain how your answer in (c) would change, if at all, if the same screw was secured much closer to A. [2]

.....

.....

.....

.....

3 A car of mass 970 kg is travelling at 27 m s^{-1} when the brakes are applied. The speed of car decreases to 15 m s^{-1} in a distance of 40 m.

(a) (i) Calculate the loss in kinetic energy of the car when the brakes are applied. [2]

loss in kinetic energy = ...

(ii) Hence, calculate the average braking force on the car. [2]

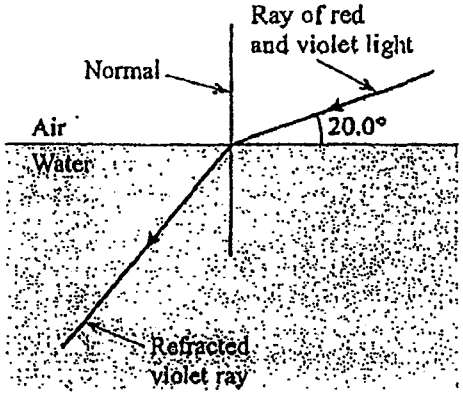
braking force = ...

(b) The car has four brake discs each of mass 1.2 kg. The material from which the discs are made has a specific heat capacity of 520 J kg^{-1} K^{-1}.

Assuming that all the kinetic energy of the car is converted into thermal energy of the brake discs equally during braking, calculate the temperature rise of each disc after braking from a speed of 27 m s^{-1} to 15 m s^{-1}. [2]

temperature rise = ...

4 Fig. 4.1 below shows a ray of red and violet light passing into the surface of water.



The diagram is not drawn to scale.

Fig. 4.1

(a) Give a reason why light is refracted as it enters water. [1]

.....

.....

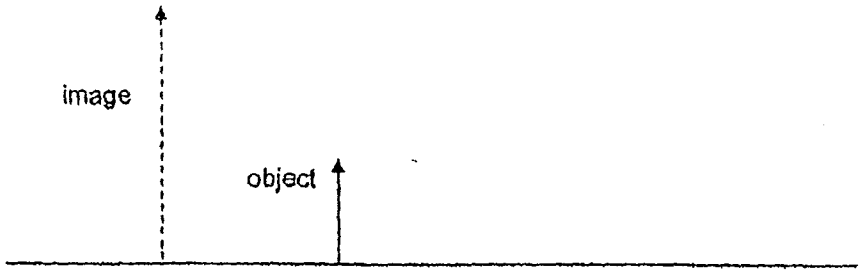
(b) The refractive index of violet light passing from air to water is 1.34. Calculate the angle of refraction of the refracted violet ray. [2]

angle of refraction = ...

(c) The refractive index of red light passing from air to water is 1.33. Add a line to the diagram to show the approximate path of the refracted red ray. [1]

5 An object is placed in front of a converging lens as shown in the diagram below. The diagra drawn to scale.

(a) By drawing two rays from the object, locate the position of the lens and its principal f Label the principal focus clearly with **F**.



(b) State an optical device that uses this lens in this arrangement.

.....

6 A light metallic coated sphere P which is suspended with an insulating string is in contact an uncharged metal sphere A which is fixed on an insulating stand. A highly positively char sphere B is moved towards A as shown in Fig. 6.1 below.

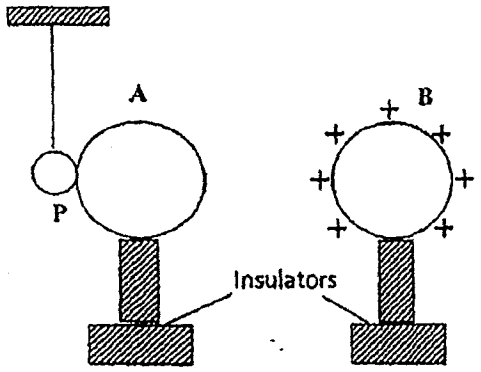


Fig. 6.1

(a) Draw on the diagram, the charge distribution on P and A. [

(b) Sphere B is allowed to come in contact with A.
Describe and explain the final position of P. [

.....

.....

.....

.....

A small positively charged metal sphere **A** is hung from an insulating string. Fig.7.1 below shows the effect on **A** when a negatively charged sphere **B** on an insulated rod is positioned close to it. The string makes an angle θ with the vertical.

The mass of sphere **A** is 4.5×10^{-5} kg and the electric force acting on **A** is 1.5×10^{-4} N. Draw a well labelled vector diagram to determine the tension of the string and the angle θ made by the string with the vertical. [4]

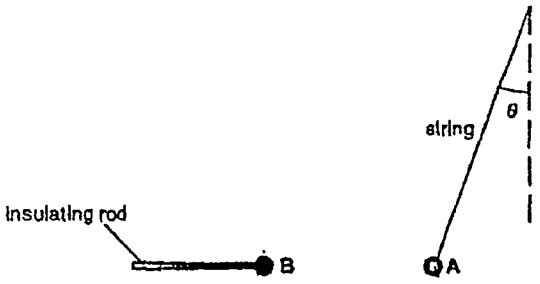


Fig. 7.1

scale = ...

tension of string = ...

angle θ = ...

1 Two smooth electrically conducting vertical tracks are joined by a horizontal metal slide of length 40 mm. The slide is supported by a sensitive spring balance and is free to move up and down the tracks in a uniform horizontal magnetic field, at right angles to its length as shown in Fig. 8.1.

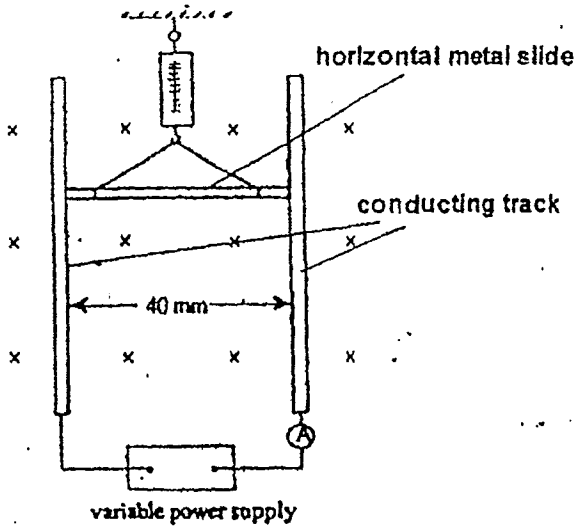


Fig. 8.1

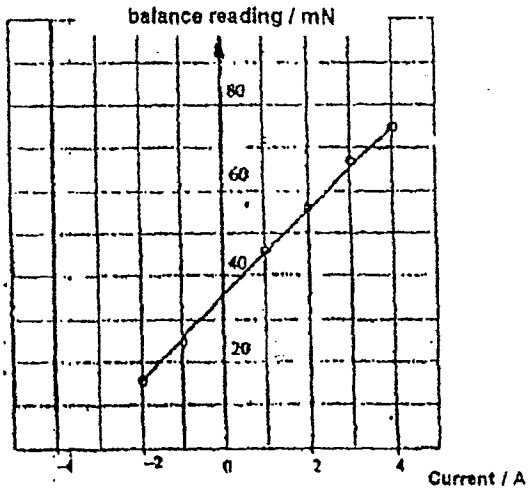


Fig. 8.2

The spring balance, which is calibrated in milli-newton, reads zero when it is hanging vertically and supporting no load. The tracks are connected to a variable power supply which can provide a current in either direction through the circuit.

A student passes various currents through the circuit and notes corresponding readings on the spring. The results are plotted in the graph as shown in Fig. 8.2.

(a) From the graph, estimate

(i) the mass of the horizontal metal slide, [2]

mass of slide = ...

(ii) the **magnitude** of the current flowing in the horizontal metal slide when the spring balance reads zero. [1]

current = ...

(b) Indicate the direction of the current on the horizontal metal slide in Fig. 8.1 when the spring balance reads zero. Explain your answer [3]

.....

.....

.....

9 The pick-up on an electric guitar produces an electrical signal from the vibrations of the guita strings. The pick-up consists of a small coil of insulated wire wound round a small cylindrical ba magnet as illustrated in Fig. 9.1 below.

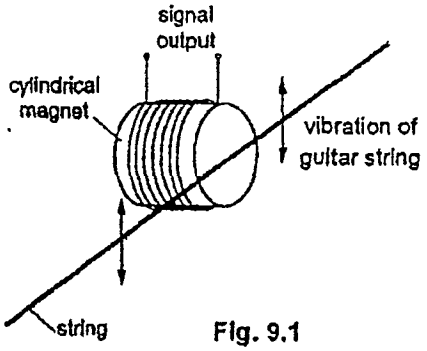


Fig. 9.1

The strings of the guitar are made of steel. When a string vibrates, an electrical signal is generated between the terminals of the coil.

(a) State Faraday's law of electromagnetic induction. [2]

(b) Use Faraday's law to explain why an electrical signal is generated. [3]

(c) Suggest why the design of the pick-up would be inappropriate for use on a guitar with nylon strings. [2]

Section B

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

10 To investigate a layer of rock underground, an explosion is triggered on the surface of the e Fig. 10.1 below shows the arrangement.

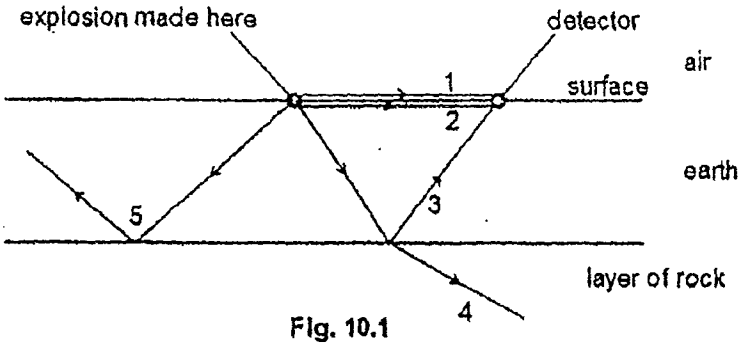


Fig. 10.1

Sound wave from the explosion may travel to the detector through air (path 1) or through e (path 2). It can also be transmitted into the layer of rock by path 4 with part of wave b reflected at the boundary between the earth and the layer of rock as indicated by path 3.

The time taken for the sound to reach the detector is shown in Fig. 10.2.

	path 1	path 2	path 3
Time taken (in seconds) for sound to travel from the source to the detector	0.10	0.02	0.30

Fig. 10.2

(a) Explain why sound wave takes the shortest time to reach the detector along path 2. [

.....

.....

(b) Given that the speed of sound in air is 330 m s^{-1}, calculate the distance between source of sound and the detector. [

distance = ...

(c) Use the answer in part (b) to calculate the speed of sound in earth. [

speed of sound = ...

(d) The sound travelling along path 5 undergoes total internal reflection. State the conditions for total internal reflection to occur. [2]

(e) Referring to path 4, explain how the speed of sound changes when it travels from earth to the layer of rock. [1]

(f) Another type of sound wave that is frequently used is called ***ultrasound***. Explain what ***ultrasound*** is and state one application of ultrasound in the medical field. [2]

In an effect called the Mpemba effect a quantity of hot water freezes completely in a shorter time than the same quantity of cold water when both are placed in the same freezer.

Two possible explanations of this effect are:

- convection effects within the water
- greater rate of evaporation of the warmer water reducing its mass.

(a) Describe the process of convection within a liquid. [2]

(b) State two differences between evaporation and boiling. [2]

1.

2.

(c) Explain in terms of molecules why the mass of a liquid reduces during evaporation. [2]

(d) Another possible explanation of the Mpemba effect is that when the two containers of water are placed next to each other on a freezer shelf, the container with the hot water melts the ice on the shelf more quickly. So there is better thermal contact between this container and the melted ice on the shelf.

Name and explain the heat transfer process that takes place between the bottom of the container of hot water and the melted ice beneath it. [2]

(e) Fig. 11.1 below was obtained by cooling two samples of water from different starting temperatures under identical conditions.

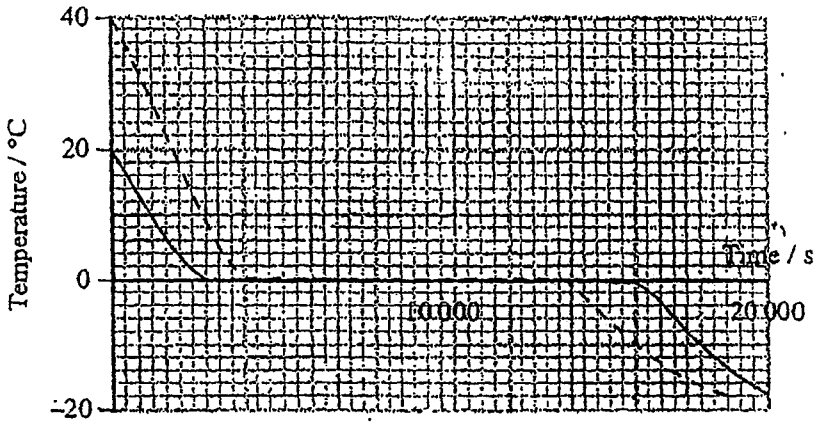


Fig. 11.1

Explain why the graphs show the Mpemba effect. Your answer should quote data from the graphs. [2]

12 EITHER

Fig 12.1 below shows the I-V characteristic of two electrical components, a resistor, line R and a thermistor, line T.

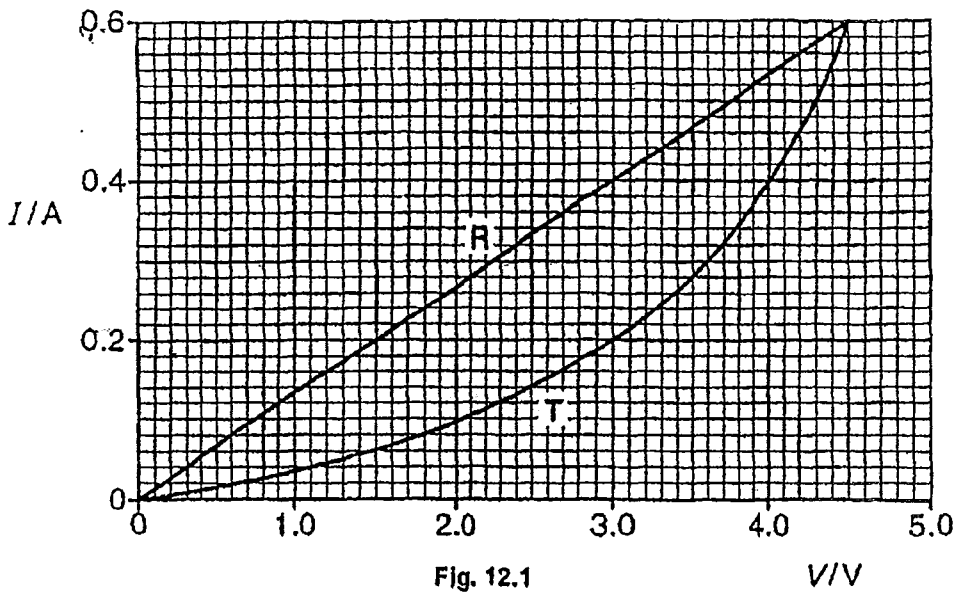


Fig. 12.1

(a) State Ohm's Law and explain why component R obey Ohm's law. [3]

(b) From the graph, determine the resistance of component R. [1]

resistance = ...

(c) Component R is constructed from a rod of diameter 3.38×10^{-3} m and length 0.012 m. Determine the resistivity of the material of the rod. [2]

resistivity = ...

(d) The resistor and the thermistor can be connected to a variable voltage supply in two ways as shown in **Figure 12.2** and **12.3.**

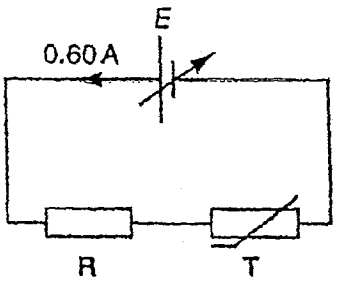


Fig 12.2

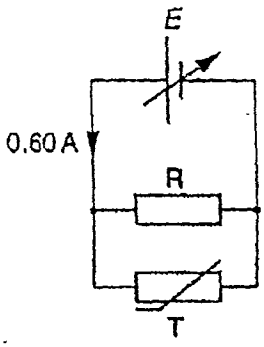


Fig 12.3

The voltage of the supply is varied in each circuit until the current drawn from it is 0.6 Use data from the graph to explain why the e.m.f of the supply is

(i) 9.0 V in **Figure 12.2.**

.....

(ii) 3.0 V in **Figure 12.3.**

OR

:sistor X is constructed from a rod of cross sectional area 9.0×10^{-6} m^2 and length 0.012 m as wn in Fig. 12.4. The resistivity of the rod is 2.4 Ω m.

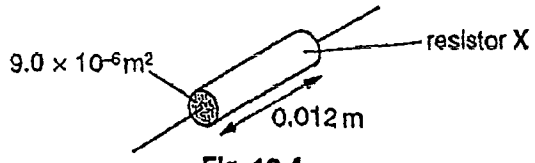


Fig. 12.4

(a) Calculate the resistance of the resistor X. [2]

resistance = ...

(b) The power rating of resistor X is 0.125 W. Show that that the maximum potential difference which should be applied safely across the resistor is 20 V. [1]

(c) A student needs a resistor of the same resistance as X but with a power rating of 0.50 W. He connected four of these resistors as shown in Fig. 12.5 to meet his requirements. The potential difference across the combination of resistors is 40 V.

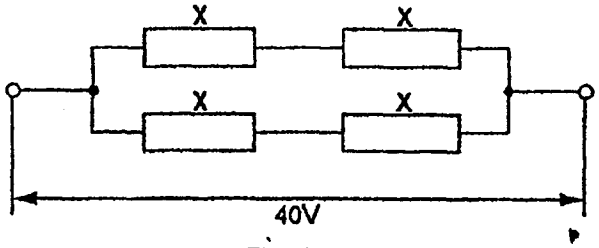


Fig. 12.5

Explain how the above connection meets the student's requirement in terms of total resistance, potential difference and power rating. [3]

(d) Another resistor Y is constructed from the same material but has twice the length and twice the diameter of resistor X.

(I) Show that the resistance R_Y of Y is half the resistance R_X of resistor X. [2]

(II) The two resistors X and Y are connected in series to a d.c. power supply as shown in Fig. 12.6.

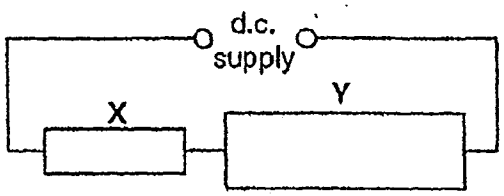


Fig. 12.6

State and explain which resistor dissipates greater power. [2]

** END OF PAPER**

COMMONWEALTH SECONDARY SCHOOL
Prelim Exam 2014
Secondary 4 Express
Mark Scheme

Paper 2

Qn			Answer	Marks	Remarks
1	(a)		• When the parachutist first leaves the plane, **resultant force = weight.** Acceleration = g or $10ms^{-2}$. • When he accelerates (velocity increases), **air resistance increases. Resultant force decreases** and he falls with **decreasing acceleration.** • When the air resistance = weight, **resultant force = 0** and he moves with terminal (constant) velocity.	1 1 1	Accept $R_{air} = 0$ Must have "decreasing acceleration"
	(b)		Force on earth by the parachutist/man	1	
	(c)		The slope is more negative/slope will be steeper/rate of decrease in velocity is greater. Slower/smaller/lower terminal velocity Take a longer time for graph to reach v=0 (longer time for parachutist to reach the ground) Reach terminal velocity earlier	1 1	
2	(a)		When a body is in equilibrium, sum of clockwise moments about a pivot is equal to the sum of anticlockwise moments about the same pivot.	1 1	The word "pivot" mention at leas once in the definition.
	(b)		F x 0.75 = 200 x 0.12 F=32 N	1 1	
	(C)		Pressure = Force/Area = 32/(0.60)(0.01)(0.01) =5.33 x 10^5 Pa	1 1	ecf
	(d)		Shorter distance will result in a greater force on the nail. Therefore pressure will be larger with the same screw area.	1 1	
3	(a)	(i)	Final KE – Initial KE = ½ (970)($27^2 - 15^2$) =2.44 x 10^5 J	 1 1	0 marks for ½ (970)(27 – 15)^2
		(ii)	Force = Ene loss/distance =2.44 x 10^5 /40	 1	ecf

Qn			Answer	Marks	Remarks
			= 6100 N or 6110 N	1	
	(b)		Thermal energy = $mc\Delta\theta$ $2.44 \times 10^5/4 = 1.2(520)\,\Delta\theta$ $\Delta\theta$=97.8 °C or K	 1 1	
4	(a)		Speed of light decreases as it enters water	1	
	(b)		Sin 70°/sin r = 1.34 r = 44.5°	1 1	
	(c)		Light ray (red) is refracted at a larger angle of refraction.	1	Not penalized for line withol arrow.
5	(a)		Ray connecting image to object. Ray parallel to principle axis. Ray is then connected from image to F. Position of lens determined correctly. Principal Focus labeled *F*.	1 1 1 1	Deduct max 1m: • missing arrows • arrows in wrong directio • arrows on dotted lines
	(b)		Magnifying glass	1	
6	(a)		-ve charges on the right side of A, +ve charges on the left side of P. Equal number of charges on the left of sphere P and right side of sphere A.	1 1	The number of charges on P need not be the same num as B.
	(b)		-ve charge in A will move to B to neutralize some of the +ve charges in B. This leaves A and B positively charged. As like charges repel, P will be repelled from A OR since P is +ve, both P and A will repel each other.	1 1	
7			• All vectors labelled correctly. • All arrows are drawn in the correct direction (with 90°angle correctly drawn) • T = 4.8×10^{-4} N • Angle = 18°	1 1 1 1	Weight of sphere A must be correctly determined. Allow 4.5×10^{-4} N to 5.0×10^{-4} N +/- 1° students are not penalized for bad/small scale.
8	(a)	(i)	Weight = 35 mN Mass = 3.5×10^{-3} kg	1 1	
		(ii)	3.5 A		
	(b)		Current flow towards the right on the slide. Upward force to balance weight when balance reads zero. By Fleming's Left Hand rule, the current flow	1 1	Students are awarded 0m if answer shows misconception contradiction.

Qn			Answer	Marks	Remarks
			towards the right.	1	
9	(a)		Faraday's law of electromagnetic induction states that the **magnitude of the induced** e.m.f. in a circuit is **directly proportional** to the rate of change of magnetic flux in the circuit/rate of cutting of magnetic flux/rate of change of magnetic lines of force linking the circuit/rate of change of magnetic field linking the circuit.	1 1	
	(b)		• The guitar string is **magnetised** by induction in the presence of the cylindrical magnet. • When the guitar string vibrates, the coil **experiences a continuous change in magnetic flux** linking the coil. • By Faraday's law, an **e.m.f. is induced** in the coil hence generating an electrical signal between its terminals.	1 1 1	Students are awarded 0m if answer shows misconception or contradiction.
	(c)		• Nylon is a **non-magnetic material** and cannot be magnetised by induction in the presence of the cylindrical magnet. • The coil does not experience a changing magnetic flux as the string vibrates and thus no e.m.f. will be induced in the coil.	1 1	
10	(a)		Sound travels faster in solid (earth) compared to air.	1	
	(b)		Distance = 330 x 0.10 = 33 m	1 1	
	(c)		Speed = 33/0.02 =1650 ms^{-1}	1 1	
	(d)		Wave must travel from a optically denser to a optically less dense medium. Angle of incidence is larger than critical angle of the optically denser medium.	1 1	
	(e)		As the sound wave bends away from the normal as it travels from earth to rock, its speed in rock is faster than earth.	1	
	(f)		Ultrasound is sound with frequencies above the upper limit of the human range of audibility/ frequencies higher than 20kHz. Prenatal scanning	1 1	Scanning of body tissue
11	(a)		Water at the surface was cooled. Its volume contracts and gets denser and therefore sinks.	1	

Qn			Answer	Marks	Remarks
			The water in the warmer region is less dense and therefore rises. (This sets up a convection current.)	1	
	(b)		Any 2 of the 6 differences listed in the textbook.	2	
	(c)		The liquid molecules **at the surface** gained enough energy from other liquid molecules to **overcome attractive forces of the other molecules/break the bonds between molecules or to separate them and** (atmospheric pressure) to escape into the atmosphere. As the molecules escapes into the atmosphere, the mass of the remaining liquid decreases.	1 1	
	(d)		Conduction Particles (atoms) at the bottom of the hot water container (hot end) vibrate more rigorously and collide with its neighbouring particles (atoms). This causes the thermal energy (heat) to be transferred to the ice.	1 1	1 m is awarded if students show an understanding of the molecular vibration mechanism.
	(e)		Students comment that it takes 16 000 s to fully freeze water at 20°C while it takes only 14 000s to fully freeze water at 40°C. This verified the Mempha effect. *(If students only describe the freezing segment, 1m is awarded)* Time taken to freeze water at 40°C is 14000-4000 = 10000 s Time taken to freeze water at 20°C is 16000-2800 = 13200 s This verified Mempha effect.	1 1 1	To accept reading to half the smallest division. No mark is awarded if student comment on the rate of cooling or only compare the cooling segment of the curve.
12 E	(a)		**Ohm's law states that the current passing through a metallic conductor is directly proportional to the potential difference** across it, provided that **physical conditions remain constant.** • Straight line (constant gradient) • Passes through the origin	1 1 1	
	(b)		$3/0.4 = 7.5\ \Omega$	1	Students to choose any convenient pair of points (V, I) to determine R.
	(c)		$7.5 = \rho\ (0.012)/[\pi(3.38 \times 10^{-3}/2)^2]$ $\rho = 5.61 \times 10^{-3}\ \Omega m$	1 1	ecf
	(d)	(i)	Series circuit, current through both components is the same (0.60 A). Both components have a p.d. of 4.5 V each from the graph. Total emf = 4.5 x 2 = 9.0 V	1 1	
		(ii)	Parallel circuit, currents through each component adds up to 0.60 A.	1	

Qn			Answer	Marks	Remarks
			At 3V, I through R is 0.40 A and I through T is 0.20 A. Total current is 0.60 A.	1	
12 O	(a)		$R=2.4\ (0.012/9\times10^{-6})$ $=3200\Omega$	1 1	
	(b)		$P = V^2/R$ $0.125 = V^2/3200$ $V = 20V$	1	
	(c)		Total resistance of connection $(1/6400 + 1/6400)^{-1} = 3200\ \Omega$ Power rating of connection $(0.125 \times 4) = 0.50$ W p.d. across each resistor remains at 20 V which is within the maximum safety limit.	1 1 1	
	(d)	(i)	$R = \rho l/\pi(d/2)^2$ $R \propto l/d^2$ $R_Y = ½\ R_X$ 1m awarded for correct substitution of $A = \pi(d/2)^2$ 1m awarded if students showed that R is proportional to l/d^2.		Full mark is only awarded if students derived at the desired relationship.
		(ii)	Series circuit, current is constant. Method 1: Using $P = I^2R$ I constant, $R_Y < R_X$ $P_Y < P_X$ Method 2: Using $P = IV$ Since R_X is larger, p.d across X is larger. Since I is constant for both X and Y. $P_Y < P_X$	 1 1 1	Deduct 1 m if student uses voltage instead of p.d.