NAME		REG. NO.		CLASS	

SERANGOON GARDEN SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2016

Subject: PHYSICS (SPA) REVISED

Paper: 5059 / 1

Level: SECONDARY FOUR EXPRESS

Date: 22 AUGUST 2016 (MONDAY)

Time: 1115 – 1215 HRS

Duration: 1 HOUR

INSTRUCTIONS TO CANDIDATES

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your full name, register number and class on the Optical Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

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 Optical 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.

Name/Signature of Parent/Guardian _____ Date _____

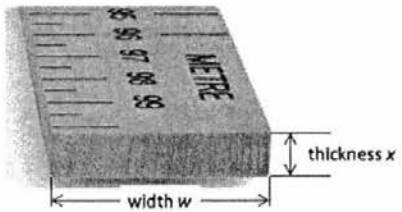
FOR MARKER'S USE
40

This question paper consists of 16 printed pages and 1 blank page.

Setter : Mr David Yee **Vetter: Mdm Ong Jiat Hwee**

[Turn over

1 In an experiment, the width w and the thickness x of a metre rule are to be measured as precisely as possible using normal laboratory apparatus.



Which combination of instruments is most appropriate for these measurements?

	measurement of w	measurement of x
A	half-metre rule	half-metre rule
B	half-metre rule	vernier calipers
C	vernier calipers	half-metre rule
D	vernier calipers	micrometer screw gauge

2 What is a reasonable estimate for the volume of a wooden metre rule found in a school laboratory?

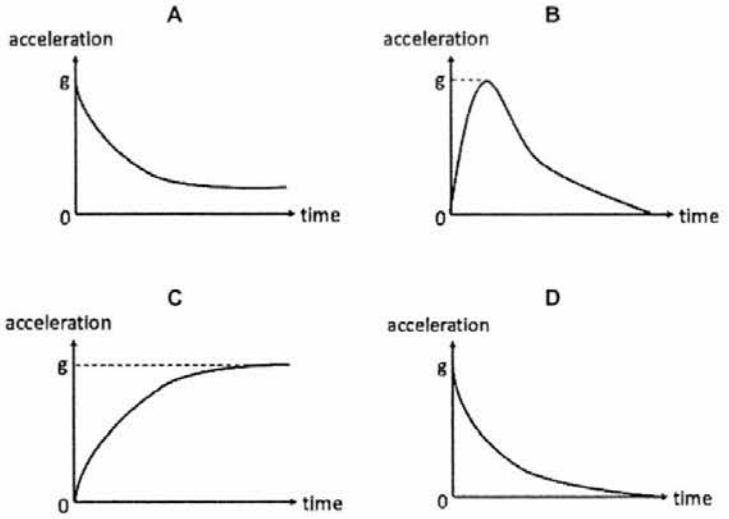
A 1.5 cm^3
B 15 cm^3
C 150 cm^3
D 1500 cm^3

3 A car accelerates uniformly from rest along a level road. The effects of air resistance on the car are negligible. The car travels 12 m in the time between 1 s and 2 s after starting.

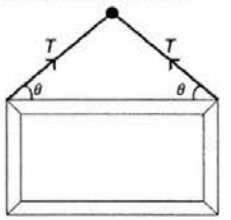
How far does it travel in the time between 3 s and 4 s after starting?

A 28 m
B 35 m
C 48 m
D 64 m

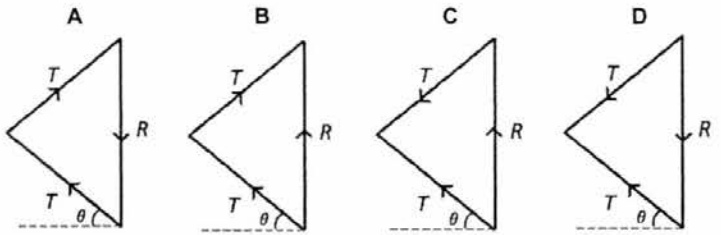
4 An object is dropped from a great height so that air resistance becomes significant. Which graph shows how its acceleration varies with time?



5 A picture frame is hung by a cord from a nail.



Which vector triangle represents the resultant R of the two tension forces T in the cord?



6 A racing car and the driver (excluding fuel) has a mass of 500 kg. It decelerates from a speed of 50 ms^{-1} to 30 ms^{-1} on a straight level road. The brakes exert a fixed retarding force of 7000 N. The time needed for the car to decelerate is t_1. When the car carries a full load of 130 kg of fuel, the time needed for the car to decelerate is t_2.

What is the difference in the times $(t_2 - t_1)$?

A 0.37 s
B 0.56 s
C 0.93 s
D 1.43 s

7 While on the moon, an astronaut gives a horizontal push to a 20 kg object, which is hanging freely. What would be the difference in effort needed on the moon compared with the effort needed on Earth?

A It is easier to push the object on the moon than on Earth.
B It is more difficult to push the object on the moon than on Earth.
C It requires no effort to push the object on the moon.
D It requires the same effort to push the object both on the moon and on Earth.

8 An experiment is done to determine the density of iron.
The mass of 10 identical iron ball bearings is 32.0 g.
A measuring cylinder contains 30.0 cm^3 of water. When 20 identical iron ball bearings are immersed into the water, the reading on the water level rises to 38.0 cm^3.

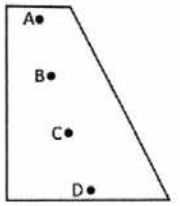
What is the density of iron?

A 8 kgm^{-3}
B 842 kgm^{-3}
C 4000 kgm^{-3}
D 8000 kgm^{-3}

9 Which of the following about weight is correct?

A The weight of an object depends only on its size.
B Weight can change and depends on the object's location.
C The densest object is the heaviest.
D Weight depends on the gravitation field strength only.

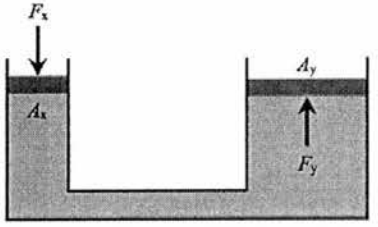
10 The centre of gravity of an object of uniform thickness is determined on Earth and on the Moon. The Moon has a gravitation field strength one-sixth that of Earth.



What is the centre of gravity (c.g.) on Earth and on the Moon?

	c.g. on Earth	c.g. on Moon
A	B	B
B	C	B
C	C	C
D	D	C

11 Which of the following shows the correct relationship between F_x and F_y and the cross sectional areas A_x and A_y in the hydraulic system shown below?



A $F_x = F_y$
B $F_x A_x = F_y A_y$
C $F_x A_y = F_y A_x$
D $F_y = \frac{A_x}{A_x + A_y} F_x$

12 At the Earth's surface, an atmospheric pressure of 1 atmosphere is able to hold up a column of mercury 76 cm in height. The density of mercury is 13600 kgm^{-3}.

What would be the height of the atmosphere above the mercury responsible for this pressure? Assume that the atmosphere has a constant density of 1.2 kgm^{-3}.

A 860 m
B 8600 m
C 86 000 m
D 860 000 m

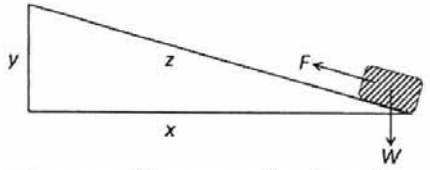
13 The function of many machines is to change energy from one form to another as efficiently as possible. Which machine is 100% efficient?

A A car engine as it converts chemical energy to kinetic energy
B An electrical heater in a kettle as it converts electrical energy to heat
C A lamp as it converts electrical energy to light
D A rocket as it converts chemical energy to gravitational potential energy

14 An electric motor hauls a cage of mass 400 kg up a mine shaft through a vertical height of 1200 m in 2.0 minutes. 20% of the total power output is used in overcoming friction, and 80% is used in raising the cage. What is the total power output of the motor?

A 4.0 kW
B 5.0 kW
C 40 kW
D 50 kW

15 A mass of weight *W* rests on a rough slope of dimensions *x*, *y* and *z* as shown.



A force *F* pushes the mass all the way up the slope. The mass starts and finishes at rest. How much work is done by the force *F*?

A *Fz*
B *Wy*
C *Wz*
D *Wy* + *Fz*

16 Brownian motion may be observed if smoke particles in a container of air are viewed through a microscope. Why are smoke particles used?

A The smoke particles and air molecules are in continuous motion.
B The smoke particles are light enough to be moved by the air molecules.
C The smoke particles are in continuos random motion while air molecules are stationary.
D The smoke particles are constantly bombarding against the walls of the smoke cell.

17 A fixed mass of gas is slowly compressed to reduce its volume. The temperature of the gas is kept constant. Which of the following describes the collisions between the gas molecules and the container walls?

A higher frequency and same velocity
B higher frequency and higher velocity
C lower frequency and same velocity
D lower frequency and higher velocity

18 Two bodies are in thermal equilibrium. Which condition **must** apply?

A Their heat capacities are equal.
B Their internal energies are equal.
C They are at the same temperature.
D They emit and absorb electromagnetic radiation at the same rate.

19 What is the purpose of painting the surface of a vessel containing flammable petroleum silver?

A Minimize heat loss by radiation
B Minimize heat gain by radiation
C Minimize heat loss by conduction
D Minimize heat gain by conduction

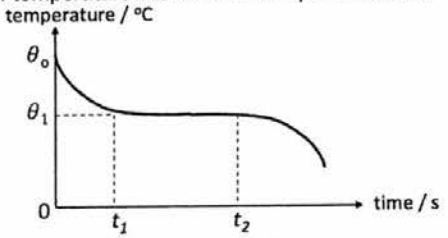
20 A thermometer uses a special type of mercury that varies at two different rates. Between 0 °C and 100 °C, the length of mercury column varies by 20 cm. Between 100 °C and 200 °C, the length of mercury column varies by 10 cm. What is the change in length of the mercury column when the temperature changes from 20 °C to 180 °C?

A 24 cm
B 30 cm
C 32 cm
D 38 cm

21 An electric kettle contains 500 g of water at 15 °C. The specific heat capacity of water is 4.2×10^3 $Jkg^{-1}K^{-1}$. The heating element of the kettle is rated at 2.2 kW. What is the minimum time needed to raise the temperature of the water to 100 °C?

A 22 s
B 81 s
C 95 s
D 8.1×10^4 s

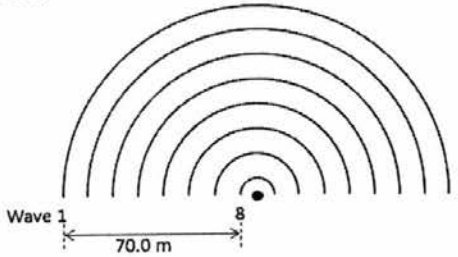
22 The variation of temperature with time for a liquid is shown.



Which of the following statements is correct?

A As the temperature does not change between t_1 and t_2, no heat is dissipated.
B Heat is dissipated only after t_2.
C The boiling point of the liquid is θ_1.
D At time t_2, the liquid has completely changed into a solid.

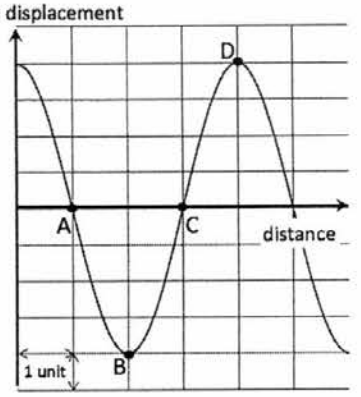
23 Circular waves were produced in a pond as shown. Waves 1 till 8 were produced in 10.0 s.



Which of the following statement correctly describes this wave?

A The longitudinal wave has a velocity of 7.0 ms^{-1}.
B The transverse wave has a wavelength of 8.8 m.
C The longitudinal wave has a period of 1.4 s
D The transverse wave has a frequency of 0.7 Hz.

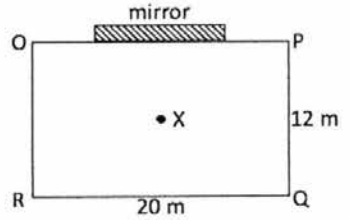
24 The graph shows the displacement of air particles from their equilibrium positions caused by a sound wave.



Which of the following correctly describe the compression, rarefaction and wavelength of this wave?

	compression	rarefaction	wavelength
A	A	C	4 units
B	B	D	8 units
C	C	A	4 units
D	D	B	4 units

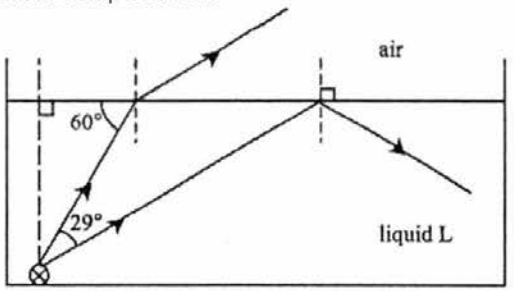
25 A plane mirror is to be installed along a wall OP in a rectangular room 20 m by 12 m.



What is the minimum width of the plane mirror on wall OP such that a person at X is able to see the entire wall QR?

A 6 m
B 10 m
C 12 m
D 20 m

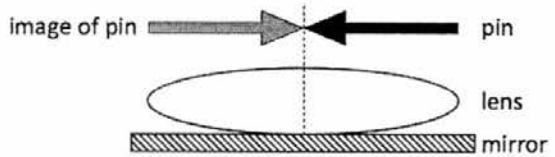
26 A lamp is placed at the bottom of a tank of a liquid L. The direction of two light rays from the lamp is shown.



What could be the refractive index of liquid L?

A 1.00
B 1.13
C 1.30
D 2.90

27 A converging lens of focal length *f* is placed on a mirror as shown in the diagram below. A pin is moved along the principal axis of the lens until there is no parallax between its image and itself.



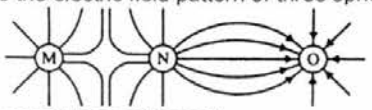
What is the distance of the pin from the optical centre of the lens?

A 0.5 *f*
B *f*
C 1.5 *f*
D 2.0 *f*

28 Which one of the following devices can operate without the use of electromagnetic waves?

A cell phone
B microwave oven
C electric fan
D television set

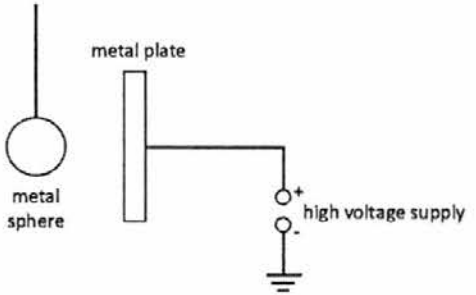
29 The disgram shows the electric field pattern of three spheres M, N and O.



What are the charges on these spheres?

	Sphere M	Sphere N	Sphere O
A	negative	negative	positive
B	positive	positive	negative
C	negative	negative	positive
D	negative	positive	negative

30 An uncharged light metal sphere is suspended from an insulating thread. The metal sphere is then brought to a metal plate as shown. The metal sphere is moved and touches the metal plate.



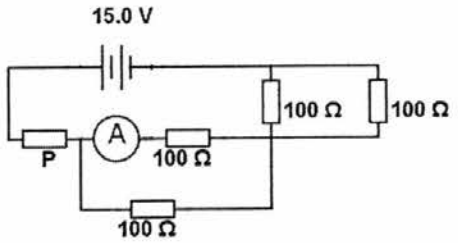
What happens after the sphere touches the metal plate?

A The metal sphere returns to its original position.
B The metal sphere remain attached to the metal plate.
C The metal sphere is displaced to the right towards the metal plate, but not touching it.
D The metal sphere is displaced to the left away from the metal plate.

31 Mobile phone manufacturers use batteries of various capacities. Their charging devices are also rated at different currents and voltages. Which mobile phone will require the least time to become fully charge?

	battery capacity /mAh	charger current rating /mA	charger voltage rating /V
A	1810	550	5.0
B	2070	770	5.0
C	2400	1200	5.1
D	3100	1500	3.85

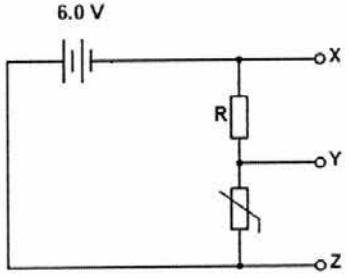
32 A circuit is set up as shown. The ammeter reading is 0.050 A.



What is the resistance of P?

A 50 Ω
B 100 Ω
C 150 Ω
D 300 Ω

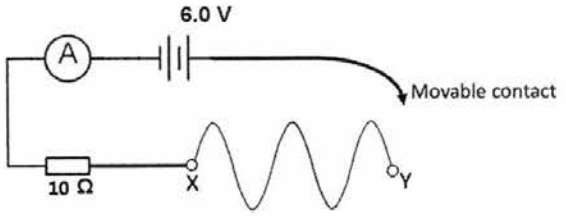
33 A circuit is set up as shown to switch on a heater when it gets too cold. The switch turns on when the voltage that it is connected to exceeds 3.0 V.



How should the switch be connected?

A across XY
B across YZ
C across XZ
D The circuit cannot be used here.

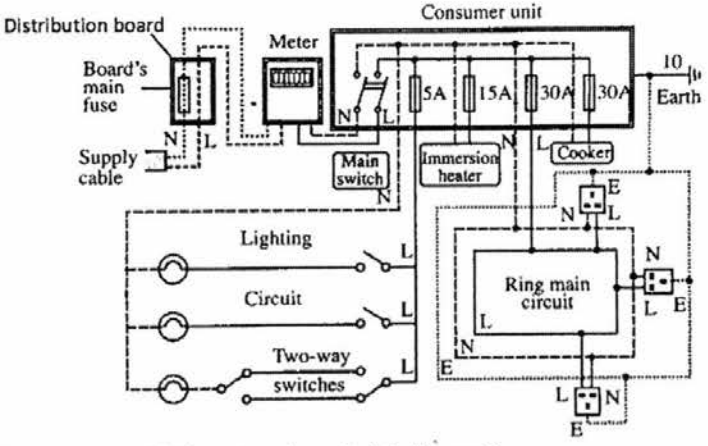
34 A 6.0 V battery, ammeter, 10 Ω resistor and a 2.0 m long resistance wire are connected in series as shown. When the movable contact is positioned at X, the ammeter reading is 600 mA. When the movable contact is at positioned at Y, the ammeter reading is 540 mA.



If the resistance wire has a diameter of 0.2 mm, what is the resistivity of the wire?

A $0.87 \times 10^{-8}\ \Omega m^{-1}$
B $1.75 \times 10^{-8}\ \Omega m^{-1}$
C $3.50 \times 10^{-8}\ \Omega m^{-1}$
D $1.80 \times 10^{-5}\ \Omega m^{-1}$

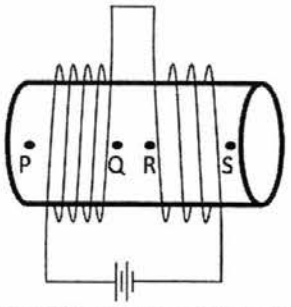
35 A domestic electrical distribution diagram is shown.



What is wrong with the setup shown in this diagram?

A The lighting circuit have too few connections for an average home.
B The ring main circuit fuse rating should be 13 A.
C The main fuse in the distribution board is not installed correctly.
D The two way switches are wired incorrectly.

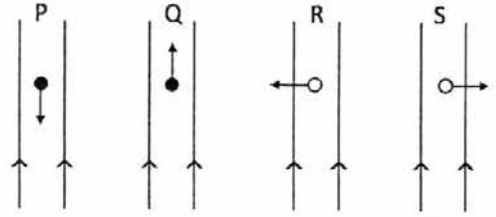
36 A wire is coiled around a soft iron core as shown. A steady current is passed through the wire. P, Q, R and S are four points on the inside of the solenoid.



Which row indicates a possible direction of the magnetic field due to the current?

	P	Q	R	S
A	←	←	→	→
B	←	→	←	→
C	→	→	←	←
D	→	←	→	←

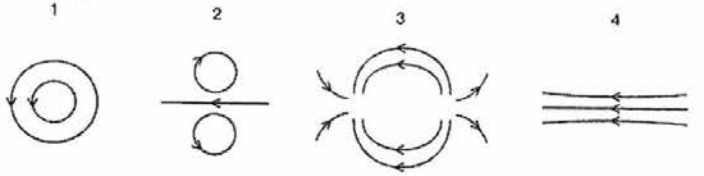
37 Charged particles experience forces in an electric field. Current-carrying wires can experience a force in a magnetic field. In the diagram, P and Q show the forces *F* acting on charged particles in an electric field. R and S show the forces *F* acting on current-carrying wires in a magnetic field.



Which row correctly identifies the charged particles and direction of the currents in the wires?

	charge on P	charge on Q	current in R	current in S
A	positive	negative	into the page	out of the page
B	positive	negative	out of the page	into the page
C	negative	positive	into the page	out of the page
D	negative	positive	out of the page	into the page

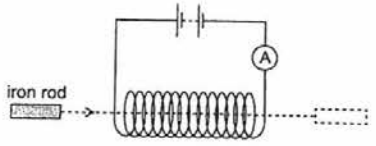
38 Four magnetic fields are shown.



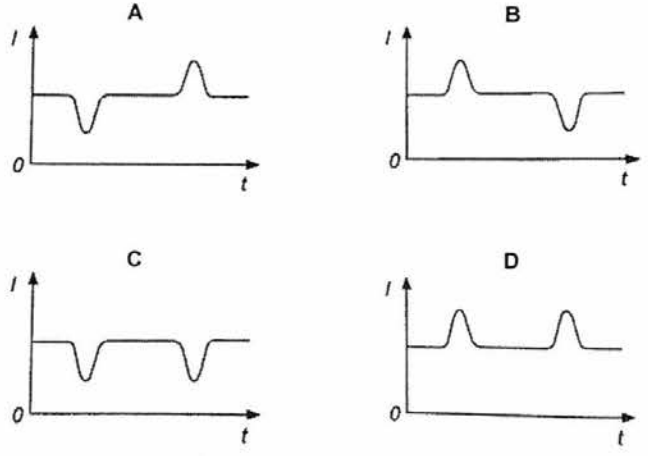
Which is the correct order for objects to match these fields?

	1	2	3	4
A	flat circular coil	bar magnet	solenoid	long straight wire
B	flat circular coil	solenoid	bar magnet	long straight wire
C	long straight wire	flat circular coil	bar magnet	solenoid
D	long straight wire	solenoid	bar magnet	flat circular coil

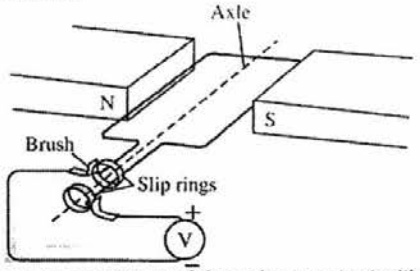
39 A solenoid with a large number of turns of wire is connected in series with an ammeter and a battery.



An iron rod is passed through the solenoid at constant speed.
Which graph shows the variation with time *t* of the reading *I* of the ammeter?

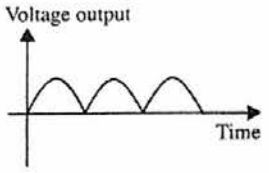


40 A simple generator consists of a rectangular coil mounted on an axle which is fixed between the poles of permanent magnet. The coil is rotated in an anti-clockwise direction.

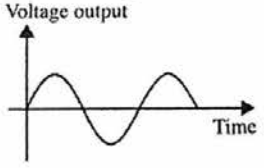


Which graph shows the variation of the voltage output with time as the coil is rotated from the position shown?

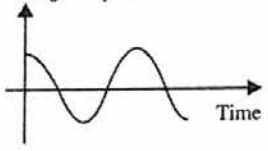
A



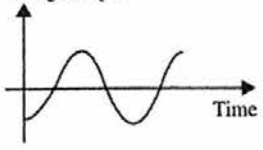
B



C



D



[End of Paper]

NAME		REG. NO.		CLASS	

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Time: 1030 – 1215 HRS

Duration: 1 HOUR 45 MINUTES

INSTRUCTIONS TO CANDIDATES

Write your name, register number and class in the spaces provided at the top of this page.
Write in dark blue or black ink.
You may use a HB pencil for any diagrams or graphs.
Section A: Answer **ALL** the questions in the spaces provided.
Section B: Answer **ALL** the questions in the spaces provided. Question 10 has a choice of parts to answer.

All quantitative answers should include appropriate units.
The use of an approved scientific calculate is expected, where appropriate.
All working are to be shown in a clear and orderly manner.

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

INFORMATION TO CANDIDATES

Unless otherwise stated, take gravitational field strength g as 10.0 N/kg.

Name/Signature of Parent/Guardian _____ Date _____

FOR MARKER'S USE
80

This question paper consists of 19 printed pages and 1 blank page.

Setter : Mr David Yee **Vetter: Mdm Ong Jiat Hwee**

Section A
Answer **ALL** the questions in this section.
Unless otherwise stated, the gravitational field strength is 10 Nkg^{-1}.

1 A student takes measurements to determine the acceleration of a ball as it rolls down a slope. The setup is as shown in Fig. 1.1.

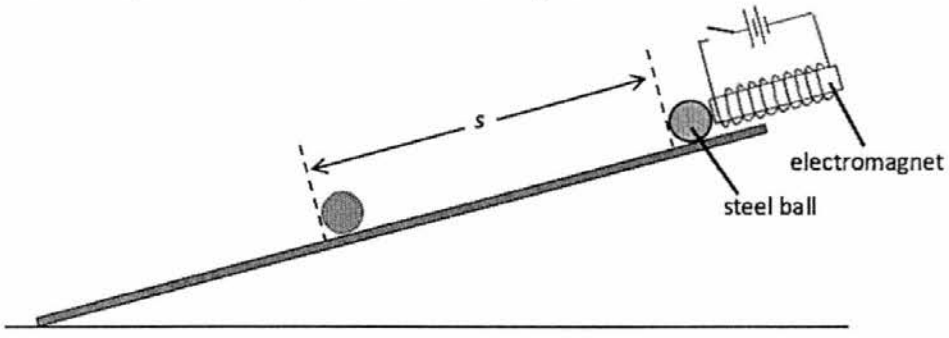


Fig. 1.1

(a) The student measures the time t for the ball to roll a distance s down the slope. An accurate value for the average time t is obtained.

Describe how s and t can be accurately obtained.

.....

.....

.....

.....

.....

.....

..... [3]

(b) Fig. 1.2 shows a graph of distance s against t^2.
It is assumed that the distance s is related to t by the following relationship:

$$s = \tfrac{1}{2} a t^2$$

where a = acceleration of the ball

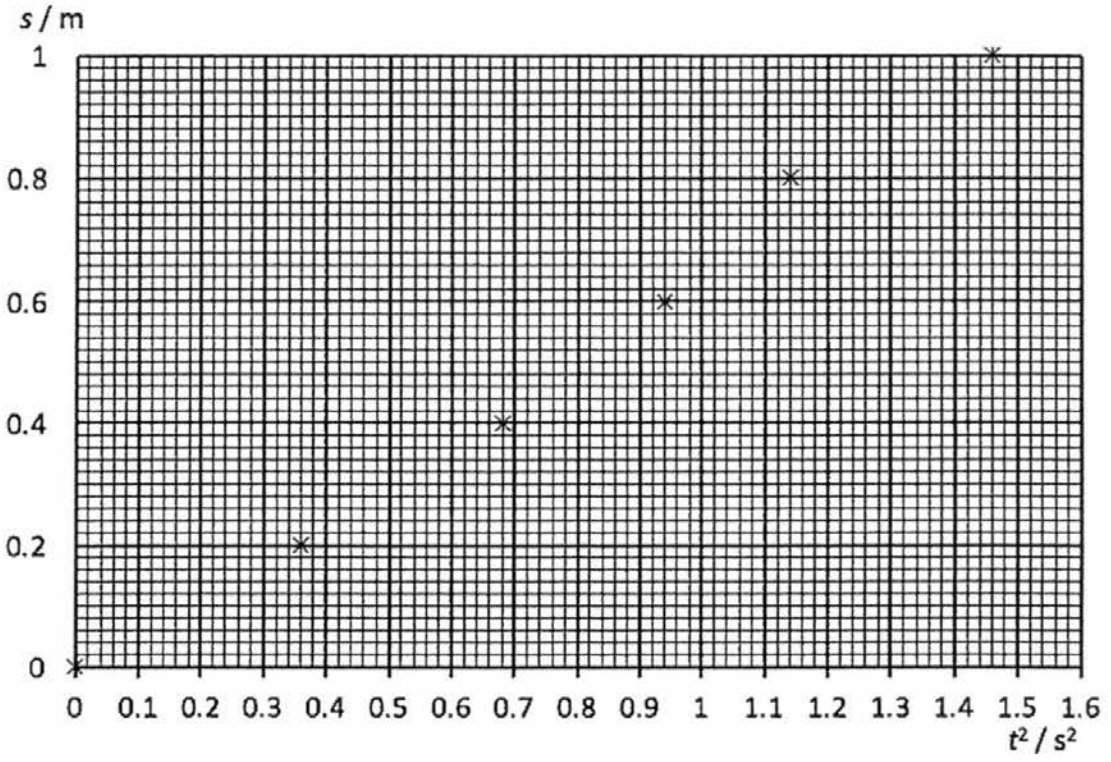


Fig. 1.2

(i) Draw a line of best fit for the data points on Fig. 1.2. [1]

(ii) Use Fig. 1.2 to determine a value for the acceleration of the ball down the slope.

acceleration = ... [3]

(iii) State why, by drawing a line of best fit for the data points on Fig. 1.2b, the effect of error is reduced.

.....

..... [1]

2 A gondola, shown in Fig. 2.1, is a traditional, flat-bottomed Venetian rowing boat. When fully loaded, the gondola has a mass of 1200 kg and becomes partially submerged under water to a depth of h. An area of 8.50 m^2 of the gondola is submerged under water.

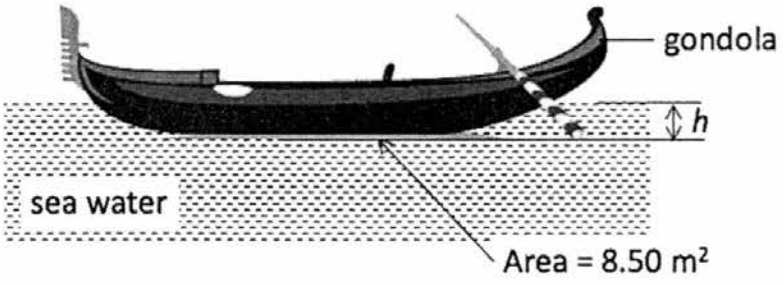


Fig. 2.1

(a) On Fig. 2.1, draw **two** arrows to show the directions of the forces on a stationary and fully loaded gondola. Label these two forces. [1]

(b) Determine the pressure exerted by the fully loaded gondola on the sea water.

pressure = ... [2]

(c) Given that sea water has a density of 1.025 gcm^{-3}, determine h.

h = ... [2]

(d) Fig. 2.2 shows an unloaded gondola being lifted out of the sea water by two ropes. The gondola remains horizontal and travels vertically upwards at a constant speed after leaving the water. The weight of the gondola is 3.5 kN. The tensions in the ropers 1 and 2 are T_1 and T_2 respectively.

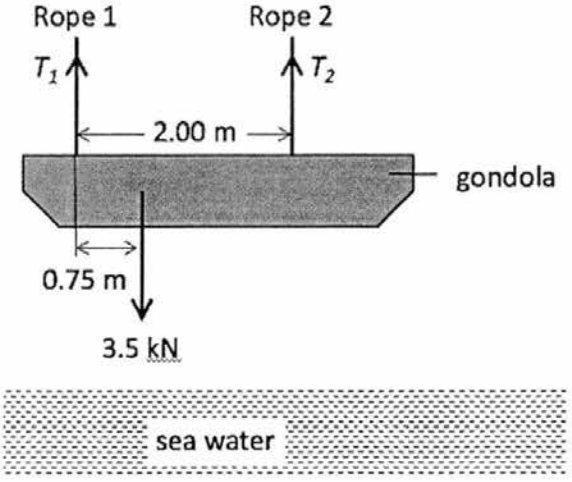


Fig. 2.2

(i) The position of the centre of gravity of the gondola is not at its midpoint. Suggest what this implies about the distribution of mass in the gondola.

.....

..... [1]

(ii) Use the principle of moments to determine the tensions in the two ropes.

T_1 = ...

T_2 = ... [3]

3 Properties such as the speed of sound and density of ethanol-water mixtures are of concern in applications such as the calibration of ultrasound imaging machines.

For one particular calibration, pure ethanol of density 0.7890 gcm^{-3} is added to 535.0 cm^3 of pure water of density 1.000 gcm^{-3} to obtain 800.0 cm^3 of ethanol-water mixture of density 0.9555 gcm^{-3}.

(a) Define ultrasound.

.....

..... [1]

(b) Determine the volume of pure ethanol used to obtain 800 cm^3 of ethanol-water mixture.

volume of pure ethanol = ... [3]

(c) Fig. 3.1 shows the setup used to determine the speed of sound in the ethanol-water mixture.

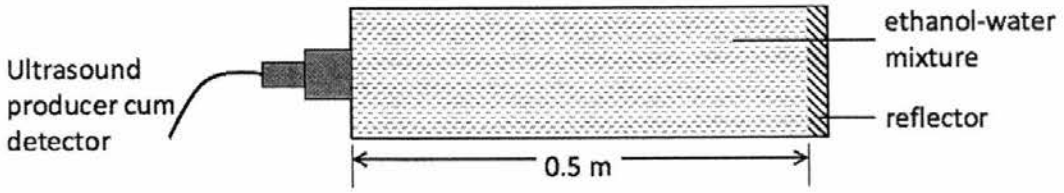


Fig. 3.1

The ethanol-water mixture is placed in a tube. The tube consists of a sound producer and detector on one end, and a sound reflector at the other end. An ultrasound ping is produced and the detector picks up two signals as shown in Fig. 3.2.

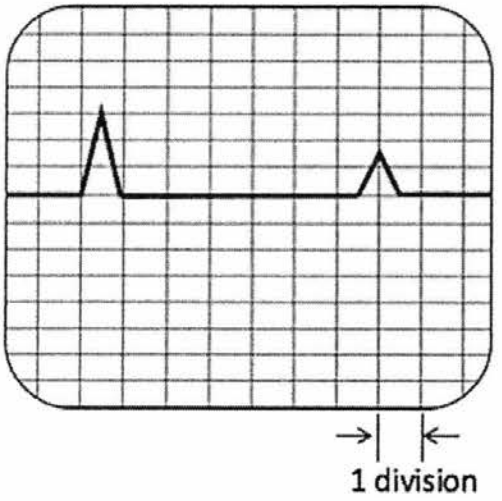


Fig. 3.2

(i) Explain why two signals are detected.

.....

..... [1]

(ii) The time-based setting on the detector is 0.10 ms / division. Calculate the speed of sound in the ethanol-water mixture.

speed = ... [2]

(iii) Suggest why the setup does not work properly if the ethanol-water mixture contains bubbles of air.

.....

..... [1]

4 Energy can be defined as the ability to do work.

(a) Define *work* and state its SI unit.

.....

.....

..... [1]

(b) Calculate the work that can be done in each of the following situations.

In each case, state a possible object on which the work may be done and also explain how the law of conservation of energy can be applied.

The first situation is an example of how the question can be answered.

Situation	Numerical value of the work that can be done	On what object is the work done?	Application of the conservation of energy
Car A car of mass 1200 kg stopping (without skidding) from a speed of 30 ms^{-1}	Kinetic energy $= ½ mv^2$ $= ½ (1200)(30^2)$ $= 540\ 000$ J	Work is done on the brakes.	Almost all the kinetic energy is converted to thermal energy.
Hot air balloon A hot air balloon of mass 800 kg descending from an altitude of 1500m to ground.	[1]	[1]	[1]
Battery A battery of e.m.f. 12.0 V pushing a total charge of 800 C through an electric drill.	[1]	[1]	[1]

5 Fig. 5.1 shows an object, O, placed in front of a thin converging lens. A ray of light from the top of the object when reaching P on the lens is refracted as shown. (Note: M is **not** the focal length of this lens.)

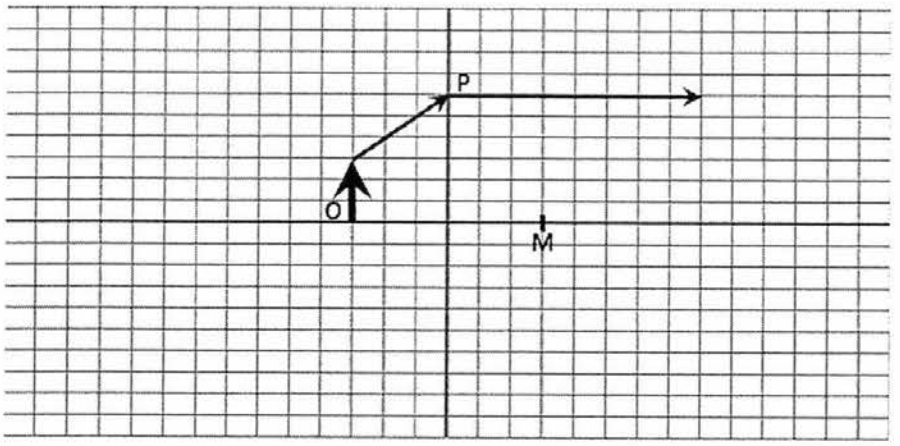


Fig. 5.1
(drawn to scale)

(a) On Fig. 5.1, draw **two** more rays from object O to locate the image of O. [2]

(b) Define the term focal length.

.....

..... [1]

(c) State the focal length of this lens.

focal length = ... [1]

(d) The lens is replaced by another lens who principal focus is at M. State an application of this setup.

.....

..... [1]

6 Fig. 6.1 shows a 200 V house electrical circuit. Lamps 1, 2 and 3 are connected in the circuit. A person switches on these three lamps in sequence.

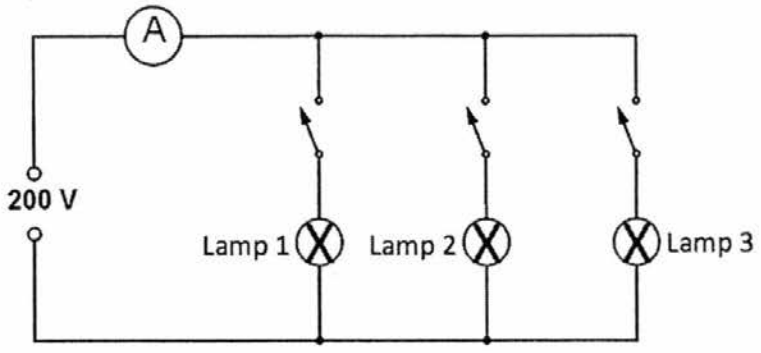


Fig. 6.1

An ammeter connected in the circuit shows that the current to the lamp 1 alone is 0.50 A. When both lamp 1 and 2 are switched on, the current is 1.70 A. When all three lamps are in use, the current is 8.70 A.

(a) Calculate the resistance of the lamp 3.

resistance = ... [2]

(b) Calculate the combined resistance of all three lamps.

resistance = ... [1]

(c) Calculate the weekly cost of electricity if all three lamps are in use at the same time for 90 minutes each day. The cost of electricity is $0.20 per kWh.

cost = ... [2]

(d) A fuse is added to the circuit. Draw on Fig. 6.1 the position where the fuse can be placed. [1]

(e) Explain the use of the fuse that is added to the circuit. Suggest a suitable fuse rating.

.....

..... [2]

7 Fig. 7.1 shows a coil of insulated wire tightly wound on a non-magnetic tube to make a solenoid.

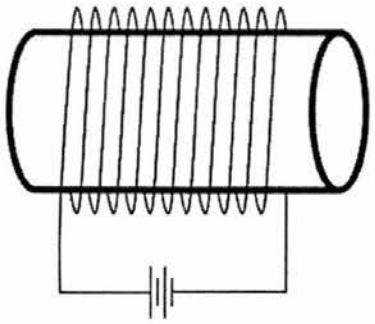


Fig. 7.1

(a) On Fig. 7.1, draw the pattern of the magnetic field inside and around the solenoid. Use arrows to show the direction of the field inside the solenoid. [2]

(b) A U-shaped stiff wire ABCD is inserted into the solenoid as shown in Fig. 7.2. When in use, there is a turning effect on the stiff wire caused by a current in BC.

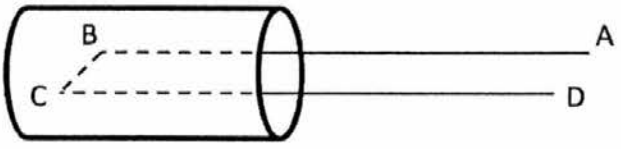


Fig. 7.2

(i) Explain why the current in BC causes a turning effect.

.....

.....

.....

..... [2]

(ii) Explain why currents in AB and CD do not contribute to the turning effect.

.....

..... [1]

Section B

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

Answer only one of the two alternative questions in **Question 10**.

8 A student uses the circuit in Fig. 8.1 and setup in Fig. 8.2 to determine the specific heat capacity of a liquid. The resistor is used as a heater and the thermistor is used as to measure the temperature of the liquid. The voltmeter connected between A and B has infinite resistance. The battery has an e.m.f. of 24.0 V. The resistors each have a resistance of 2.4 Ω. The variation with temperature of the resistance of the thermistor is shown in Fig. 8.3.

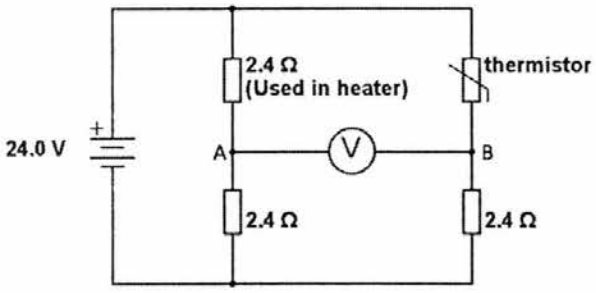


Fig. 8.1

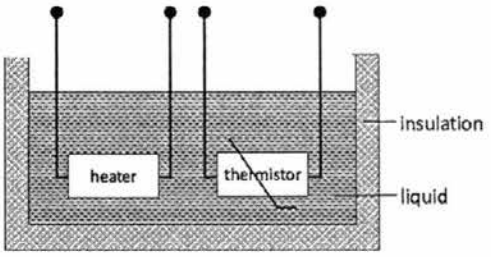


Fig. 8.2

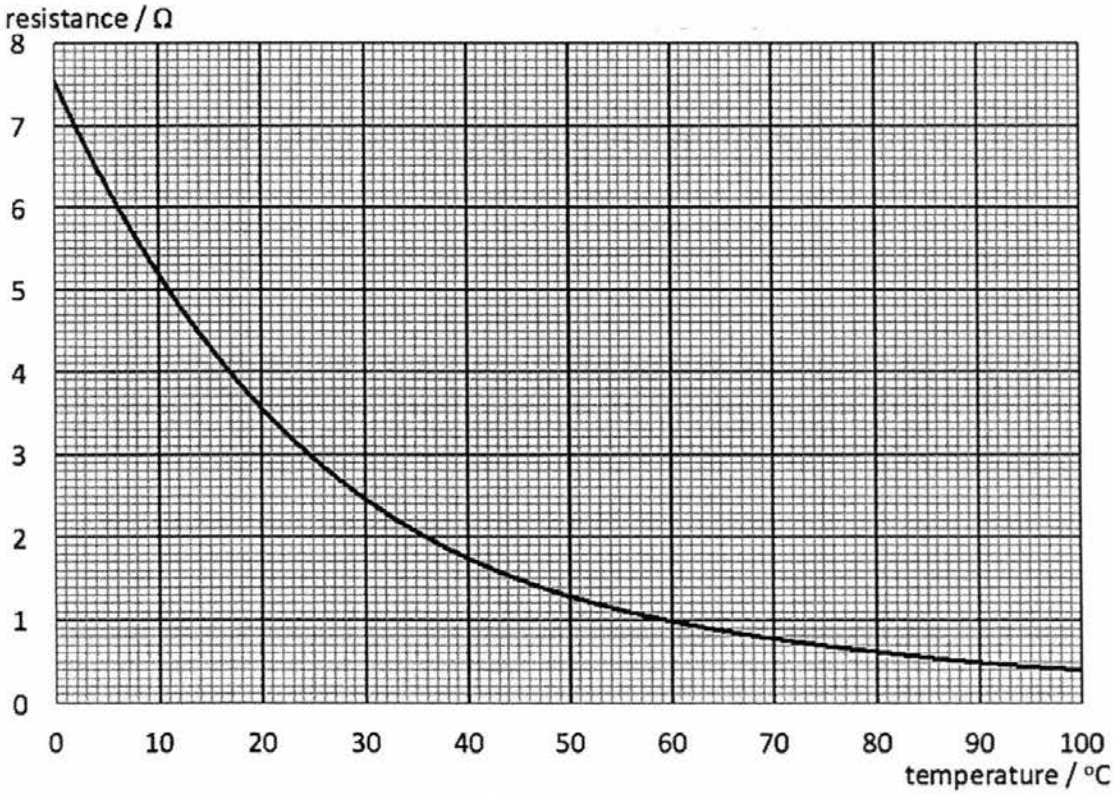


Fig. 8.3

(a) Using Fig. 8.3, determine the temperature at which the voltmeter reads zero.

temperature = ... [2]

(b) The mass of the liquid is 140 g. The temperature of the liquid changes from 25 °C to 45 °C in 210 s.

(i) Calculate the power of the heater.

power = ... [3]

(ii) Calculate the specific heat capacity of the liquid.

Specific heat capacity = ... [2]

(c) Suggest with a reason, if the specific heat capacity calculated in **b(ii)** will be larger or smaller than the actual specific heat capacity.

.....

.....

..... [2]

(d) Using Fig. 8.3, suggest, with a reason, why the thermistor, when used as a thermometer, is more suited to measuring temperatures from 0 – 20 °C than from 80 – 100 °C.

.....

.....

..... [1]

9 Fig. 9.1 shows an ideal transformer.

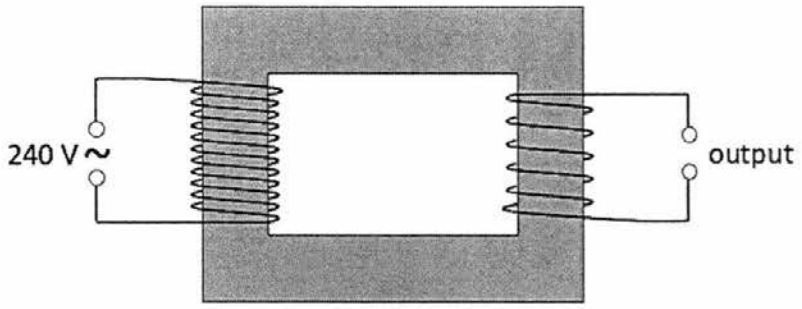


Fig. 9.1

The maximum input potential difference is 240 V. The maximum output potential difference is 9.0 V. There are 260 turns of wire on the secondary coil.

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

.....

.....

..... [1]

(b) Calculate the number of turns on the primary coil.

number of turns = ... [1]

(c) The output is connected to a bulb rated 12 W 9 V. Calculate the current drawn from the input supply.

current = ... [2]

(d) Explain why real transformers becomes hot when in use.

.....

.....

..... [1]

(e) To minimise this heat, suggest, with a reason, if thick or thin wires should be used in the primary coil and secondary coil.

.....

.....

.....

..... [2]

(f) Suggest a disadvantage to your selection in **(e)**.

.....

.....

..... [1]

(g) Sufficient cooling is required to maintain the efficiency and life expectancy of the transformer. One method is a liquid-immersed cooling. Fig. 9.2 shows a cutaway view of a transformer that uses liquid-immersed cooling.

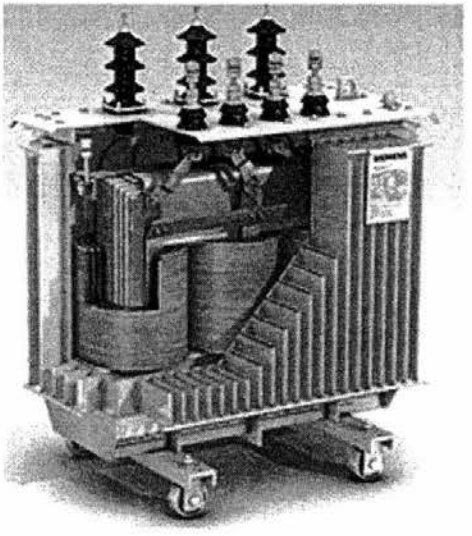


Fig. 9.2

With reference to Fig. 9.2, explain how sufficient cooling is provided.

.....

.....

.....

.....

..... [2]

EITHER

10 (a) The Traffic Police deploys new portable speed laser cameras to detect vehicle speeds of moving vehicles. The laser works at a wavelength of 905 nm.

(i) State the electromagnetic spectrum this 905 nm laser operates at.

..... [1]

(ii) Suggest a reason why X-rays are not used in the speed cameras.

.....

..... [1]

(iii) An expressway has a speed limit of 90 kmh^{-1}. A car travels on the expressway exceeds the speed limit by 54 kmh^{-1}. A police car parked at the side of the expressway gives chase 6 s after the car passes. The police car has a maximum speed of 216 kmh^{-1} and a maximum acceleration of 1.5 ms^2. Determine the time needed for the police car to catch up with the car.

time = ... [3]

(b) Fig. 10.1 shows a simplified diagram of the motor.

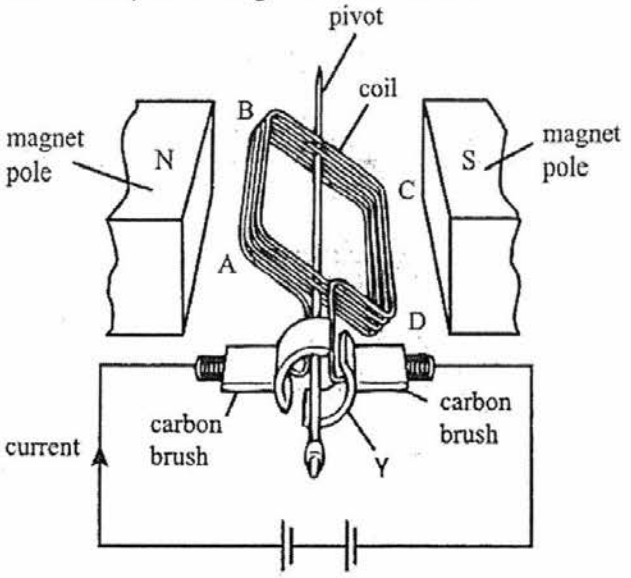


Fig. 10.1

The gap between the two halves of part Y is sufficiently wide that a carbon brush can only touch one half of part Y at any time. This protects the circuit. It also means that sometimes the motor will not start when switched on.

The coil is rotated by vertical forces that act downwards on side AB and upwards on side CD. These forces create a moment that varies as the coil turns.

(i) State the name and function of part Y.

.....

.....

..... [2]

(ii) Explain why the carbon brushes must not be allowed to touch both halves of part Y at the same time.

.....

..... [1]

(iii) Explain why sometimes the motor does not start when switched on, even if there is no friction.

.....

.....

.....

..... [2]

OR

10 A longitudinal sound wave is travelling through a gas, causing collisions of gas molecules.

(a) Explain what is meant by a *longitudinal wave*.

.....

..... [1]

(b) Explain what is meant by the *speed of the wave*.

.....

..... [1]

(c) The gas molecules, each of mass 5.3×10^{-26} kg are vibrating at a frequency of 835 Hz and an amplitude of vibration of 610 nm. The variation with time t of the vibrational kinetic energy E_k of a molecule is shown in Fig. 10.2. The maximum value of E_k is 2.71×10^{-31} J.

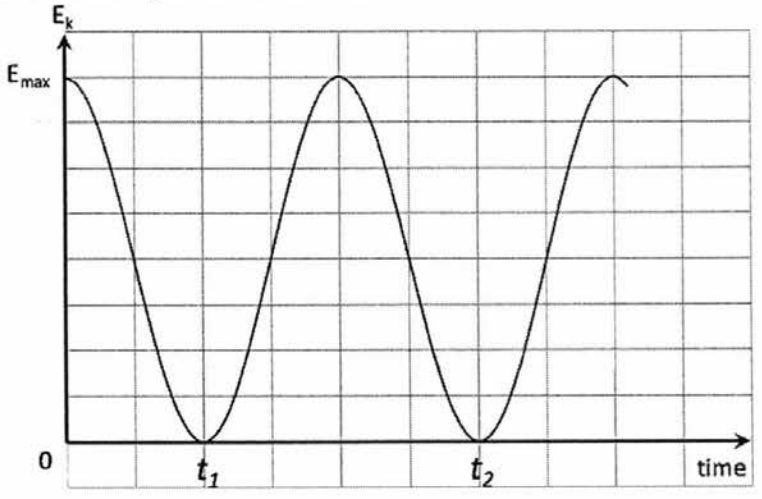


Fig. 10.2

(i) Determine the time interval $(t_2 - t_1)$.

time = ... [1]

(ii) Determine the maximum speed of a gas molecule.

speed = ... [2]

(iii) Determine the wavelength of the sound wave.

wavelength = ... [2]

(d) With reference to the speed of sound in a gas at room temperature, comment on the maximum speed of a gas molecule in c(ii).

.....

.....

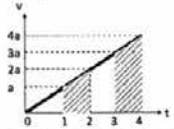
..... [2]

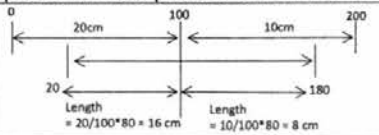
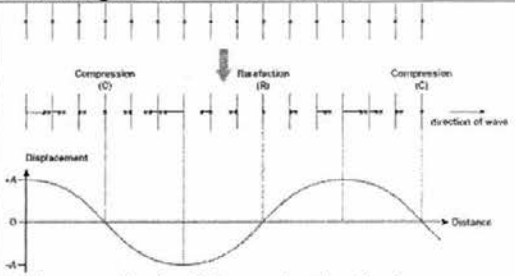
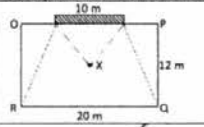
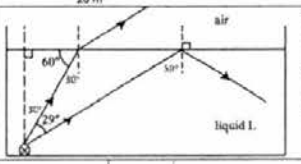
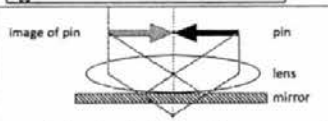
(e) State the origin of the energy of this sound wave.

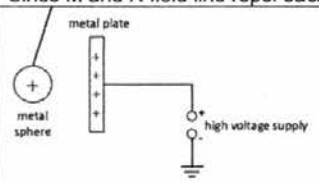
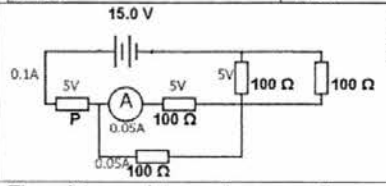
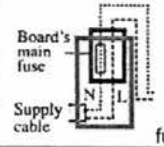
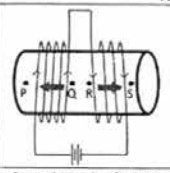
..... [1]

[End of Paper]

ıte: DAY MONTH 2016
ırmat: Paper 1 (40 MCQ) @ 1 hour

uestion	Answer	Explanation
1.	D	Typical metre rule width = 3 cm can be measured to precision of Vernier calipers (0.01cm) Typical metre rule thickness = 0.5 cm can be measured to precision of micrometer screw gauge (0.001cm)
2.	C	Typical metre rule: length = 100cm; width = 3 cm; thickness = 0.5 cm Volume = 100 x 3 x 0.5 = 150 cm^3
3.	A	Using v = u + at, since u = 0, v = at  distance from 1s to 2s = ½ (a + 2a)(1) = 12 a = 8 ms^{-2} distance from 3s to 4s = ½ (3a + 4a)(1) = 3.5 x 8 = 28 m
4.	D	At initial, no air resistance. Hence acceleration = g. Terminal velocity is reached because of 'great height' and 'significant' air resistance. Hence acceleration = 0.
5.	B	B: R is upwards based on the two tension forces. R is opposite to weight of the frame (downward force) A: R is wrong direction. C & D: Tension in wrong direction.
6.	A	Since F = ma, a = $\frac{v-u}{t} = \frac{F}{m}$ $t = \frac{m(v-u)}{F} = \frac{m(50-30)}{7000}$=0.00285m Difference in time $(t_2 - t_1)$ = 0.00285 (130) = 0.37 s
7.	D	Same mass (inertia) on Earth and Moon. Thus same horizontal force (push) is needed.
8.	D	Mass of one iron ball bearing = 32/10 = 3.2 g = 3.2 x 10^{-3} kg Volume of one iron bearing = (38.0 – 30.0)/20 = 0.4 cm^3 = 4 x 10^{-7} m^3 Density = mass / volume = 3.2 x 10^{-3} kg / 4 x 10^{-7} m^3 = 8000 kgm^{-3}
9.	B	W = mg. Weight depends on both m and g; and g is dependent on position. Here, weight is independent of size and density.
10.	C	CG is independent whether it is on moon and Earth. CG is towards the larger base.
11.	C	Pressure = $\frac{F}{A} = \frac{F_x}{A_x} = \frac{F_y}{A_y}$ $F_x A_y = F_y A_x$
12.	B	Pressure by air on mercury = pressure by mercury $(hpg)_{air} = (hpg)_{Hg}$ h_{air} (1.2) = 0.76 (13600) h_{air} = 8613 m
13.	B	When converting electrical energy to heat in a kettle, 100% of the heat energy generated is efficient.
14.	D	Power to raise the cage = work done / time = GPE / time = mgh / time = (400)(10)(1200) / (2)(60) = 40 kW Total power of motor = 40 kW / 0.8 = 50 kW
15.	A	Work done = Force (F) x distance moved by object (z) = Fz Here, the work done is not equal to gain in GPE (Wy)
16.	B	Air molecules are constantly bombarding the smoke particles. The smoke particles need to be light enough for the effects to be observed.
17.	A	Same temperature = same velocity Smaller volume = more collisions
18.	C	Thermal equilibrium = no net transfer of thermal energy = same

		temperature
19.	B	Both the light colour and the shine make the vessel a poor absorber and good reflector of radiant heat. The intention is to reduce the heat gain by radiation that may raise the temperature of the vessel making the petroleum more prone to combustion or explosion.
20.	A	 Length = 20/100*80 = 16 cm Length = 10/100*80 = 8 cm
21.	B	Q = Pt = mcT 2200 t = (0.5)(4200)(100-15) t = 81 s
22.	D	A & B: Heat is dissipated throughout the cooling curve. C: Graph shows cooling of a liquid. θ_1 is freezing point.
23.	D	Water waves are transverse waves. 7 waves = 70 m = 10 s 1 wavelength = 10 m = 1.4 s = 0.7 Hz.
24.	A	 A: Compression (particles coming together) C: Rarefaction (particles moving apart) Wavelength = 2x AC = 4 units B & D represent maximum displacement from equilibrium position, not compression or rarefaction.
25.	B	 A mirror of half the width of OP is needed.
26.	C	 Finding n from critical angles: n = 1/sin c At 30°, n = 1/sin30 = 2 At 59°, n = 1/sin59 = 1.16 Hence n is between 1.16 and 2.00
27.	B	 The light rays from the pin at the focal plane pass through the convex lens and emerges as parallel rays. The parallel incident rays are then reflected at the plain mirror to form parallel reflected rays. The convex lens converges the parallel reflected rays and forms a real image at the focal plane, at the same distance from of the lens as the object.
28.	C	Cell phone uses radio waves, microwave oven uses microwaves and a television set uses light rays; whereas a fan can operate with just a power

		supply, an electrical circuit and a fan blade attached to an electric motor
29.	B	Field lines from positive to negative. O is negative. N is positive. Since M and N field line repel each other, M is positive.
30.	D	 The metal sphere becomes positively charged on contact with the positively charged metal plate. Since like charges repel, the light metal sphere is displaced to the left away from the heavier metal plate.
31.	C	Q = It (independent of V) Battery Capacity /mAh (Q) | Current Rating /mA (I) | Time / h (t = Q/I) 1810 | 550 | 3.29 2070 | 770 | 2.96 2400 | 1200 | 2.00 3100 | 1500 | 2.06
32.	A	 V= IR 5 = 0.1 R R = 50 Ω
33.	B	Thermistor: resistance decreases [increases] as its temperature increases [decreases]. When temperature is low, the resistance of the thermistor increases. Thus its voltage also increases. This will result in the increase of voltage output across the thermistor, and switches on the heater.
34.	B	When movable contact is at X, I = 0.6A, $V_{10\,\Omega\ resistor}$ = 6V and V_{wire} = 0 When movable contact is at Y, I = 0.54A, $V_{10\,\Omega\ resistor}$ = 5.4V and V_{wire} = 0.6V R_{wire} = V/I = 0.6 / 0.54 = 1.111 Ω R = pL/A P = RA/L = $(1.111)(\pi)(0.1\times10^{-3})^2$ / 2 = 1.75×10^{-8} Ωm^{-1}
35.	C	 fuse on neutral (instead of live)
36.	A	
37.	D	An electric field exerts a force in the same direction as that of the field of a positive charge. Direction of current can be found using Fleming's left hand rule.

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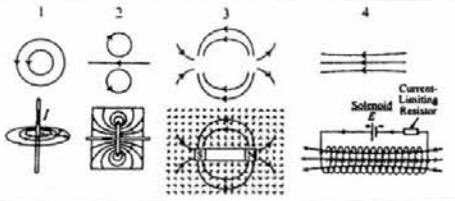
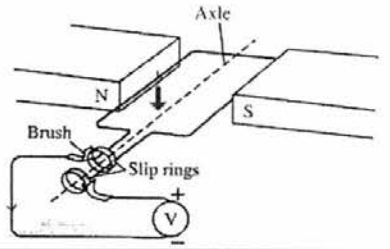
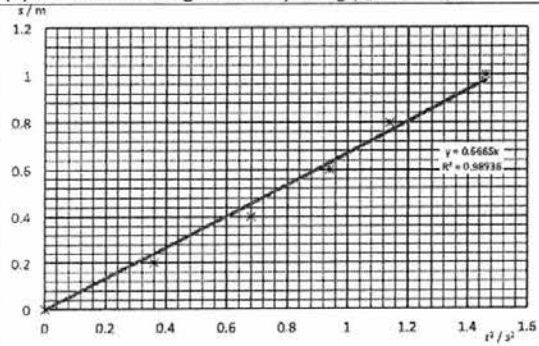
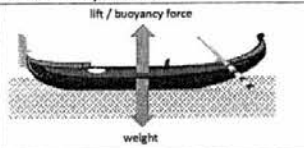
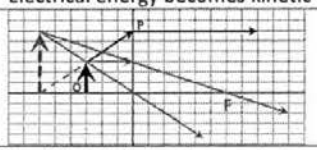
38.	C	
39.	A	When iron enters the solenoid, the magnetic flux linkage in the solenoid increases and decreases when it leaves. From Lenz's law, the induced emf opposes the change in the magnetic flux linkage. Hence, induced emf first decreases and then increases.
40.	D	

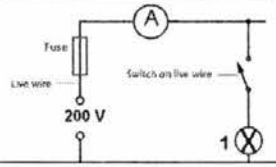
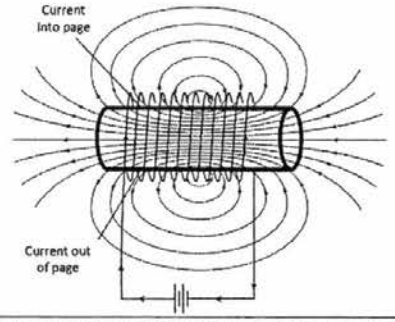
SGS_Physics / 4E / MYE_2016

ıte: DAY MONTH 2016
ırmat: Paper 2 (Section A: 50 marks; Section B: 30 marks) @ 1 hour 45 minutes

ıper 2: Section A [50 marks]

_ı	Explanation	Mark
1a	*s* is measured with a meter rule. (1) Switch on the electromagnet and attach the steel ball to the electromagnet. (2) Mark on the plank the edge of the steel ball. (3) Use the meter rule to mark a distance *s* on the other end of the plank. *t* is measured with a digital stopwatch. (4) Start the stopwatch as the electromagnet is switched off. (5) Stop the stopwatch as the edge of the steel ball reaches the marked distance *s* (6) Repeat Steps (1, 4 & 5) to obtain a total of 3 values of *t*. (7) Obtain an average time *t* by using $(t_1 + t_2 + t_3)/3$	0.5 0.5 0.5 0.5 0.5 0.5
1b(i)	 [1] for best fit line	1
1b(ii)	Given $s = ½ at^2$ Therefore, ½ a = gradient of best fit line = 0.6685 (+/- 10%: 0.60 to 0.735) a = 1.33 ms^{-2} (accept 1.20 – 1.47) (units need to be correctly specified)	1 1 1
1b(iii)	A line of best fit follows the trend of the data point by best fitting the spread of the data points.	1
2a		0.5 0.5
2b	Pressure = Force / Area = Weight / Area = mg / area = (1200)(10) / (8.5) = 1411 Pa	1 1
2c	Pressure of sea water (hpg) = Pressure by gondola (1411 Pa) h (1025)(10) = 1411 [note: density of sea water converted to 1025 kgm^{-3}] h = 0.14 m (13.7 cm)	 1 1
2d(i)	The mass of the gondola is not uniformly distributed such that the mass is more distributed to the left of the gondola. Hence, the weight acts towards the left of the gondola's midpoint.	0.5 0.5
2d(ii)	Taking moments about pivot at rope 1: ΣCM = ΣACM (3.5)(0.75) = T_2 (2)	 1

	T_2 = 1.3125 kN = 1.3 or 1.31 kN Resolving forces vertically, [or taking moments about pivot at rope 2] $T_1 + T_2 = 3.5$ $T_1 = 3.5 - 1.31 = 2.2$ or 2.19 kN	1 1
3a	Ultrasound are sound waves with frequencies higher than the upper audible limit of human hearing., i.e. 20 kHz.	0.5 0.5
3b	Density = mass / volume Mass of ethanol-water mixture = density x volume = 0.9555 x 800 = 764.4 g Mass of 535 cm^3 of pure water = 1.000 x 535 = 535 g Mass of pure ethanol = mass of mixture – mass of water = 764.4 – 535 = 229.4g Volume of pure ethanol = mass / density = 229.4 / 0.789 = 290.7 cm^3	 1 1 1
3c(i)	First signal belong to the initial ping from sound producer. Second signal belong to the reflected ping.	0.5 0.5
3c(ii)	From Fig. 1.2, time taken to detect reflected sound = 6.5 divisions = 0.65 ms Given speed = distance / time = (2 x 0.5m) / (0.65 x 10^{-3}) = 1540 ms^{-1}	1 1
3c(iii)	Any one: (1) Sound is reflected off the surfaces of bubbles at various lengths of the tube. This creates noise in the detection, reducing the strength of signal of reflection. (2) Sound travels at different speeds in air (~330 ms^{-1}) and liquid (1540 ms^{-1}). This results in a longer time to detect the reflected sound, and obtaining an inaccurate (and slower) speed of sound.	1
4a	Work done by a constant force is the product of the force and the displacement in the direction of the force. SI unit is joule.	0.5 0.5
4b	Hot air balloon: Work done = gravitational potential energy = mgh = (800)(10)(1500) = 1.2 x 10^7 J Work is done on the hot air balloon. GPE becomes kinetic energy of the hot air balloon.	 0.5 0.5 1 1
4b	Battery: Work done = electrical energy = EQ = (12.0)(800) = 9600 J Work is done on the electrons that are moved around the drill's electric circuit. Electrical energy becomes kinetic energy of the drill bit.	 0.5 0.5 1 1
5a	 dotted line from PO to principal axis to find focal length. Two rays (with arrows) from O to image Correct image (dotted)	0.5 1 0.5
5b	Focal length is the distance between the optical center of the lens and the principal focus	1
5c	6 units (3cm, need to verify from printed papers) (units required)	1
5d	Spotlight [object at principal focus: upright, virtual, enlarged image]	1
6a	Applying Kirchoff's law, current through lamp 3 = 8.70 – 1.70 = 7.00 A	1

	pd of lamp 3 = 200 V Applying V = IR, 200 = 7R. R = 28.6 Ω	 1
6b	V = IR 200 = 8.7R R = 23.0 Ω	 0.5 0.5
6c	Energy = Pt = IVt = (200)(8.7)(90/60)(7) = 18270 W = 18.27 kW Cost of electricity = (18.27)(0.2) = $3.65	1 1
6d	 fuse on live wire [0.5] (switch on live wire) fuse symbol drawn correctly [0.5]	0.5 0.5
6e	A fuse is a type of low resistance resistor that acts as a sacrificial device to provide overcurrent protection. It is a metal wire that melts when too much current flows through it, interrupting the circuit that it connects. Further damage by overheating or fire is prevented. Suitable rating: 10 A	1 1
7a	 Inside solenoid: correct magnetic field lines correct direction (arrows) Outside solenoid: correct magnetic field lines correct direction (arrows)	 0.5 0.5 0.5 0.5
7b(i)	When a current flows through BC, the current in wire produces a magnetic field that interacts with the magnetic field of the solenoid. As current in BC is perpendicular to the magnetic field of the solenoid, a magnetic force acts on BC. The direction of force can be determined by Fleming's Left Hand Rule.	1 1
7b(ii)	The direction of current in AB and CD is parallel to the magnetic field of the solenoid. Thus, no magnetic force acts on AB and CD.	1
8a	When voltmeter reads 0 V, potential at A = potential at B. Thus, resistance of thermistor = 2.4 Ω. From Fig. 8.3, when thermistor's resistance = 2.4 Ω, temperature = 30 °C (accept 31 °C).	 1 1
8b(i)	From Fig. 8.1, pd of heater = ½ (24) = 12.0 V Power P = $V^2/R = 12^2 / 2.4$ = 60 W	1 1 1
8b(ii)	Applying Q = mcΔT = Pt (0.140) (c) (45 – 25) = (60) (210) [140g converted to 0.140 kg] [ecf allowed] c = 4500 J kg^{-1} K^{-1} [correct units needed]	1 1 1
8c	Calculated c is larger than actual c.	0.5

	The setup in Fig. 8.2 is not covered by a lid. Some of the thermal energy supplied by the heater is lost to the surroundings through convection. Thus, more thermal energy was supplied than actually needed.	0.5 0.5 0.5
8d	In the range 0 – 20 °C, the rate of change of resistance (7.5Ω to 3.5Ω over 20°C) with respect to temperature is much larger compared to the range 80 – 100 °C (0.6Ω to 0.4Ω over 20°C)	1
9a	Faraday's law of electromagnetic induction: The magnitude of the induced emf is directly proportional to the rate of change of magnetic flux linkage.	1
9b	Applying $\frac{N_{secondary}}{N_{primary}} = \frac{V_{secondary}}{V_{primary}}$, $\frac{260}{N_{primary}} = \frac{9}{240}$ $N_{primary}$ = 6933 = 6930 turns [accept 6900]	0.5 0.5
9c	Assuming 100% efficiency, Power in primary coil = power in secondary coil = power of bulb $V_p I_p = V_s I_s$ = power of bulb $(240)(I_p) = 12$ $I_p = 12/240 = 0.050$ A	 1 1
9d	Any one [accept other reasonable explanations] Each time the magnetic field is reversed, a small amount of energy is lost due to hysteresis within the core. Iron core is a good conductor. Eddy current circulates within the core and causes resistive heating of the iron core.	1
9e	Thick wires have larger cross-sectional area. Given R = pL/A, thick wires have lower resistances than thin wires. Since heat loss = I^2R, thick wires experience less heat loss.	0.5 0.5 0.5 0.5
9f	Insulated thick wires would mean a longer coil than thin wires. This makes a larger transformer which requires more space and higher cost.	0.5 0.5
9g	Cooling is provided by: (1) convection by setting up convection currents between the coils & iron core and the surrounding liquid. (2) radiation to the surrounding through the walls and fins	 1 1
(Either) 10a(i)	Near infra-red [accept infra-red]	1
10a(ii)	X-rays are high energy radiation and could cause harm to the driver and user.	1
10a(iii)	To catch up with the speeding car, the police must travel the same distance as the car. Speed of car = 90 + 54 = 144 km/h = 40 m/s Speed of police car = 216 km/h = 60 m/s <u>Solving using speed-time graph</u> v = u + a t 60 = 0 + 1.5 (t - 6) t = 46 s Distance covered by police car = distance covered by speeding car ½ [(T – 46) + (T – 6)] (60) = (40)(T) T = 78 s Police car needs 78 – 6 = 72 seconds to catch up with the speeding car.	 1 1 1

9b(i)	Y: Split-ring commutator Y rotates together with the coil. It enables the electric motor to rotate in the same direction after half-turn by reversing the current in the loop.	1 1
9b(ii)	If the carbon brushes touch both halves of the split-ring, the current will bypass the coil and the circuit will be short-circuited.	1
10b(iii)	If the coil is at vertical position when the motor is turned on, the contact between the split-ring and the carbon brush is broken due to the gap. No current is delivered to the coil, so the motor does not turn.	1 1
(OR) 10a	A longitudinal wave is a wave in which the particles oscillate parallel to the direction of wave propagation.	1
10b	The speed of the waves means the distance travelled per unit time by a wave front of the wave.	1
10c(i)	Period T = 1/frequency = 1/835 = 1.20×10^{-3} s $t_2 - t_1 = T = 1.20 \times 10^{-3}$ s	 1
10c(ii)	Given $E_k = \frac{1}{2} mv^2 = 2.71 \times 10^{-31}$ J $\frac{1}{2} (5.3 \times 10^{-26}) v^2 = 2.71 \times 10^{-31}$ J $v = 3.2 \times 10^{-3}$ ms^{-1}	 1 1
10c(iii)	$v = f\lambda$ $3.2 \times 10^{-3} = 835 \lambda$ [allow ecf of v from (ii)] $\lambda = 3.8 \times 10^{-6}$ m	 1 1
10d	The speed of sound in air is 330 ms^{-1} (10^5 times the maximum speed). This means the sound wave moves relatively fast in the gas, whereas the gas molecules oscillates back and forth about their original positions with relatively small speeds.	1 1
10e	Energy of wave originates from the vibrational motion of the gas molecules.	1