CONVENT OF THE HOLY INFANT JESUS SECONDARY
Preliminary Examination in preparation for
the General Certificate of Education Ordinary Level 2024

CANDIDATE NAME			
CLASS		REGISTER NUMBER	

PHYSICS 6091/02

Paper 2 Structured and Free Response

23 August 2024

1 hour 45 minutes

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

READ THESE INSTRUCTIONS FIRST

Write your class, register number and name on all the work you hand in.
Write in dark blue or black ink.
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 yours answers in the spaces provided.

Section B
Answer **one** question.
Write yours answers in the spaces provided.

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.

Section A

Answer **all** the questions.

1 Fig. 1.1 shows a toy drone. It can hover and travel through air.

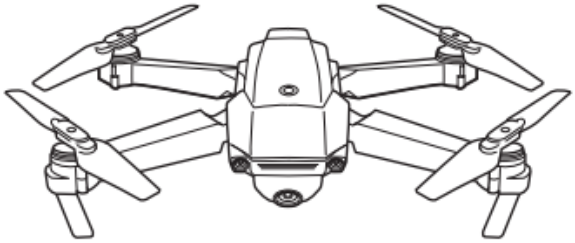

Fig. 1.1

A student flies the drone on a journey from A to B to C to D at a constant height.

Fig. 1.2 is a scale drawing of the path of the drone, viewed from above.

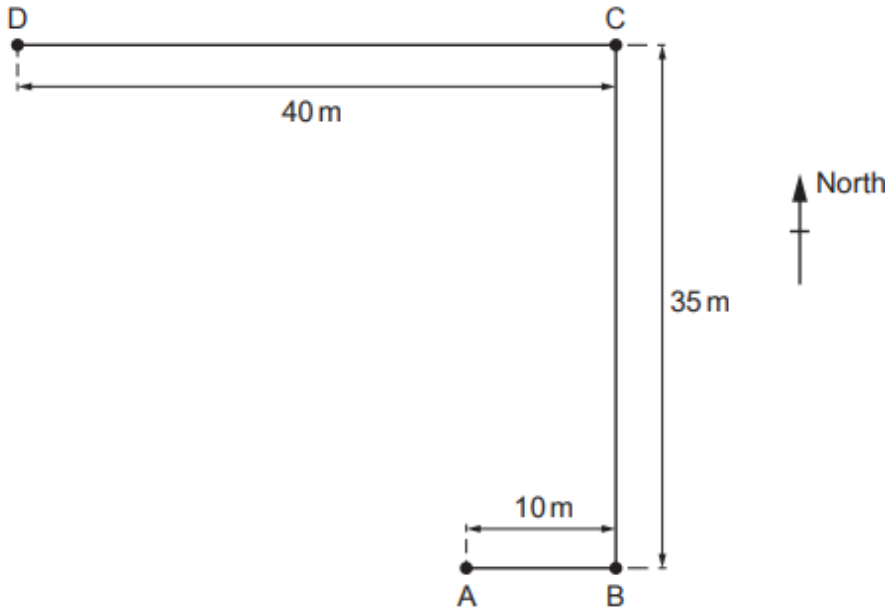

Fig. 1.2 (to scale)

(a) (i) Determine the total distance travelled by the drone.

total distance = ……[1]

(ii) The toy drone makes the journey in 60 s.

Calculate the average speed during the journey.

average speed = ……[2]

(b) **(i)** State the difference between distance and displacement.

……..…

…..……[1]

(ii) Determine the scale used to construct Fig. 1.2 and complete the sentence.

1 cm on the diagram represents …… on the path. [1]

(iii) Using Fig. 1.2, determine the displacement of point D from point A.

displacement = ……..……[1]

(c) State what is meant by *velocity*.

……..……

……..[1]

(d) Another toy drone flies directly from point A to point D in 60 s.

Explain why the magnitude of the velocity of this toy drone is smaller than the answer in part **(a)(ii)**.

……..……

……..

……..……

……..[1]

[Total: 8]

[Turn over

2 A stone falls vertically, hits a rubber mat and rebounds vertically upwards.
Fig. 2.1 shows the speed-time graph for the stone.

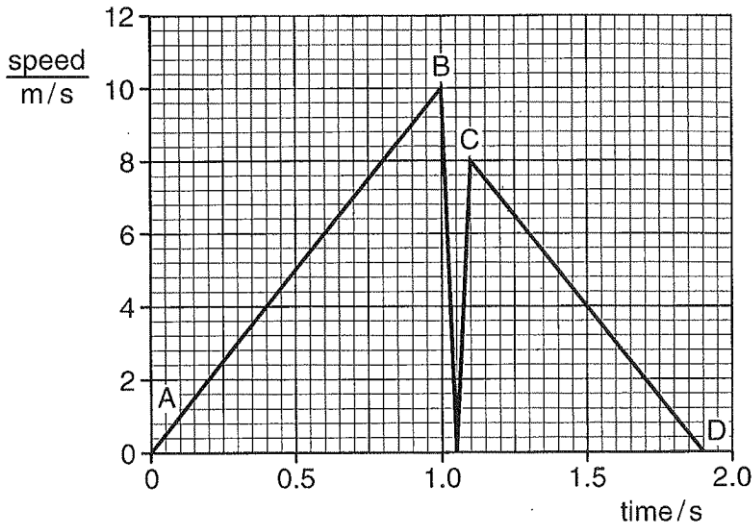

Fig. 2.1

The stone is released at A, hits the rubber mat at B and is in contact with the mat between B and C. D is the highest point reached as the stone rises.

(a) Using the information from Fig. 2.1, describe the motion of the stone between A and B.

……

……..[1]

(b) State how Fig. 2.1 shows that the stone's maximum height after rebound is lower than the original height that it was released.

……

……

……

……..[2]

(c) Determine

1. the change in speed of the stone between B and C, ……..[1]

2. the change in velocity of the stone between B and C. ……[1]

[Total: 5]

3 A plane, irregular lamina has a mass of 60 g. It hangs from a nail that passes through a small hole, H, near the edge of the lamina.

The nail acts as a pivot and the lamina can swing about it. The lamina is held in the position shown in Fig. 3.1, a small distance above a horizontal bench.

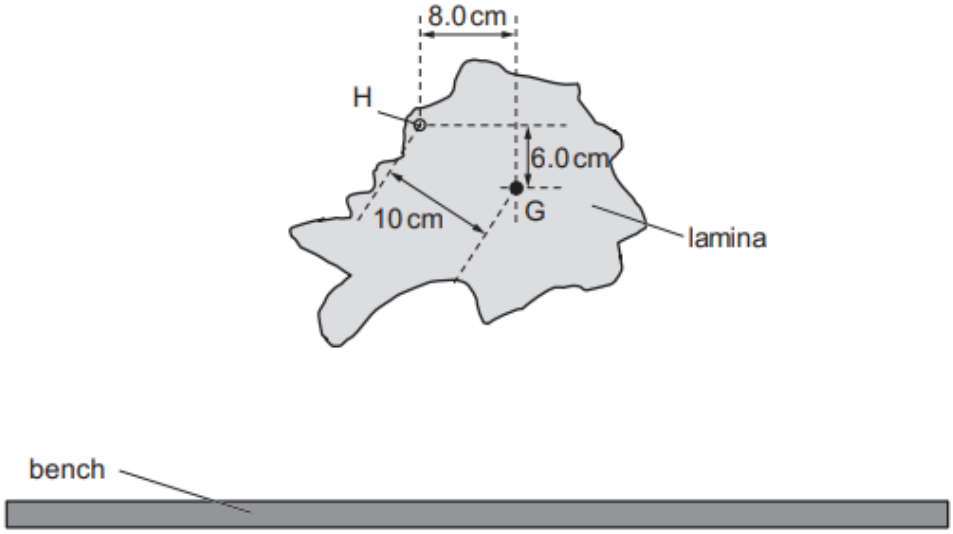

Fig. 3.1 (Not to scale)

The centre of gravity of the lamina is at G.

(a) The weight of the lamina is a force that acts downwards.

(i) Explain why the lamina experiences this downward force.

……

……[1]

(ii) Calculate the weight of the lamina on Earth. Take g = 10 N/kg on Earth.

weight = ……[2]

[Turn over

(b) The weight produces a moment about the pivot through H.

(i) Using Fig. 3.1, calculate the moment of the weight about the pivot.

moment = ……..[2]

(ii) The lamina is now released from the position shown in Fig. 3.1.

Describe what happens to the lamina from the time it is released until it stops moving.

……...…

……...…

…..……[2]

[Total: 7]

4 Fig. 4.1 shows a man standing under an outdoor heater on a cold evening in Paris, France.

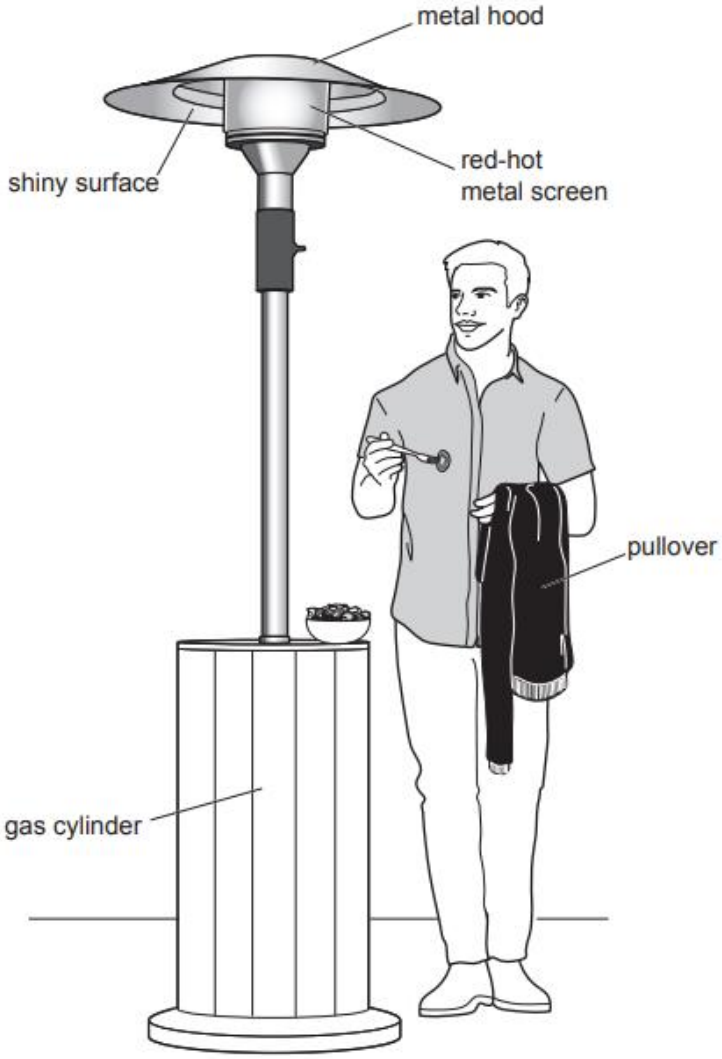

Fig. 4.1

Gas in the cylinder at the base of the heater is the fuel for the heater. When the heater is operating, the gas travels to the top of the heater where it burns.

(a) State the energy store possessed by the gas.

……..[1]

(b) A metal screen surrounding the burning gas is heated by the burning gas until it is red-hot. The hot metal screen warms the man who is standing under it.

(i) Describe how the thermal energy in the red-hot metal screen is transferred to the man.

……...…

……...…

…..……[2]

[Turn over

(ii) At the top of the heater is a metal hood that has a shiny lower surface.

Explain why this makes the energy transfer from the metal screen more efficient.

……...…

…..……[2]

(iii) The surrounding air temperature decreases and the man puts on a black pullover.

Explain one way in which wearing the black pullover helps to keep the man warm.

……...…

…..……[1]

[Total: 6]

5 Microwaves are waves in the electromagnetic spectrum.

(a) **(i)** State the name of waves in one other part of the electromagnetic spectrum that have wavelengths shorter than microwaves.

…..…….[1]

(ii) A wave in the electromagnetic spectrum has a wavelength shorter than microwaves. Explain why the frequency of this wave is higher than the frequency of microwaves.

……...…

……...…

……...…

…..…….[2]

(b) Microwaves are sometimes used to send telephone messages over long distances. They are sent from large dish aerials on top of high buildings or towers.

There are often repeater or booster stations placed between the transmitter and the receiver, as illustrated in Fig. 5.1.

Fig. 5.1

State why

(i) the aerials are placed on top of high buildings or towers,

……...…

…..…….[1]

(ii) repeater or booster station are necessary.

……...…

…..…….[1]

[Total: 5]

[Turn over

6 Fig. 7.1 shows a 20.0 V battery, a voltmeter, two ammeters and three fixed resistors connected in a circuit.

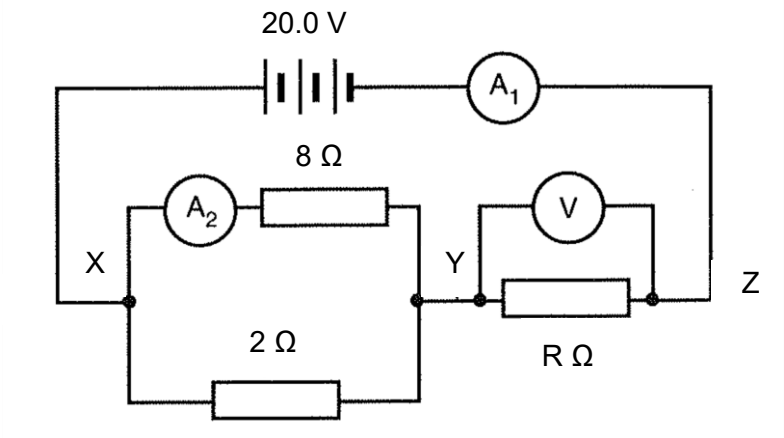

Fig. 6.1

(a) Write down the ratio, current measured by A_1 : current measured by A_2.

$A_1 : A_2$ = …… [1]

(b) The voltmeter reads 12.0 V.

Calculate

(i) the ammeter readings, A_1 and A_2.

ammeter A_1 reading = ……..[1]

ammeter A_2 reading = ……..[1]

(ii) the unknown resistor R.

resistance of R = ……..…… [1]

(c) A wire of negligible resistance is connected between X and Y.

Calculate the new ammeter reading A_1.

new ammeter reading A_1 = ……..…… [1]

Fig. 6.2 shows 5 resistors connected to a current source of 8 A.

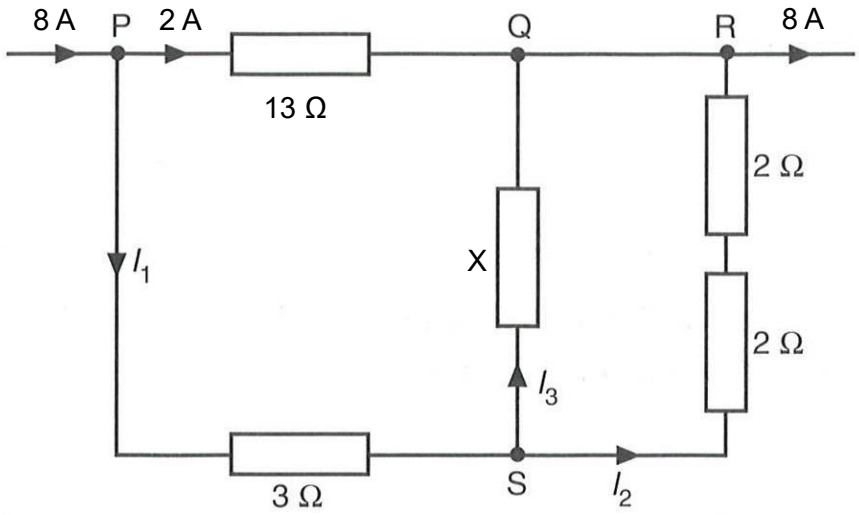

Fig. 6.2

(d) Determine the resistance of X.

resistance of X = ……..…… [2]

[Total: 7]

[Turn over

7 Fig. 7.1 shows a gardener cutting damp grass with a high-powered electric mower.

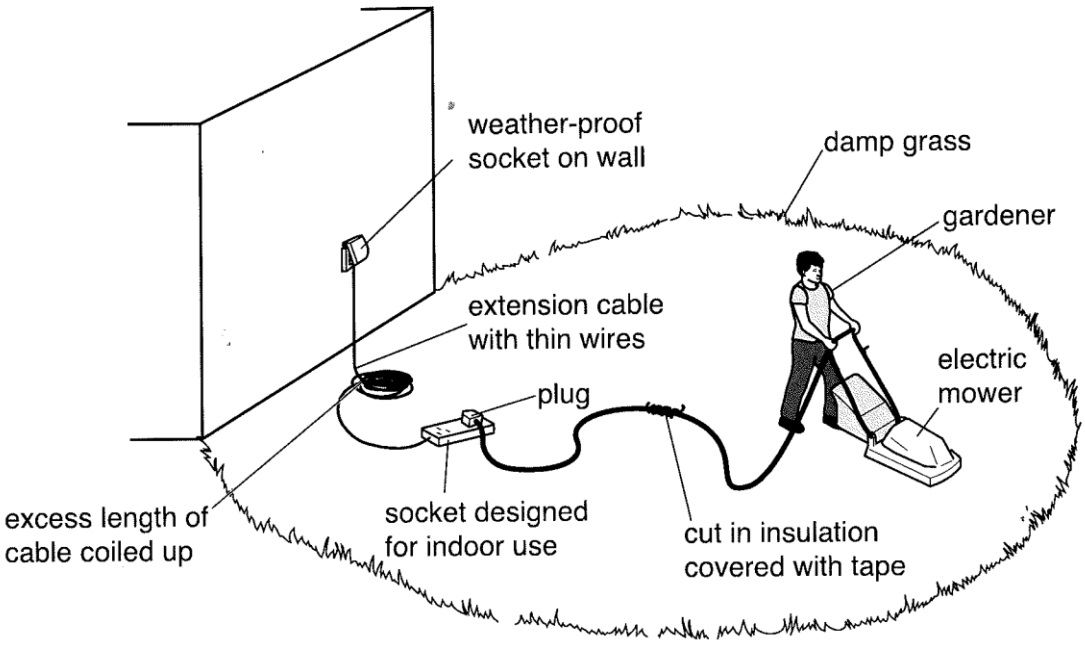

Fig. 7.1

The mower cable has thick wires appropriate for the current of the mower and the correct fuse. This mower cable is too short for the mower to reach the entire area covered by the grass. The gardener uses an extension cable with thin wires and sockets intended for indoor use.

Identify and discuss the 3 hazards of electricity usage in the arrangement shown in Fig. 7.1.

1……

……

……

2……

……

……

3……

……

……[6]

[Total: 6]

8 Fig. 8.1 shows a coil in a magnetic field. The coil rotates about the axis.

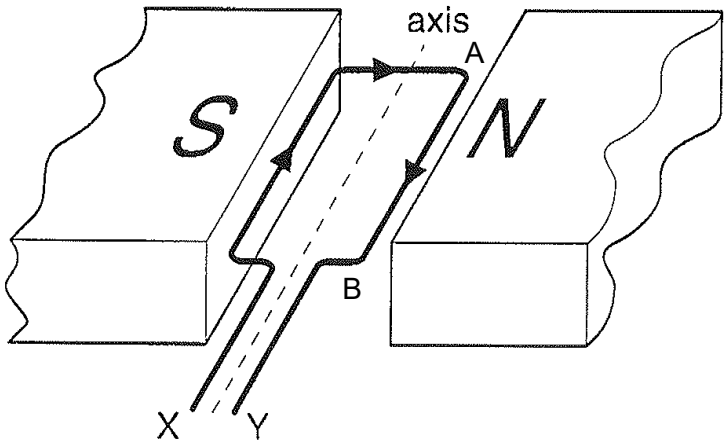

Fig. 8.1

The ends X and Y of the coil are connected directly to a d.c. power supply. The arrows on the sides of the coil show the direction of the current in the coil.

(a) On Fig. 8.1, draw an arrow to show the direction of the force acting on the side AB of the coil. [1]

(b) Explain why this force exist.

……..……

……..……

……..[2]

Fig. 8.2 shows part of the coil and the ends X and Y.

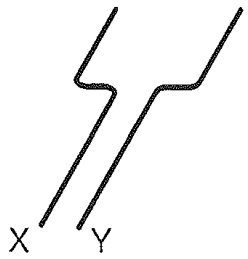

Fig. 8.2

(c) On Fig. 8.2, complete the electrical circuit between X and Y with suitable components such that the coil can rotate continuously in the same direction when switched on.

[2]

[Total: 5]

[Turn over

9 Some information is given from the manufacturer of an electric car for use in a town.

	with a load of 80 kg	with a load of 160 kg
maximum speed	10.9 m/s	10.9 m/s
initial acceleration	2.00 m/s^2	1.85 m/s^2

mass of car without any load	900 kg
furthest distance travelled by car at maximum speed without recharging	49 km
average power produced by battery at maximum speed	4.24 kW
e.m.f. of battery	48 V
maximum charging current	95 A

(a) (i) When the load in the car doubles from 80 kg to 160 kg, the initial acceleration of the car decreases slightly. Explain why the acceleration decreases but does **not** decrease by half.

…….……..…

…….……..…

…….……..…

…….……..[2]

(ii) Explain, in terms of the forces acting on the car, why the car has a maximum speed.

…….……..…

…….……..…

…….……..…

…….……..[2]

(b) The car travels the furthest distance at the maximum speed without recharging.

Calculate

(i) the time taken,

time = ……..[1]

(ii) the energy provided by the battery,

energy = ……..……[1]

(iii) the minimum time taken to fully recharge the battery.

time = ……..[2]

(iv) State one assumption that you made in calculating part **(iii)**.

…...……..…

…...……..…

…...……..[1]

(c) Suggest one environmental advantage of using an electric car in a town.

……..……

……..……

……..[1]

[Total: 10]

[Turn over

10 A highly radioactive source that emits only beta-particles is placed a few centimetres away from a detector, as shown in Fig. 10.1.

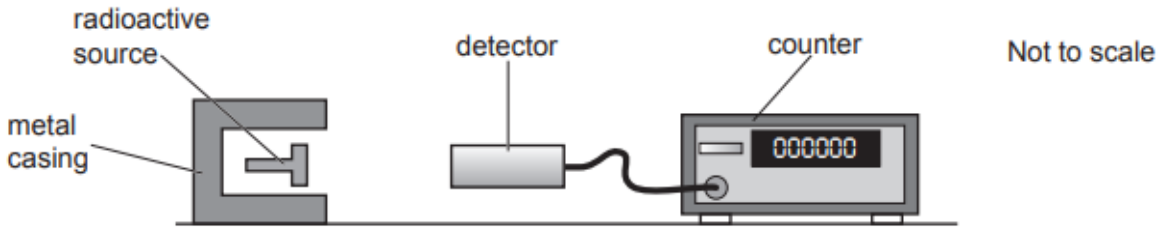

Fig. 10.1

(a) Explain why a metal casing is sufficiently safe in containing the radioactive source.

……

……..[1]

(b) State and explain what happens to the number of particles detected in a minute as the radioactive source is moved:

(i) a few centimetres **further** away from the detector,

……

……

……[2]

(ii) more than a metre away from the detector.

……

……

……[2]

(c) A nucleus of thorium-234 (Th-234) decays by beta emission to a nucleus of protactinium (Pa).

Complete the equation for this decay.

[2]

$$^{234}_{90}\text{Th} \rightarrow \overset{\cdots\cdots}{\cdots\cdots}\text{Pa} + \overset{\cdots\cdots}{-1}\beta$$

(d) Nuclear fusion and nuclear fission both release large amounts of energy.

(i) Describe how the process of nuclear fusion differs from the process of nuclear fission.

……...…

……...…

…..……[2]

(ii) Describe the conditions needed for nuclear fusion to take place.

……...…

……...…

…..……[2]

[Total: 11]

[Turn over

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CANDIDATE NAME

CLASS

REGISTER NUMBER

Section B

Answer **one** question from this section.

11 Fig. 11.1 shows an electric kettle.

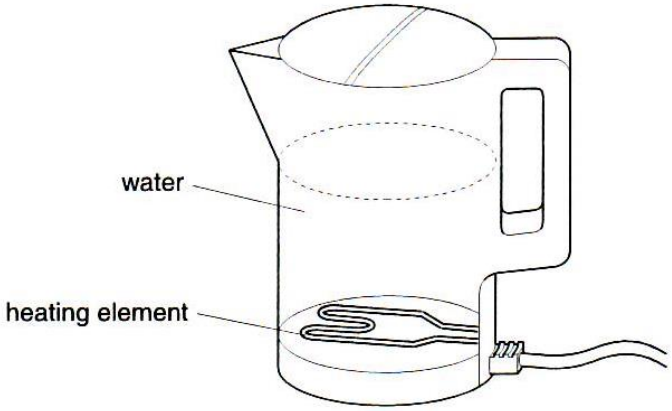

Fig. 11.1

(a) The specific latent heat of vaporisation of water is 2260 J/g.

Using this value of the specific latent heat of vaporisation of water, describe an experiment to determine the power output of the kettle. You should state clearly how the readings are obtained and how the power is calculated.

Suggested apparatus: kettle, electronic balance, stopwatch, thermometer

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……[4]

[Turn over

(b) The electrical kettle has a power output of 1800 W and is used for 5 minutes.

(i) Calculate the electrical energy, in joules, supplied to the kettle.

electrical energy = ……. [2]

(ii) Calculate the electrical energy, in kilowatt hours, supplied to the kettle.

electrical energy = …….[1]

(iii) Using your answers to part **(b)(i)** and **(b)(ii)**, calculate the number of joules that is equivalent to 1.0 kWh.

number of joules = …….[1]

(c) When the kettle is switched off, the water cools down. Explain, in molecular terms, how evaporation causes a loss of energy from the water.

…….....

…….....

…….....

…….....

…….....[2]

[Total: 10]

12 A basic microscope is usually made up of two converging lenses. One reason for using two lenses rather than just one is that it is easier to get higher magnification. For example, in order to have an overall magnification of 20, one lens can magnify by a factor of 5, and the second by a factor of 4.

It is generally easier to get a large magnification factor of 20 in this way than to use a single lens.

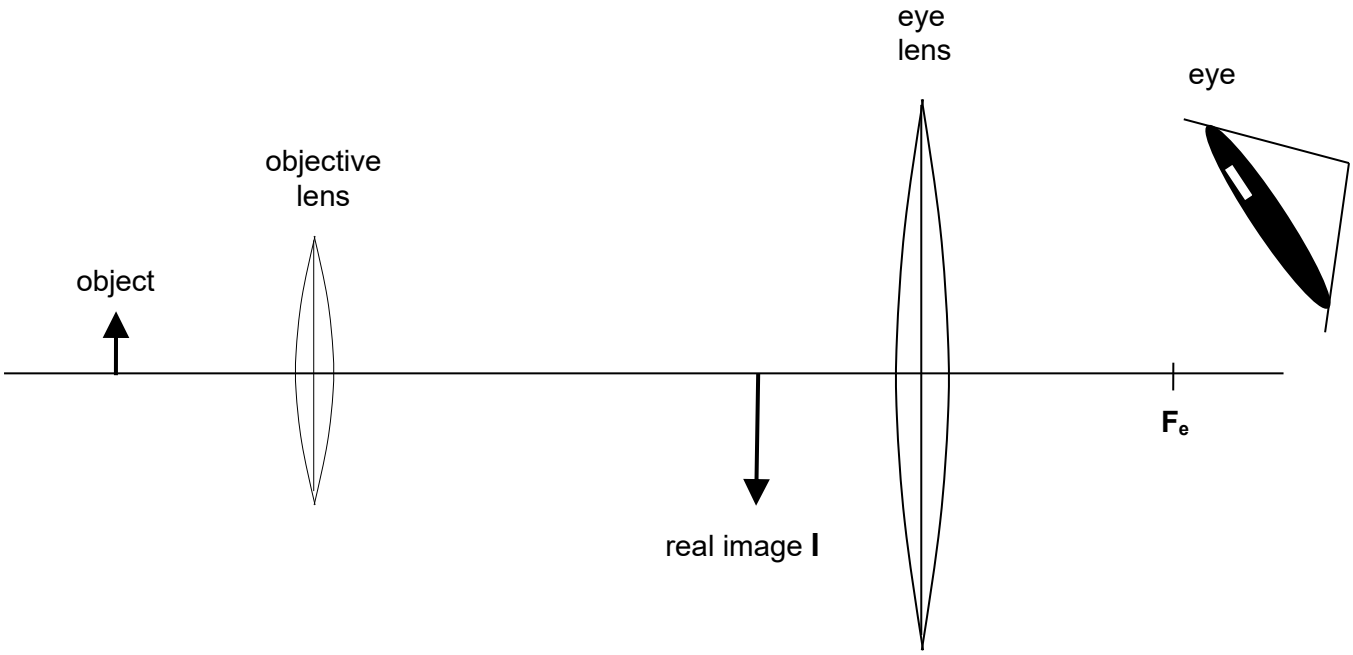

Fig. 12.1

A microscope arrangement is shown in Fig. 12.1. The objective lens creates a real image **I**. This image is the object for the eye lens (with its focal point at $\mathbf{F_e}$), and the image created by the eye lens is the one seen by the eye through the microscope.

(a) On Fig. 12.1, draw the two rays from the object to show how the real image **I** is being formed by the objective lens. Hence, locate and label the focal point $\mathbf{F_o}$ of the objective lens. [3]

(b) Draw two rays to locate the image as seen by the eye, when **I** is being magnified by the eye lens on Fig. 12.1. Label this image **P**. [3]

[Turn over

(c) State **two** other characteristics of the magnified image **P**.

……..….[2]

(d) The converging lens works based on the laws of refraction of light.

State the laws of refraction.

1. ……

……..……..

2. ……

……..….[2]

[Total: 10]