REGENT SECONDARY SCHOOL
PRELIMINARY EXAMINATION 2024
SECONDARY FOUR (EXPRESS)

NAME: _____ INDEX NUMBER: _____

CLASS: _____ SETTER: MDM NOR RASIDAH

PHYSICS 6091/02

Paper 2 Theory **27 Aug 2024**

1 hour 45 minutes

Candidates answer on the Question Paper.
No Additional Materials are required

READ THESE INSTRUCTIONS FIRST

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

Section A
Answer **all** questions.
Write your answers in the spaces provided on the question paper.

Section B
Answer **one** questions.
Write your answers in the spaces provided on the question paper.

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

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

	TARGET
80	
PARENT'S SIGNATURE	

Section A [70 marks]

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

1 Fig. 1.1 shows the speed of a ball of mass 35 g falling through the air.

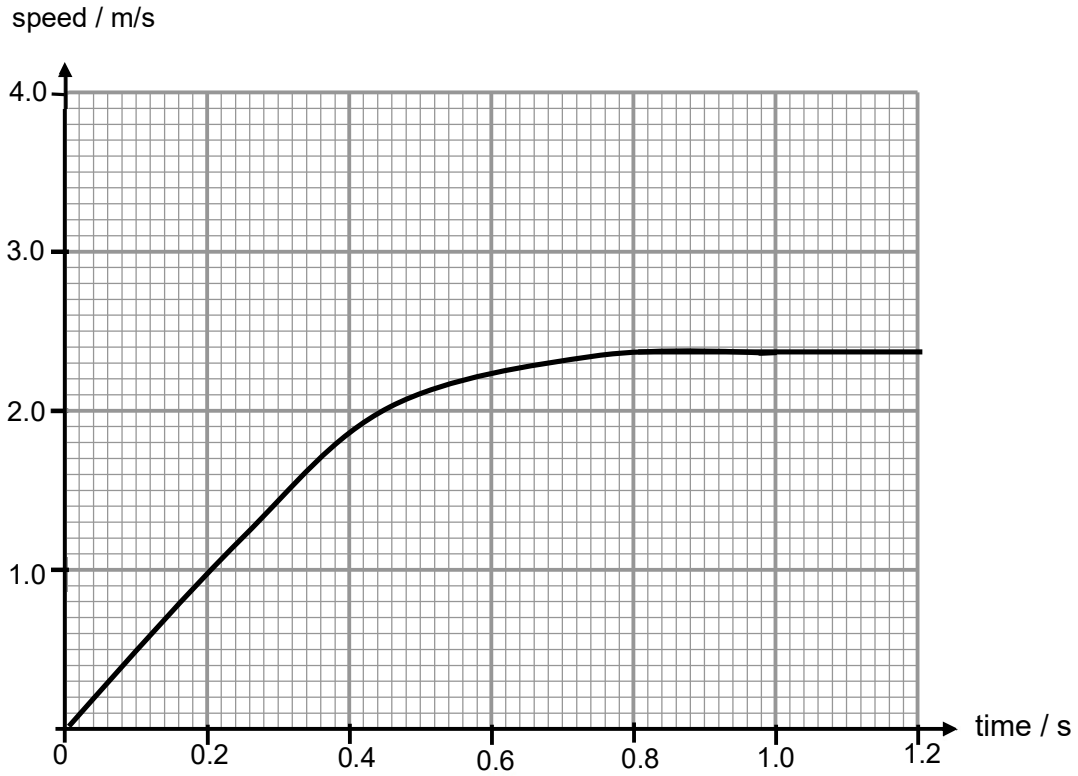

Fig. 1.1

(a) On Fig. 1.1, draw a graph to show the speed of the ball falling from rest in a vacuum. [1]

(b) Calculate the acceleration of the ball falling through the air at t = 0.20 s.

acceleration = ... [2]

(c) Calculate the resistive force at time t = 0.20 s.

resistive force = ... [2]

(d) State and explain the maximum resistive force acting on the ball as it falls through the air.

……

……

…….. [2]

2 A small metal sphere S is supported by an insulating string as shown in Fig. 2.1.

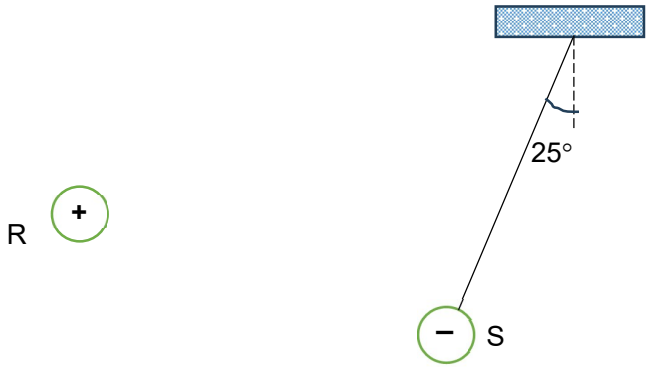

Fig. 2.1 (Not drawn to scale)

Sphere S has a negative charge while sphere R has a positive charge. Sphere S has a weight of 5.0×10^{-4} N and the tension of the string is 4.0×10^{-4} N.

(a) On Fig. 2.1 draw the electric field lines to represent the electric field in the region between R and S. [2]

(b) By the means of a vector diagram, determine the magnitude of the electric force acting on S. State the scale used.

scale: ……..

electric force = …….
[3]

3 Fig. 3.1 shows a worker carrying a ladder with a bucket hanged at one end. The ladder has a mass of 1.6 kg, and its centre of mass is 0.85 m from the worker's shoulder.

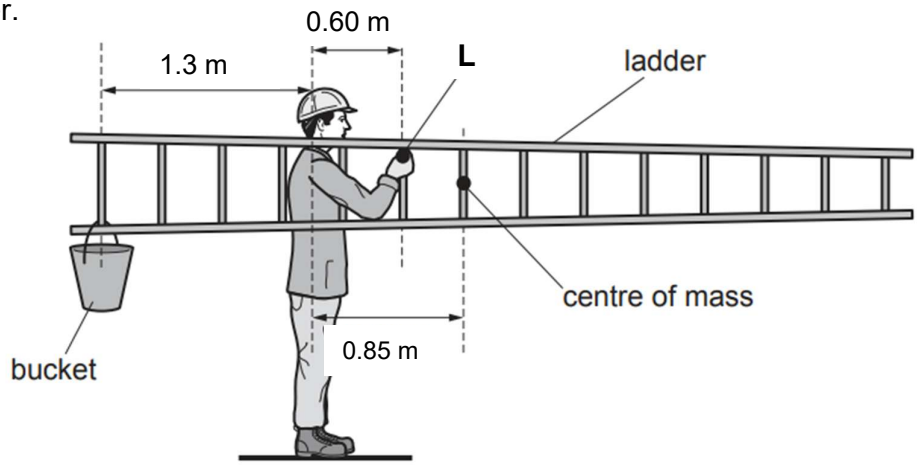

Fig. 3.1

(a) A bucket of weight 4.0 N is suspended from the ladder at a horizontal distance of 1.3 m from the worker's shoulder. The worker keeps the ladder horizontal by exerting a vertical force at point **L**. **L** is a horizontal distance of 0.60 m from his shoulder.

Determine the size and direction of the force exerted at **L**.

magnitude of force at **L** = ... N

direction of force **L** = ... [3]

(b) The ladder is wider at one end than at the other end.

Explain why this improves the stability of the ladder when it is being used.

.....

.....

..... [2]

4 Fig. 4.1 shows a bicycle pump.

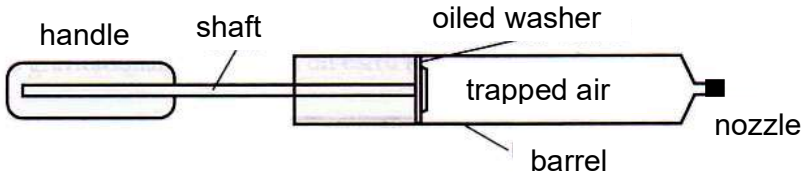

Fig. 4.1

(a) Explain in terms of molecular motion how the trapped air creates a pressure on the washer.

.....

.....

..... [2]

(b) The nozzle of the pump is connected to a manometer as shown in Fig. 4.2. and the handle of the pump is pulled to the left until the pressure of the trapped air is at 0.75×10^5 Pa.

Atmospheric pressure is 1.0×10^5 Pa and density of mercury is 13 600 kg/m^3.

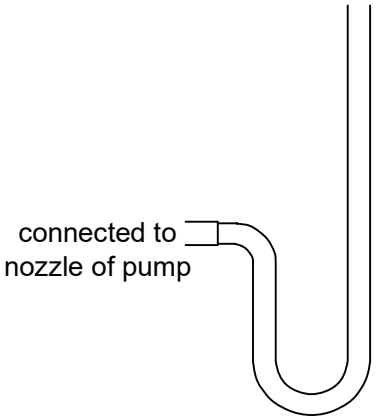

Fig. 4.2

(i) On Fig. 4.2, draw the level of the mercury in the manometer. [1]

(ii) Calculate the height difference between the mercury in the two sides of the manometer.

height difference = ... [2]

5 A water wave is travelling from left to right across the water surface of a pond at a speed of 24 cm/s.

Fig. 5.1 shows a snapshot of the wave at a certain moment. **R** and **S** are two water particles on the water surface. **R** makes 45 complete oscillations in one minute.

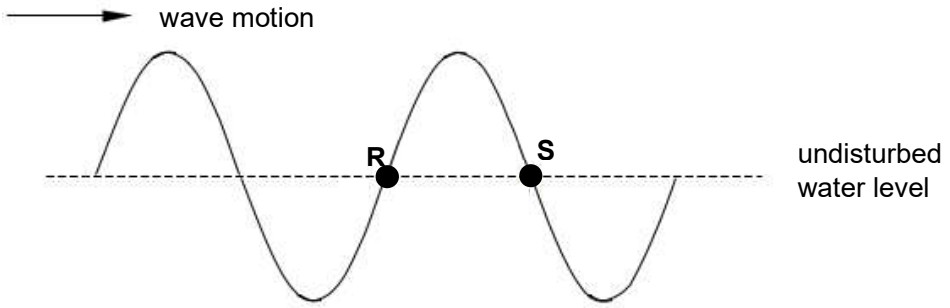

Fig. 5.1 (Not drawn to scale)

(a) State the type of wave generated. Explain your answer.

……..

……..

…….[2]

(b) Calculate

(i) the time taken for **R** to reach the highest point,

time taken = ……. [2]

(ii) the distance between **R** and **S**.

distance = ……. [2]

6 Fig. 6.1 shows a ray of light travelling from air into a prism made of diamond.

The refractive index of diamond is 2.4. The path of the ray is incomplete.

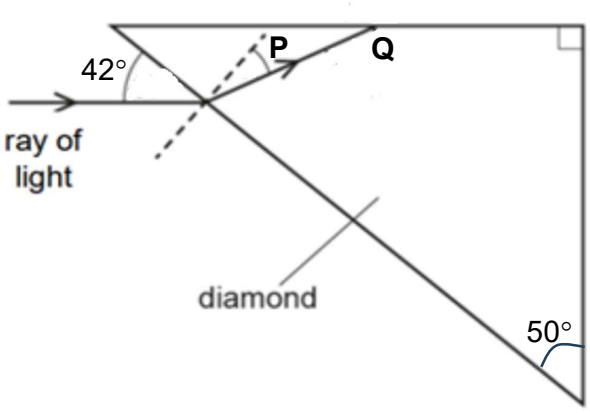

Fig. 6.1 (not drawn to scale)

(a) Calculate the speed of light in diamond.

speed of light in diamond = ... [2]

(b) Calculate angle **P**.

angle **P** = ... [2]

(c) Explain what is meant by critical angle.

.....

.....[1]

(d) Calculate the critical angle of diamond.

critical angle = ... [1]

(e) State and explain the path of the ray after it incident at point **Q**.

.....

.....

..... [2]

7 A 6.0 V battery of e.m.f. 6.0 V is connected to a network of resistors and a voltmeter, as shown in Fig. 7.1.

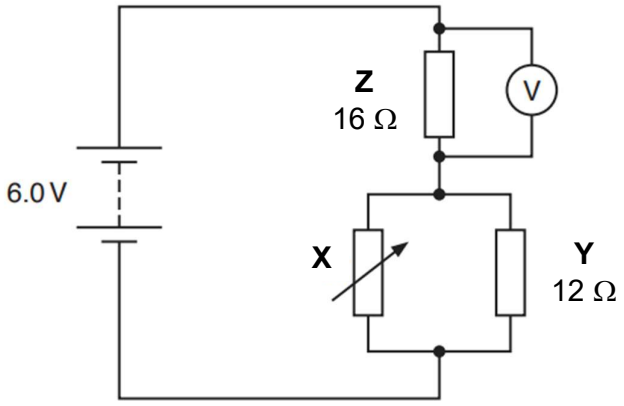

Fig. 7.1

Resistor **Y** has a resistance of 12 Ω and resistor **Z** has a resistance of 16 Ω. The resistance **X** of the variable resistor **X** is adjusted until the voltmeter reads 4.8 V.

(a) Calculate

(i) the current in resistor **Z**,

current = ... [1]

(ii) the total resistance of **X** and **Y** connected in parallel,

total resistance = ... [2]

(b) The resistance **X** is now decreased.

State and explain the change, if any, to the reading on the voltmeter.

.....

.....

..... [2]

(c) Resistor **Z** is replaced with a thermistor.

State and explain the change, if any, to the reading on the voltmeter when the surrounding temperature increases.

...

...

... [2]

8 A liquid contains some radioactive material is injected into the patient's blood stream. This radioactive material would be absorbed by the kidneys and then passed to the patient's bladder.

A special camera is used to detect the radiation coming from the patient's kidneys.

The half-life of four gamma sources W, X, Y and Z are listed in the Table 8.1.

Table 8.1

Radioactive Source	Half- life
W	2 min
X	5 min
Y	4 hours
Z	8 days

(a) The initial count rate of Y is 8000 counts per minute.

What is the count rate of Y after 24 hours?

activity = ……counts per min [2]

(b) The examination of the patient lasts for 15 minutes.

State and explain which radioactive source would be most suitable for the examination.

...

...[2]

(c) Radioactive materials that emits alpha particles are never injected into the body to obtain medical images of parts of the body.

State two reasons why alpha emitting materials are unsuitable.

……..

……[2]

(d) Protactinium-234 ($^{234}_{91}Pa$) is a radioactive isotope of protactinium that decays to uranium-234 ($^{234}_{92}U$).

Complete the equation: $^{234}_{91}Pa \rightarrow {}^{234}_{92}U +$ ……. [1]

9 A student uses the apparatus shown in Fig. 9.1 to conduct an experiment.

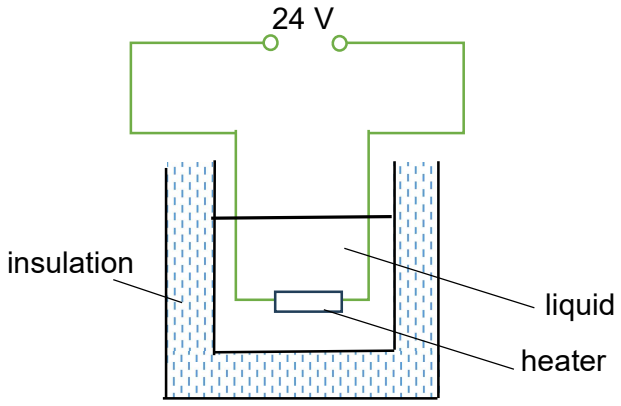

Fig. 9.1

A power supply of 24 V is connected to the heater of resistance 2.5 Ω. At t = 0 s, the mass of the liquid is 0.14 kg. At t = 250 s the temperature of the water is 100 °C.

Fig. 9.2 shows how the temperature of the water changes with time t.

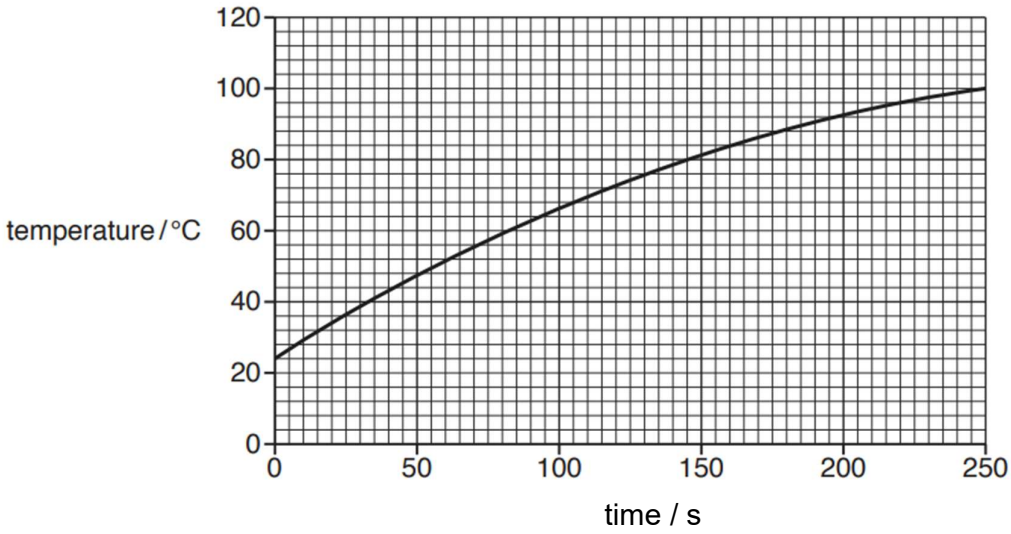

Fig. 9.2

The specific heat capacity of water is 4 200 J / (kg °C).

(a) Using Fig. 9.2, determine the increase in the internal energy of the water between t = 0 and t = 250 s.

increase in internal energy = ... [2]

(b) Calculate the amount of energy that is transferred electrically to the heater in the 250 s.

energy transferred electrically = ... [2]

(c) The heater provides a constant power supply to the water.

State and explain why the temperature increases in the manner shown in Fig. 9.2.

.....

.....

.....[2]

(d) When the temperature reaches 100 °C, the power supply is kept on.

State and explain, the observation about the temperature of water for the next 150 seconds.

.....

.....

.....[2]

(e) The insulation layers contain pockets of air.

Explain why these pockets of air reduces the energy transfer to the surrounding.

.....

.....

.....[2]

10 Fig. 10.1 shows a wind turbine. When the turbine turns, part of the energy in the kinetic store of the wind is transferred mechanically to the kinetic store of the motor blades of the turbine.

The blades of the turbine are 10 m long. On average, 18 000 kg of air, moving at a speed of 12 m/s, hit the blades every second.

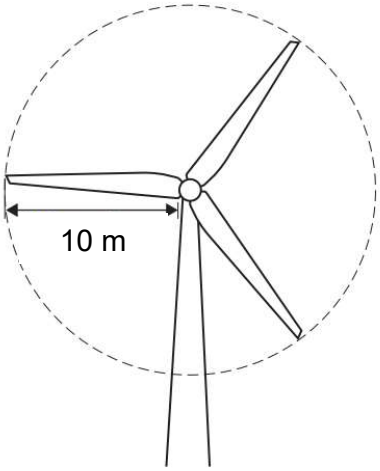

Fig. 10.1

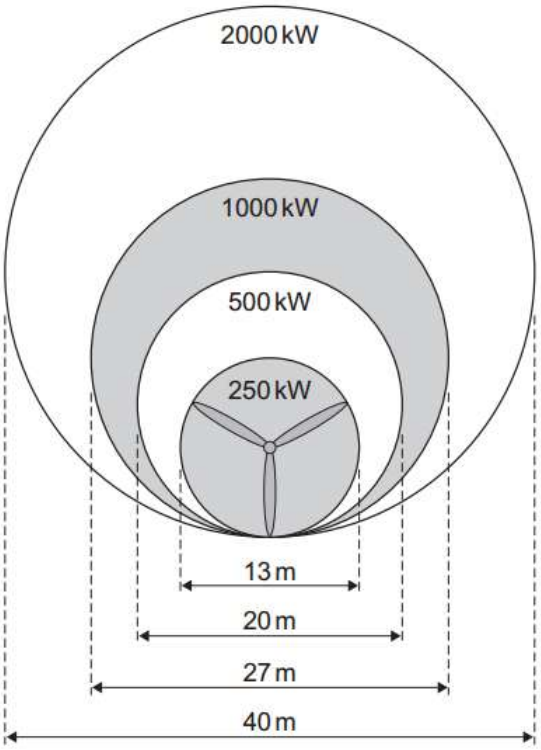

Fig. 10.2

Fig. 10.2 shows that, for the same wind speed, the power output of a turbine depends on the length of the turbine blades.

(a) Calculate the energy in the kinetic store of the air hitting the blades shown in Fig. 10.1 in each second.

energy in the kinetic store = ... [2]

(b) Use the information given, show that doubling the diameter of the blades, more than doubles the power output of a turbine.

……..

……..[2]

(c) Calculate the efficiency of the turbine with 10 metres long blades.

efficiency = ……[1]

(d) State a disadvantage of using wind turbines to produce electrical power.

……

……..…… [1]

(e) The wind turbine is connected to a generator as shown in Fig. 10.3. The turbine causes the coils in the generator to rotate.

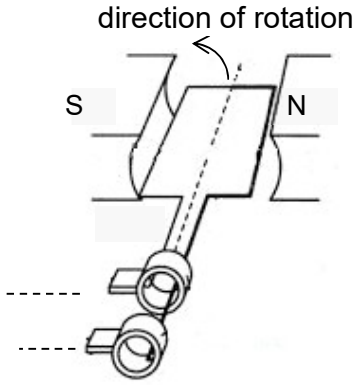

Fig. 10.3

Explain why an e.m.f. is induced in the coil when it rotates between the magnets.

……..……

……..……[1]

(f) The set-up in Fig. 10.4 shows another way in which an e.m.f. is induced in a coil. Fig. 10.5 shows the result after the magnet is released from a height.

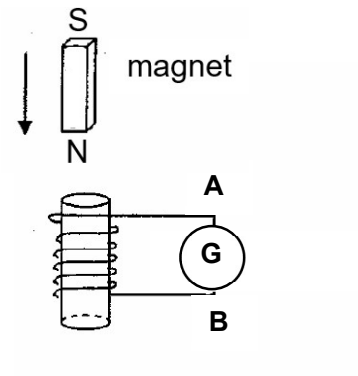

Fig. 10.4

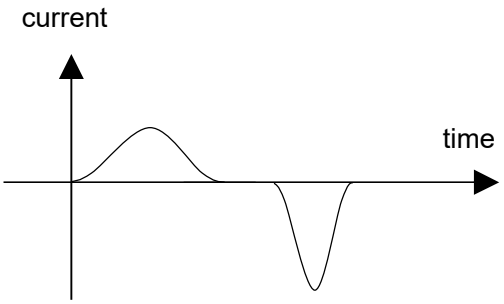

Fig. 10.5

(i) State the polarity induced at end **A** of the solenoid when the magnet enters the coil.

……[1]

(ii) Explain why the magnitude of the 'negative peak' is greater than that of the 'positive peak'.

……

……

……[2]

Section B [10 marks]
Answer one question from this section.

11 An electron has a negative charge, and objects can be electrically charged.

(a) A negatively charged rod is placed near the brass cap of an electroscope, as shown in Fig. 11.1.

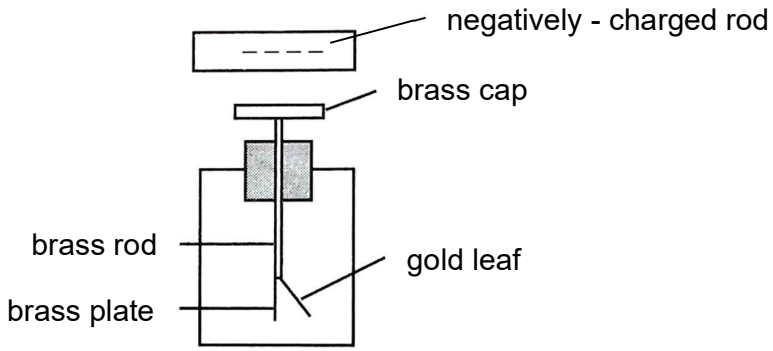

Fig. 11.1

(i) Explain why the gold leaf moves away from the brass plate.

……

…… [2]

(ii) What happens to the deflection of the gold leaf when the charged rod is removed?

……[1]

(iii) A positively charged rod accidentally touched the brass cap. 0.15 C of charge was transferred in 500 ms .

Calculate the current flow during this period.

current = …… [1]

(b) In an electrical circuit, electrons flow due to the presence of a potential difference.

(i) Define '*potential difference*'.

……

……..……[1]

(ii) Calculate the potential difference across a bulb when 80 J of energy is transferred electrically to the bulb when 20 C of charge flows.

potential difference = …….. [1]

(c) A metal wire **JK** is connected to a battery. End **K** is connected to the positive terminal of the battery and end **J** is connected to the negative terminal. The wire **JK** is placed horizontally between two magnetic poles as shown in Fig. 11.2.

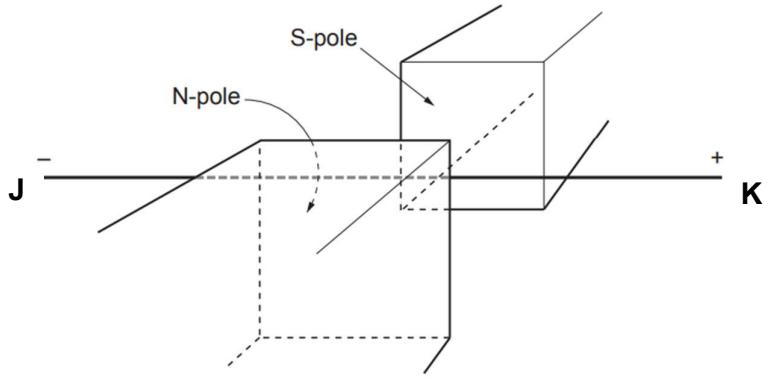

Fig. 11.2

(i) The part of **JK** that is in the magnetic field experiences a force F.

State the direction of F and describe how this direction is deduced.

……

……

……[2]

(ii) The equipment in Fig. 11.3 is used in a similar experiment as that shown in Fig. 11.2.

The part of **JK** that lies between the poles of the magnets, now passes through a long iron tube that is fixed in position.

The tube is shown in Fig. 11.3

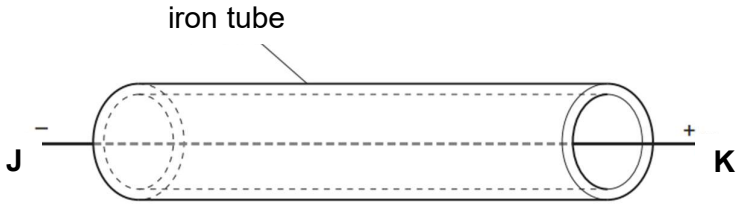

Fig. 11.3

JK is connected to the battery in the same way as before.

State and explain what happens to force F on the wire.

…….....

…….....

…….....[2]

12 Filament lamps are common electrical component in the laboratory and in homes.

(a) You are provided with a lamp **X** rated at `2 V, 12 W'.

(i) Draw a labelled circuit diagram to show how lamp **X** can be operated normally from the 24 V alternating current supply using a transformer. [2]

(ii) Explain how the transformer works.

……

……

……[2]

(iii) There are 300 turns in the primary coil.
Calculate the number of turns in the secondary coil for lamp **X** to light normally.

number of turns in the secondary coil = …….. [1]

(iv) Calculate the current in the primary coil if the transformer is 100 % efficient.

current in the primary coil = …….. [1]

(b) Fig. 12.1 shows how the current through the filament of a lamp and a fixed resistor varies as the potential difference across them are altered.

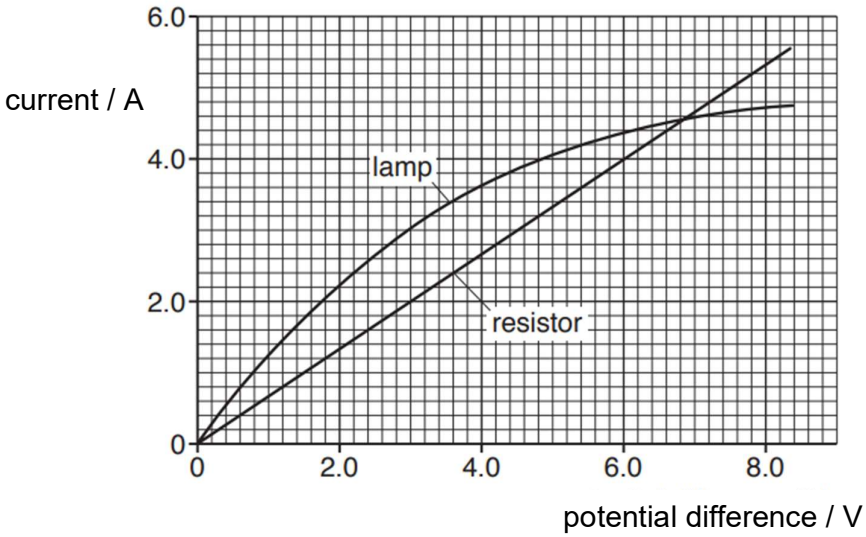

Fig. 12.1

Compare the resistance of the resistor and lamp.

.....

.....

.....

.....

.....

.....[2]

(c) Lamps are used in the lighting circuit of a car. The lamps at the front of a car are connected in parallel as shown in the diagram. Switches are not shown.

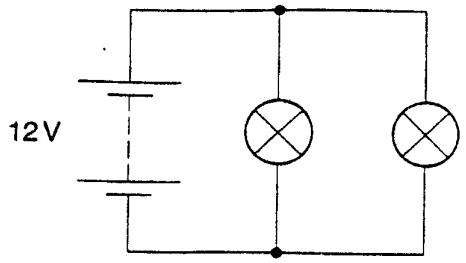

Fig. 12.2

One advantage of connecting lamps in parallel is that when one lamp blows, the other lamp will continue to light up.

State and explain another advantage of connecting the lamps in parallel rather than in series.

……

……

……[2]

End of Paper