Class:	Candidate Name:	Candidate Index Number:

EDGEFIELD SECONDARY SCHOOL
2024 PRELIMINARY EXAMINATION
Secondary 4

O Syllabus

PHYSICS

6091/ 02

August 2024

1 hour 45 minutes

Paper 2 Structured and Free Response

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

READ THESE INSTRUCTIONS FIRST

Write in dark blue or black ink.
You may use a soft 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.

Section B
Answer **one** question.
Write your 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.

FOR EXAMINER'S USE	
Section A	**/ 70**
Section B	**/ 10**
TOTAL	**/ 80**

My target grade/mark: _____

_____
Parent's signature

SECTION A

Answer **all** the questions in the spaces provided.

1 A set of traffic lights hangs from the end of a metal cable. A horizontal chain pulls the traffic lights to the right so that they are above the middle of the road. Fig. 1.1 shows the metal cable inclined to the vertical.

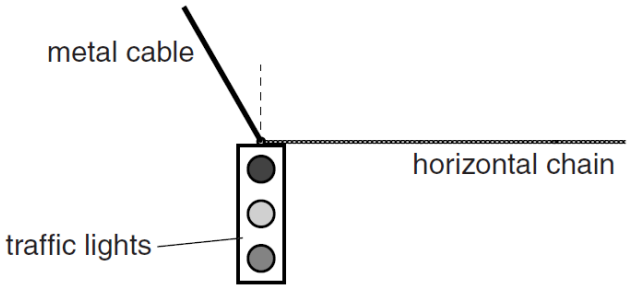

Fig. 1.1

The weight of the traffic lights is 240 N.

(a) Two of the forces on the traffic lights are the tension in the horizontal chain and the weight of the traffic lights. On Fig. 1.1, mark and label the two forces using arrows. [1]

(b) The tension in the horizontal chain is 140 N. In the space below, use a scale diagram to determine the size and direction of the resultant of the weight and the tension in the chain. State the scale used for the diagram.

scale = ...

size of resultant force = ...

direction of resultant force = ... [3]

[Total: 4]

2 Fig. 2.1 shows a steel disc of radius 10.0 cm. Three holes of radii 2.0 cm each are drilled on parts of the steel disc as shown.

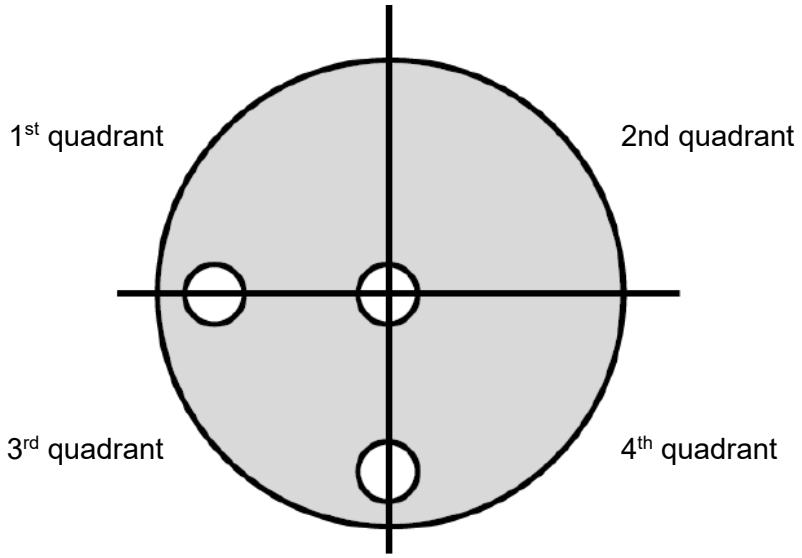

Fig. 2.1

(a) State the meaning of *centre of gravity*.

.....

.....

..... [1]

(b) State the quadrant in which the centre of gravity of the steel disc is located.

..... [1]

(c) The position of the centre of gravity can be confirmed by balancing the steel disc on a finger. When the steel disc is balanced and does not topple, the centre of gravity is directly above the finger.
Explain, using concepts of moment, how this method works.

.....

.....

.....

.....

..... [2]

(d) Given that the density of steel is 8.05 g/cm^3 and that the steel disc has a thickness of 0.2 cm, calculate the mass of the steel disc with the three holes.

mass = ... [2]

(e) Sketch, in the space below, any additional drillings to be made, such that the centre of gravity of the steel disc lies definitely at the centre of the disc.

[1]

[Total: 7]

3 A farmer uses a hydraulic system to operate machinery that is pulled behind a tractor. Two cylinders and the flexible pipe that joins them contain oil. Two pistons keep the oil in the cylinders. The arrangement is shown in Fig. 3.1.

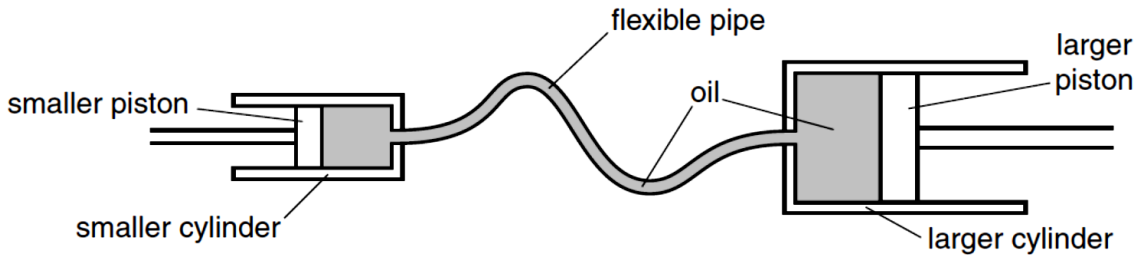

Fig. 3.1

The cross-sectional area of the smaller cylinder is 0.048 m^2.
The cross-sectional area of the larger cylinder is 0.14 m^2.
The smaller piston exerts a force of 12 000 N on the oil.

(a) Calculate

(i) the pressure in the oil,

pressure = ... [2]

(ii) the force exerted by the oil on the larger piston.

force = ... [1]

(b) Suggest why the resultant force on the larger piston is less than the value obtained in **(a)(ii)**.

.....

..... [1]

(c) The smaller piston moves a distance of 0.065 m into the cylinder.
Calculate the work done on the oil by the smaller piston.

work done =..... [2]

[Total: 6]

4 One type of renewable energy source is shown in Fig. 4.1.

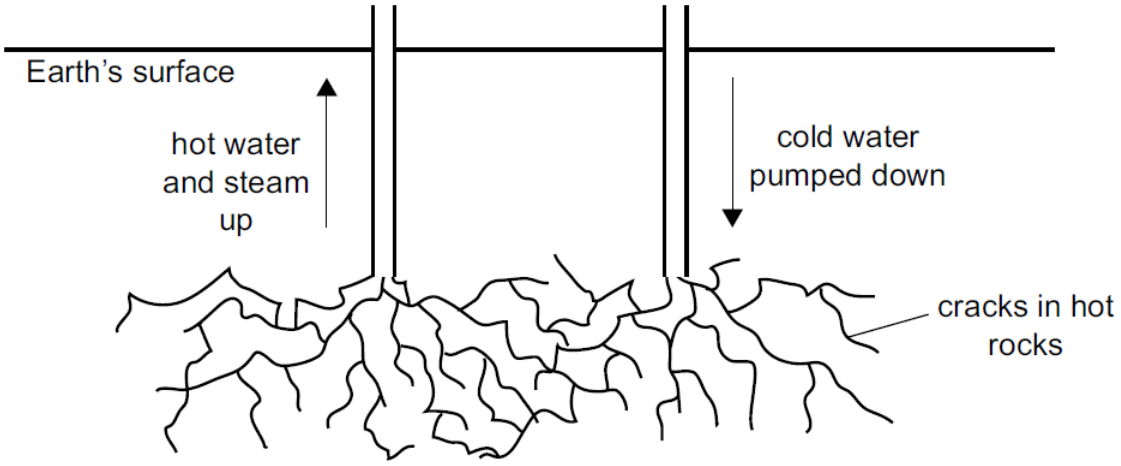

Fig. 4.1

(a) State the name of the renewable energy source shown in Fig. 4.1.

..... [1]

(b) 1000 kg of cold water at a temperature of 20 °C is pumped down to the hot rocks.
The water returns partly as steam and partly as hot water.
The steam and the hot water are both at a temperature of 100 °C.
The specific heat capacity of water is 4200 J / (kg °C).

(i) Calculate the energy needed to heat 1000 kg of water from 20 °C to 100 °C.

energy = ...[2]

(ii) Explain why more energy is transferred when 1 kg of the steam cools to 20 °C than when 1 kg of the hot water cools to 20 °C.
You should include a reference to the arrangement of particles in liquids and in gases in your answer.

.....

.....

.....

.....

..... [2]

[Total: 5]

5 Fig. 5.1 shows a converging lens, an object O and the image I produced by the lens. Fig. 5.1 is drawn to the scale shown.

Fig 5.1

(a) On Fig. 5.1 a horizontal ray has been drawn from the top of the object to the lens.

(a) (i) Continue this ray until it meets the image. [1]

(ii) Using Fig. 5.1, determine the focal length of the lens.

..... [1]

(iii) Draw another two rays from the top of the object to show how the image is formed. [1]

(b) The image formed is real and magnified.

(b) (i) Explain what is meant by *real image*.

.....

..... [1]

(ii) Determine the magnification of the image formed.

magnification = ... [1]

[Total: 5]

6 Fig. 6.1 shows an advertisement about an electrostatic carpet sweeper.

Electrostatic carpet sweeper

With the mighty mini Electrostatic Carpet Sweeper, your can keep the bulky vacuum in the closet! Being lightweight and quiet, the Electrostatic Carpet Sweeper is just the thing for quick touch-ups and small jobs inevitable in every household. The natural pig bristle rotor brush gathers everything from dust, ash, and pet hair to paper clips and glass into dual dust pans. Corner brushes pull dirt from hard-to-reach location and along baseboards. Double action rollers automatically adjust to different surface heights and clean with each forward and backward stroke. Use on carpeted, hard surface floors and even wooden floors for fast and easy cleaning!

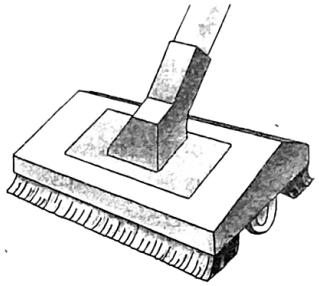

Fig. 6.1

(a) Explain how can the electrostatic sweeper pick up dust, ash, etc.

.....

.....

.....

..... [2]

(b) Why is the sweeper especially useful for carpets and wooden floors?

.....

.....

.....

..... [2]

(c) Suggest an advantage of using the electrostatic sweeper over the electric vacuum cleaner.

.....

..... [1]

[Total: 5]

7 A 4.5 V battery is connected in a circuit with an ammeter, a light-dependent resistor (LDR) and a 1800 Ω fixed resistor. Fig. 7.1 shows the circuit diagram.

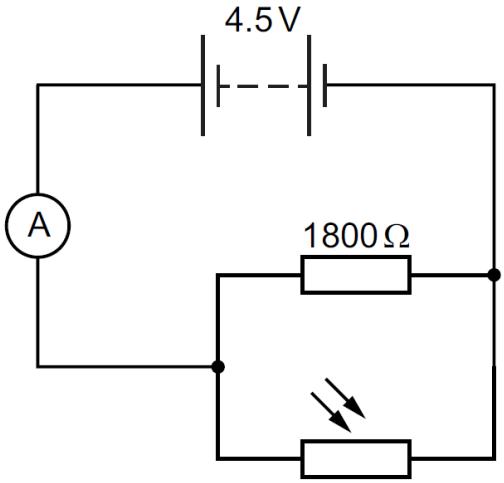

Fig. 7.1

(a) The light incident on the LDR causes its resistance to be 9000 Ω.

Calculate:

(i) the total resistance of the circuit

resistance = ...[2]

(ii) the reading on the ammeter.

reading = ...[2]

(b) A very bright lamp is switched on and the intensity of the light incident on the LDR increases.

(i) State and explain what happens to the current in the LDR.

what happens to the current .....

explanation .....

.....[1]

(ii) State and explain what happens to the current in the 1800 Ω resistor..

what happens to the current .....

explanation .....

.....[1]

[Total: 6]

8 Fig. 8.1 shows a circuit containing a 230 V a.c. supply connected to a television and two lamps.

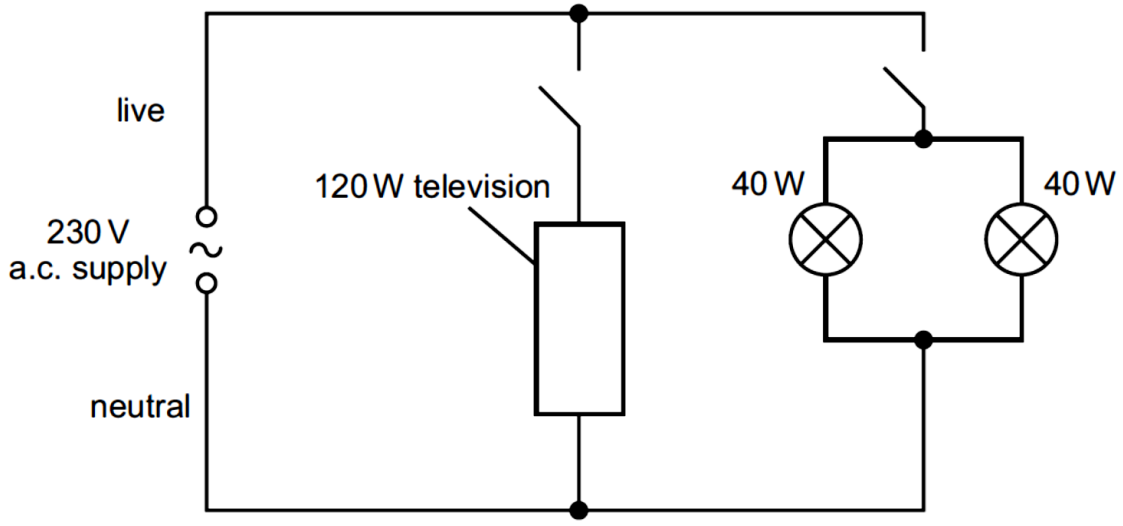

Fig. 8.1

In normal operation, both switches are closed. The power supplied to each lamp is 40 W and the power supplied to the television is 120 W.

(a) Calculate, in normal operation:

(i) the total number of kilowatt-hours (kW h) of energy supplied to the circuit in 1.0 hour

number of kW h = ...[1]

(ii) the current in each lamp.

current = ...[2]

(b) Explain why the switches are placed in the live wire and not in the neutral wire.

.....

.....

.....

..... [2]

(c) State one advantage of connecting the two lamps in parallel in this circuit.

.....

.....[1]

[Total: 6]

9 **(a)** Fig. 9.1 shows a horizontal, current-carrying wire PQ in the gap between the poles of a permanent magnet.

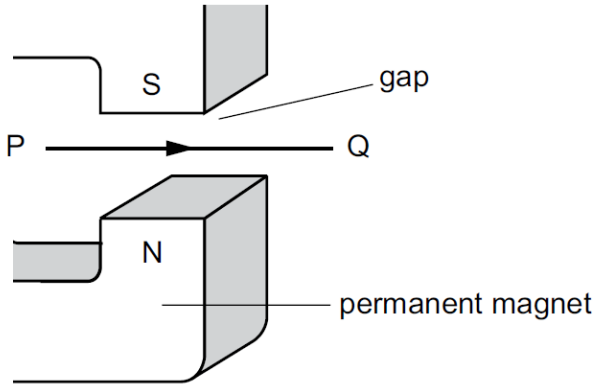

Fig. 9.1

(i) There is a magnetic field in the gap between the N pole and the S pole.
The current in PQ is from left to right.
Describe the effect of the magnetic field on PQ.

.....

.....[1]

(ii) State the effect on PQ of increasing the strength of the magnetic field in the gap.

.....[1]

(b) Fig. 9.2 shows part of a torch. The torch does not contain a battery.

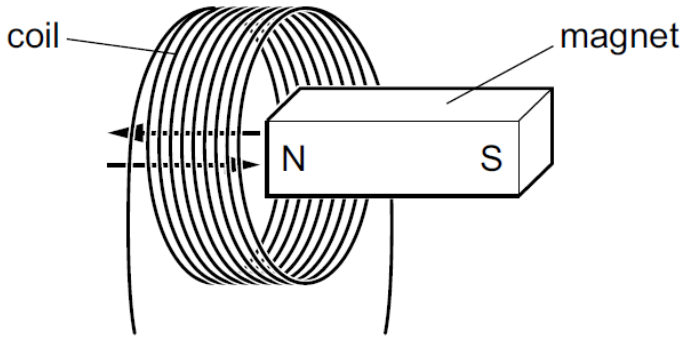

Fig. 9.2

The torch is shaken and this causes the magnet to move backwards and forwards through the coil.

(i) Explain why an electromotive force (e.m.f.) is induced across the coil when the magnet moves.

.....

.....

.....

.....[1]

(ii) State one way to increase the e.m.f. induced.

.....

.....[1]

(iii) As the magnet moves into the coil, the induced e.m.f. produces a current in the coil. Explain how this opposes the motion of the magnet.

.....

.....

.....

.....

.....[2]

[Total: 6]

10 The following passage is about physics in swimming:

In swimming, the freestyle stroke consists of five phases: entry, extension, pull, push, and recovery. The major acceleration comes from the pull phase. Many beginners assume that if you move your arms through the water as fast as you can, you will improve the force exerted during the pull phase. While this is true for other phases, the pull phase relies more on the volume of water displaced by the swimmer's hand than the speed the hand moves through the water. This volume is increased by the shape or position the hand is held in as it travels through the water. To move the most water, the hand should be cupped as shown in Fig. 10.1, with the fingers close together. This will move much more water than an 'open palm' method, as illustrated in Fig. 10.2.

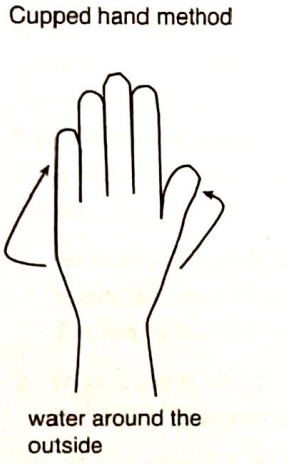

Fig. 10.1

Fig. 10.2

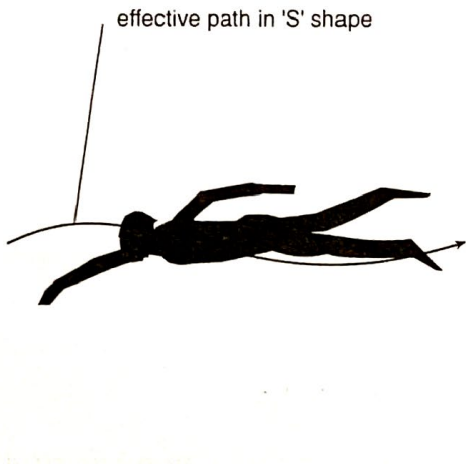

Fig. 10.3

In addition, the path that the hand takes through the water affects the speed. The most effective path is an 'S' shape through the water. If the swimmers are looked from the bottom of the pool, their hands should make the shape of an 'S' from the end of the extension phase to the swimmer's waist (Fig. 10.3). This path slightly improves the amount of water moved by the hand, but the bigger advantage is seen in lessening the water resistance. By making the 'S' shape, the swimmers keep their hands closer to the water surface. If the hand and arm go deeper, the streamline breaks, increasing the area facing water. Therefore, water resistance is large. The shallower hand motion keeps the water from being churned below and aids in minimizing the water resistance.

(a) Draw a free-body diagram in the space below to show all the horizontal forces acting on the swimmer during the pull phase. Assume the swimming direction is the same as in Fig. 10.3.

[2]

(b) Explain using Newton's Third Law, how 'pulling his hand backward against the water' can lead to a forward force on the swimmer.

.....

.....

.....

.....

..... [2]

(c) Using your answer in **(b)**, hence explain why the pull phase relies more on the volume of water displaced by the swimmer's hand.

.....

.....

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.....

..... [2]

(d) Explain using Newton's Second Law, how a forward force on the swimmer can lead to an acceleration of the swimmer.

.....

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.....

.....[2]

(e) Other than the effect on water resistance, the efficient path is an 'S' shape that has another advantage due to it's long length.

Describe how this affects the work done on the water.

.....

.....

.....

.....

.....[2]

[Total: 10]

11 **(a)** A scientist has three radioactive sources. The first source emits only alpha-particles, the second source emits only beta-particles and the third source emits only gamma-rays.

(i) Explain how the scientist demonstrates that the three types of radiation have different penetrating powers.
In your account
• draw a diagram of the apparatus used,
• state what materials are used to show the different penetrating powers,
• explain how the apparatus is used.

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.....
.....
.....
.....
.....
.....
..... [4]

(ii) State two different safety precautions the scientist must follow when handling the radioactive sources.

.....
.....
.....
..... [2]

(iii) Explain why the half-lives of the radioactive sources used in the demonstration should be greater than 1 second.

.....
.....
..... [1]

(b) A doctor has the choice of two isotopes, $^{131}_{53}\mathrm{I}$ and $^{125}_{53}\mathrm{I}$, to inject into a patient.
These isotopes emit radiation from deep inside the body. The radiation is detected outside the body and provides information to help the doctor find out what is wrong with the patient. The isotope 131 53I decays into a stable isotope of xenon by emitting a beta-particle (β) and a gamma ray (γ).

(i) Complete the equation to show the radioactive decay of $^{131}_{53}\mathrm{I}$.

$$^{131}_{53}\mathrm{I} \rightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{Xe} + {}^{\cdots\cdots}_{-1}\beta + \gamma$$

[2]

(ii) When a nucleus of $^{125}_{53}\mathrm{I}$ decays, only a gamma ray is emitted.
Suggest why it is better for the doctor to inject the isotope $^{125}_{53}\mathrm{I}$ into the patient.

.....

.....[1]

[Total: 10]

SECTION B

Answer **one** question from this section.

12 A metal filament lamp is connected to a power supply. The electromotive force (e.m.f.) produced by the supply can be varied. Fig. 12.1 is the circuit diagram.

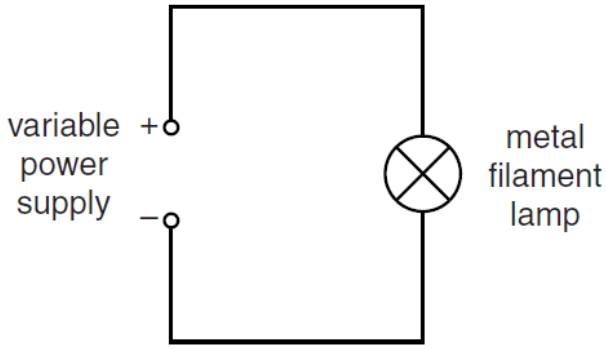

Fig. 12.1

(a) State what is meant by *electromotive force (e.m.f.).*

.....

.....

.....[1]

(b) Add appropriate circuit symbols to Fig. 12.1 to show the position of

(i) an ammeter that measures the current in the circuit, [1]

(ii) a voltmeter that measures the voltage across the lamp. [1]

(c) A student adds meters to the circuit and makes measurements of the current and voltage. He then plots the current/voltage graph shown in Fig. 12.2.

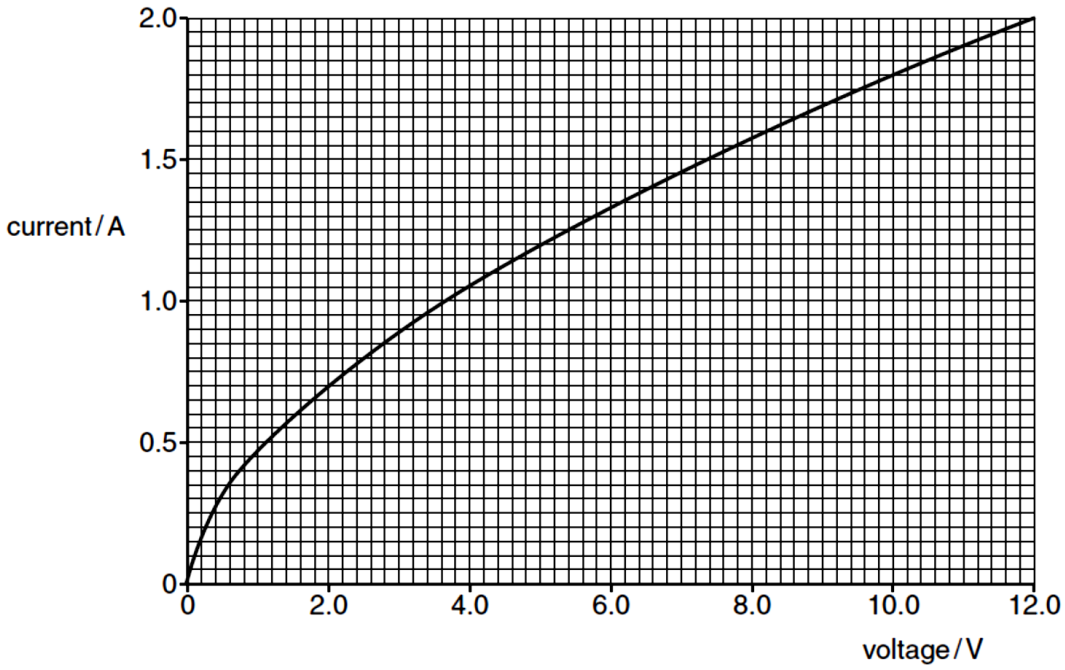

Fig. 12.2

(i) Using values from Fig. 12.2, calculate the resistance of the lamp when the current is 0.70 A. Give your answer to an appropriate number of significant figures.

resistance = ...[2]

(ii) State and justify using Fig. 12.2, if anything, happens to the resistance of the lamp as the voltage increases.

.....

.....[1]

(d) **(i)** In normal use, the lamp is connected to a 12 V supply.
Use Fig. 12.2 to determine the power of the lamp when it is used in this way.

power = ...[2]

(ii) State and describe how the brightness changes when one more identical lamp is connected in series to the lamp in Fig. 12.2.

.....

.....

.....

.....

.....[2]

[Total: 10]

13 Fig. 13.1 shows an electric train of mass 5.5×10^5 kg.

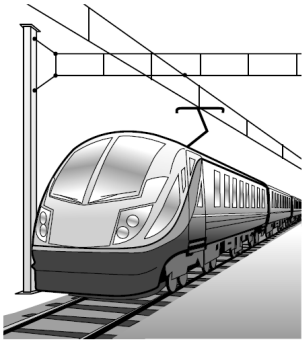

Fig. 13.1

The train is initially at rest. The electric motor exerts a constant force, and the train accelerates. Its acceleration decreases until the train reaches a speed of 40 m / s.

The train then continues at this constant speed.

(a) On the axes in Fig. 13.2, sketch a speed-time graph for the train.

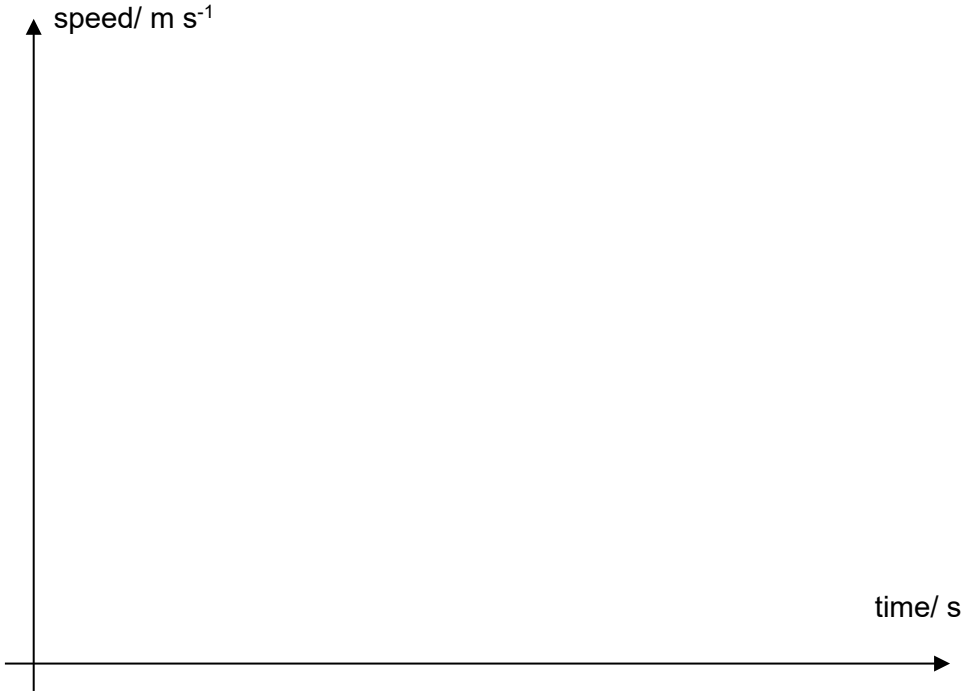

Fig. 13.2

[3]

(b) Explain, in terms of the forces acting,

(i) why the acceleration of the train decreases,

.....

.....

.....[2]

(ii) why the train eventually reaches constant speed.

.....

.....[1]

(c) **(i)** Calculate the kinetic energy of the train when it is travelling at a speed of 40 m / s.

kinetic energy = ...[2]

(ii) As the train accelerates to 40 m / s, electrical energy supplied to the motor is converted into kinetic energy of the train. The efficiency of this process is 40 %.

Calculate the electrical energy supplied to the motor.

energy = ... [2]

[Total: 10]

**********End of Paper**********