* 0000800000001 * DFD

Cambridge Assessment International Education

Cambridge O Level

CANDIDATE NAME

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* 4 7 2 6 6 1 3 8 9 5 *

PHYSICS **5054/21**

Paper 2 Theory **October/November 2025**

1 hour 45 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m/s^2).

INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].

This document has **20** pages. Any blank pages are indicated.

1 A car is at rest on a straight horizontal road.

At time t = 0, the car begins to accelerate.

Fig. 1.1 shows how the momentum of the car varies with time.

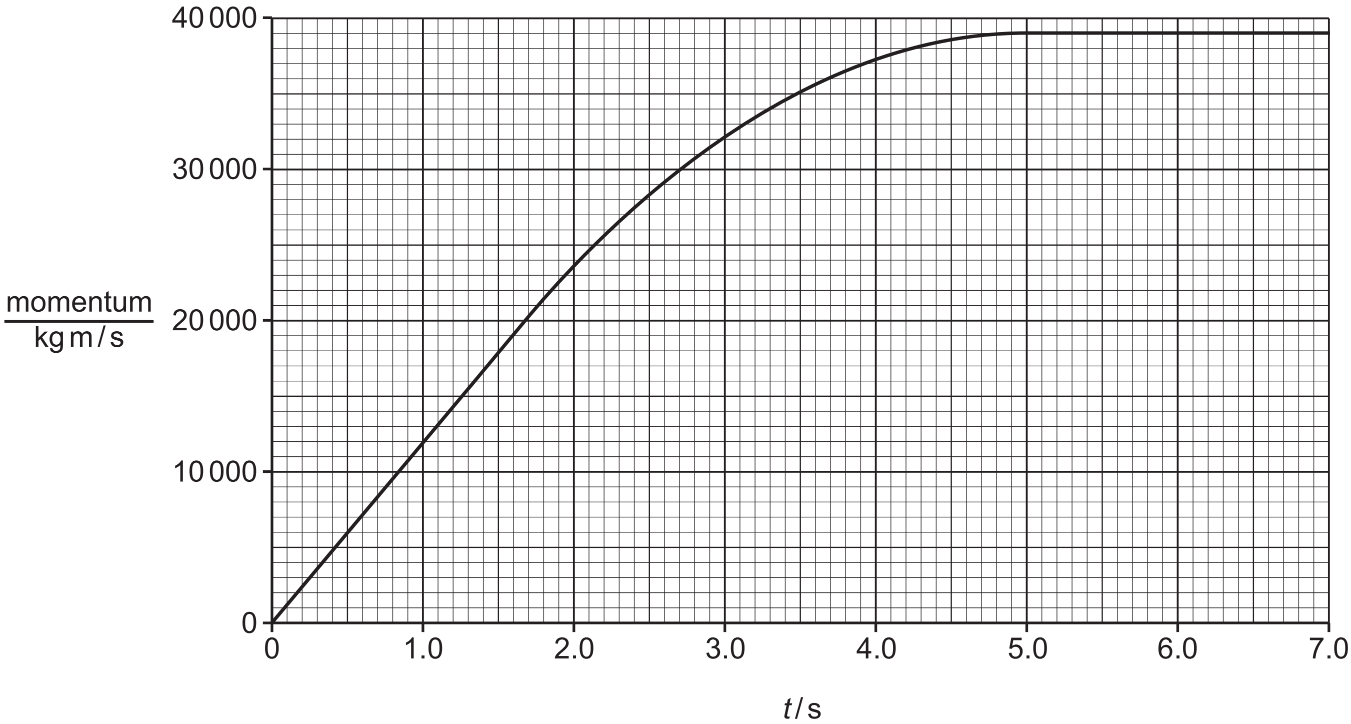

Fig. 1.1

(a) Use Fig. 1.1 to determine the resultant force acting on the car during the first 1.5 s of its motion.

resultant force = ... N [3]

(b) The car has mass *m*.

(i) When the momentum of the car is *p*, its kinetic energy is E_k.

Show that $\frac{p^2}{2m} = E_k$.

[2]

(ii) At $t = 6.0$ s, the kinetic energy of the car is 5.4×10^5 J.

Use Fig. 1.1 to determine the momentum *p* of the car at $t = 6.0$ s, and use the equation in **(b)(i)** to determine the mass *m* of the car.

Show your working.

p = ... kg m / s

m = ... kg
[3]

[Total: 8]

2 In a factory, an electric motor is used to lift the boxes shown in Fig. 2.1.

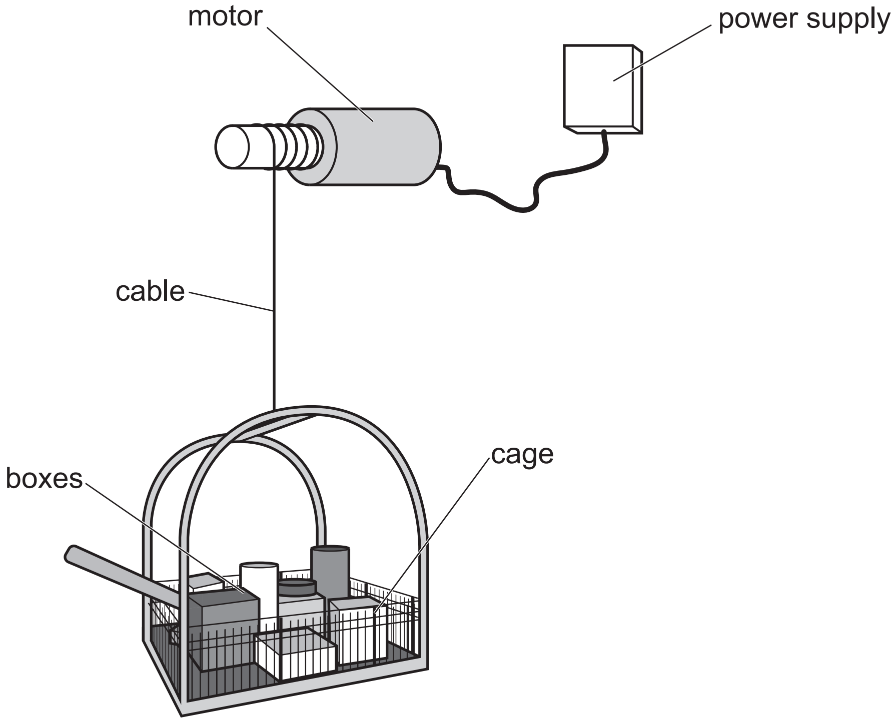

Fig. 2.1

The boxes are placed in a cage and the motor winds a cable around a cylinder to lift the cage and boxes.

The total mass of the boxes is 37 kg and they are lifted vertically through 13 m to a storage area.

(a) Calculate:

(i) the total weight of the boxes

weight = ... N [1]

(ii) the useful work done in lifting the boxes to the storage area.

useful work done = ... J [2]

(b) The e.m.f. of the power supply for the motor is 230 V. The current in the motor is 5.6 A.

It takes 11 s for the motor to lift the cage and boxes to the storage area.

Calculate:

(i) the total energy transferred electrically to the motor in 11 s

energy = ... J [2]

(ii) the percentage efficiency of the lifting process.

efficiency = ... % [1]

(c) Some of the energy transferred by the motor during the lifting process is not transferred usefully.

State **two** reasons why the efficiency of the lifting process is less than 100%.

1 ....

....

2 ....

....

[2]

[Total: 8]

3 Fig. 3.1 shows a small block of ice at 0 °C and a plastic cup that contains 0.24 kg of water.

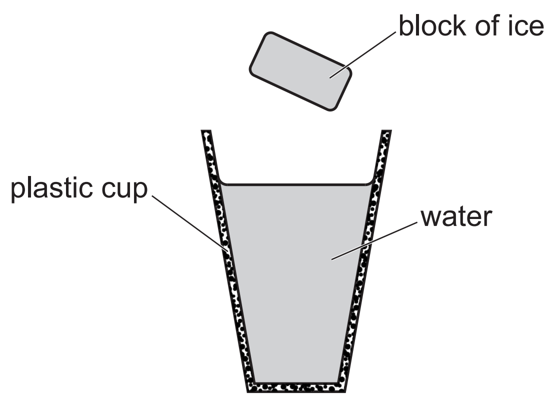

Fig. 3.1

The initial temperature of the water in the cup is 22.0 °C.

The block of ice is dropped into the water.

(a) Describe, in terms of molecules, how energy is transferred by conduction from the water to the ice.

....

....

....

.... [2]

(b) All of the ice melts and, at equilibrium, the temperature of the water in the cup is 6.0 °C.

(i) The specific heat capacity of water is 4200 J / (kg °C).

Calculate the energy transferred from the 0.24 kg of water as it cools.

energy = ... J [2]

(ii) Describe how the molecular structure of water at 6.0 °C differs from the molecular structure of ice at 0 °C.

....

....

....

.... [2]

(iii) The plastic cup containing water at 6.0 °C is left in a room where the room temperature is 22.0 °C. The temperature of the water in the cup rises slowly to room temperature.

When the water at 6.0 °C is left in a metal cup, the temperature of the water rises to room temperature more quickly.

State why the temperature of the water in the cup returns to room temperature more quickly when the cup is made from metal.

....

.... [1]

[Total: 7]

4 Fig. 4.1 shows a ray of light striking the left-hand surface of a thin glass converging lens.

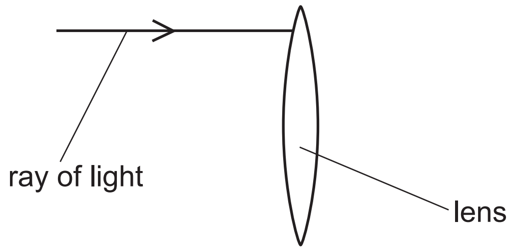

Fig. 4.1

(a) Explain why the ray refracts and changes direction as it enters the glass.

....

....

....

.... [2]

(b) Explain what is meant by:

(i) the principal focus (focal point) of a lens

....

....

....

.... [2]

(ii) the focal length of a lens.

....

.... [1]

(c) An object O of height 1.8 cm is placed at a point 2.2 cm to the left of the centre of the lens.

Fig. 4.2 is a full-scale diagram that shows the converging lens, its principal axis and its two principal focuses, F_1 and F_2.

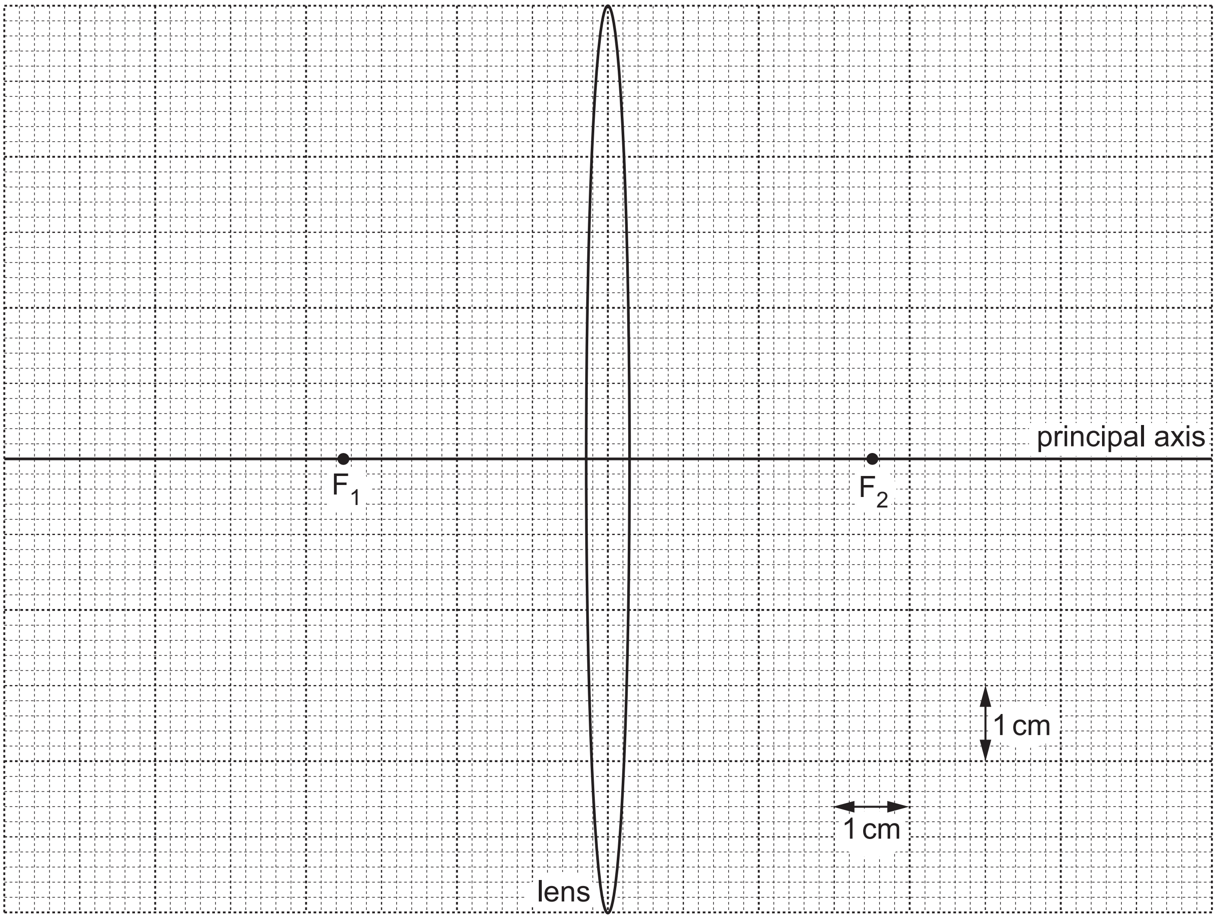

Fig. 4.2

(i) On Fig. 4.2, draw an arrow to represent the height and position of object O. The arrow should start on the principal axis. [1]

(ii) On Fig. 4.2, draw **two** rays from the tip of the arrow drawn in **(c)(i)** to locate the position of the tip of the image I of object O.

Draw an arrow to represent the image I of the object O. Label the image I. [3]

(iii) State whether the image I of the object O is a real or a virtual image, and explain your answer.

....

....

.... [1]

[Total: 10]

5 An iron beaker containing liquid X is placed on the bench in a laboratory.

Liquid X begins to evaporate slowly.

(a) Explain why the evaporation causes the temperature of liquid X to decrease.

....

....

....

.... [2]

(b) The iron beaker containing liquid X is placed on an induction heater as shown in Fig. 5.1.

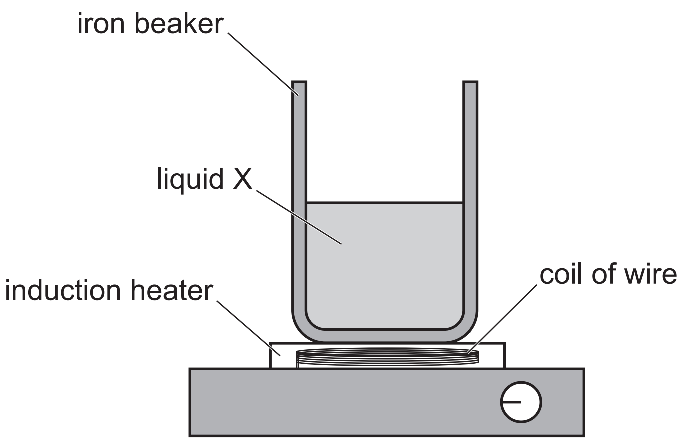

Fig. 5.1

(i) The induction heater contains a coil of wire in which there is a high-frequency alternating current (a.c.).

The alternating current in the coil generates a current in the base of the iron beaker by electromagnetic induction.

Explain how electromagnetic induction generates the current in the base of the iron beaker.

....

....

....

....

....

.... [3]

(ii) The current in the base of the iron beaker causes the base to become hot. The temperature of the liquid at point P just above the base increases.

Fig. 5.2 shows the position of point P.

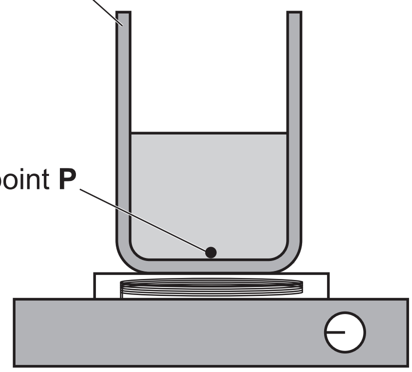

Fig. 5.2

Explain, in terms of particles, why the density of liquid X decreases as its temperature increases.

....

....

....

.... [3]

(iii) The decrease in the density of the liquid at point P causes the transfer of thermal energy throughout liquid X.

Explain how this happens.

....

....

....

.... [2]

[Total: 10]

6 A circuit consists of a battery of e.m.f. 9.0 V, a switch, a resistor P, an ammeter, a 4.0 Ω resistor and a voltmeter.

Fig. 6.1 is the circuit diagram of the circuit.

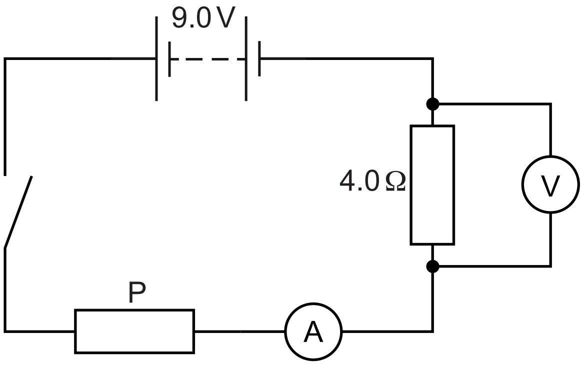

Fig. 6.1

(a) State Ohm's law.

....

....

.... [2]

(b) Resistor P is a cylinder of length l, made from conducting modelling clay.

Fig. 6.2 shows resistor P.

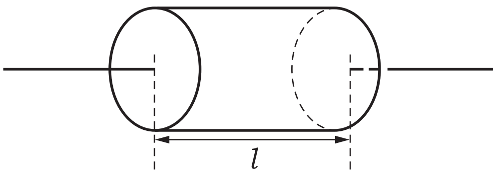

Fig. 6.2

P has a resistance of 8.0 Ω.

(i) The switch in the circuit in Fig. 6.1 is closed.

Calculate the reading on the ammeter.

ammeter reading = ... A [2]

(ii) Calculate the power transferred electrically to resistor P.

power transferred = ... W [2]

(c) Resistor P is removed from the circuit.

The conducting modelling clay from resistor P is reshaped to make a second cylindrical resistor that has the same volume as resistor P but has a length $\frac{l}{2}$.

Fig. 6.3 shows the reshaped resistor.

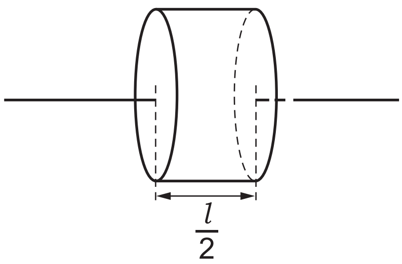

Fig. 6.3

(i) Calculate the resistance of the reshaped resistor.

resistance of reshaped resistor = ... Ω [2]

(ii) The reshaped resistor is connected into the circuit instead of resistor P.

Calculate the new reading on the voltmeter. Show your working.

voltmeter reading = ... V [2]

[Total: 10]

7 An insulating rod is made of plastic and is initially uncharged. The rod is rubbed with a cloth and becomes negatively charged.

(a) Describe, in terms of particles, what happens as the rod becomes negatively charged.

....

....

.... [2]

(b) A light ball has a thin conducting surface. The ball is suspended from the ceiling by an insulating thread. The ball is not charged.

The negatively charged rod is brought close to the ball.

Fig. 7.1 shows that the ball experiences a force attracting it towards the negatively charged rod.

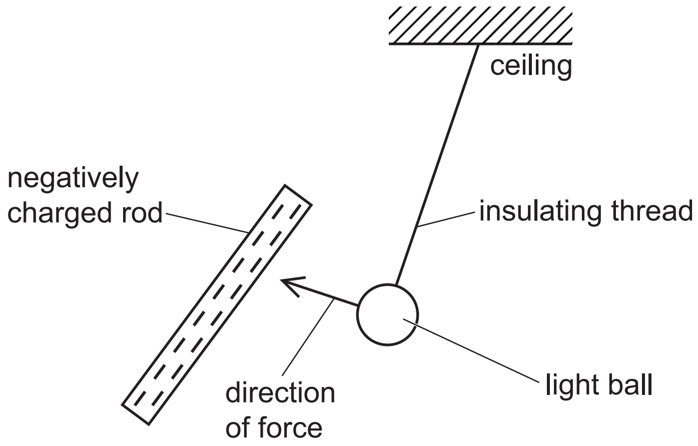

Fig. 7.1

(i) Explain, in terms of particles, how an electrical conductor differs from an electrical insulator.

....

....

.... [1]

(ii) The conducting surface of the ball contains both negatively charged particles and positively charged particles.

Explain what happens to the negatively charged particles and to the positively charged particles as the rod is brought close to the ball.

....

....

....

.... [3]

(iii) Explain why the resultant force on the ball is towards the rod.

....

....

....

.... [2]

[Total: 8]

8 The nuclide notation for the radioactive isotope radon-222 is $^{222}_{86}Rn$.

An atom of radon-222 decays by the emission of an alpha particle (α-particle).

(a) Describe how the composition of an atom of radon-222 differs from that of an atom of radon-224.

....

....

.... [2]

(b) Radon-222 decays to an isotope of polonium (Po).

Complete the nuclide equation for the decay of radon-222.

$$^{222}_{86}Ra \longrightarrow {}^{\dots\dots\dots}_{\dots\dots\dots}\alpha + {}^{\dots\dots\dots}_{\dots\dots\dots}Po$$

[3]

(c) Radon-222 is used in an alpha-particle scattering experiment.

Fig. 8.1 shows a beam of alpha particles from radon-222 hitting a very thin sheet of gold in a vacuum.

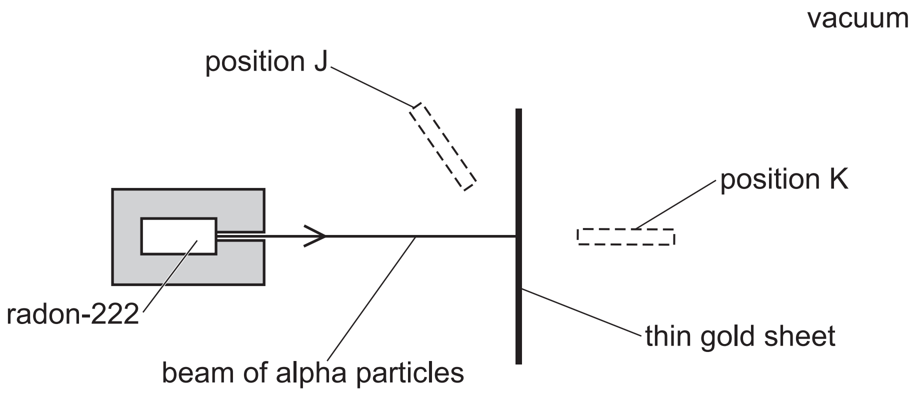

Fig. 8.1

An alpha-particle detector is moved around in the vicinity of the gold sheet. Two positions of the detector, J and K, are shown.

(i) Describe what is observed when the detector is at position J and when it is at position K.

position J ....

....

....

position K ....

....

.... [2]

(ii) Explain what these observations show about the structure of a gold atom.

....

....

....

.... [2]

[Total: 9]

9 An object moves through space. It is a large distance from any other object.

(a) There are no external forces acting on the object.

Describe **two** features of the motion of the object that are a consequence of Newton's first law.

1 ....

....

2 ....

.... [2]

(b) Planet X and Venus are two of the planets in the Solar System.

Fig. 9.1 shows the orbit of Venus and the orbit of planet X. Both orbits are approximately circular.

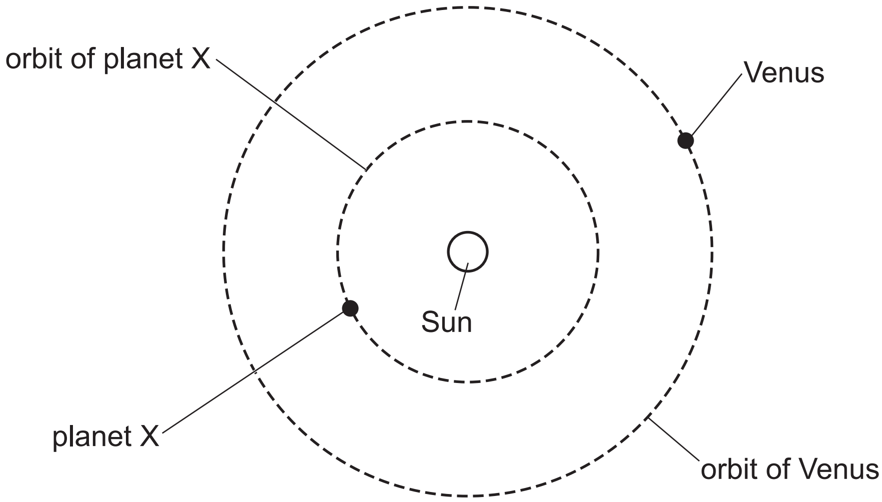

Fig. 9.1

Venus experiences an external force as it orbits the Sun.

(i) State why a force must act on Venus to keep it following an approximately circular orbit.

....

.... [1]

(ii) State what causes this force, and state the direction of the force.

cause ....

....

direction .... [3]

(iii) The average radius of the orbit of Venus is 1.1×10^{11} m. It takes Venus 5400 hours to complete one orbit of the Sun.

Calculate the average orbital speed of Venus around the Sun.

speed = ... m/s [2]

(iv) Planet X is closer to the Sun than Venus.

State the name of planet X and state how its orbital speed around the Sun compares with the orbital speed of Venus.

name ....

speed ....

.... [2]

[Total: 10]

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