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PHYSICS**0625/42**

Paper 4 Theory (Extended)

February/March 2025**1 hour 15 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 Fig. 1.1 shows a force–extension graph for a spring.

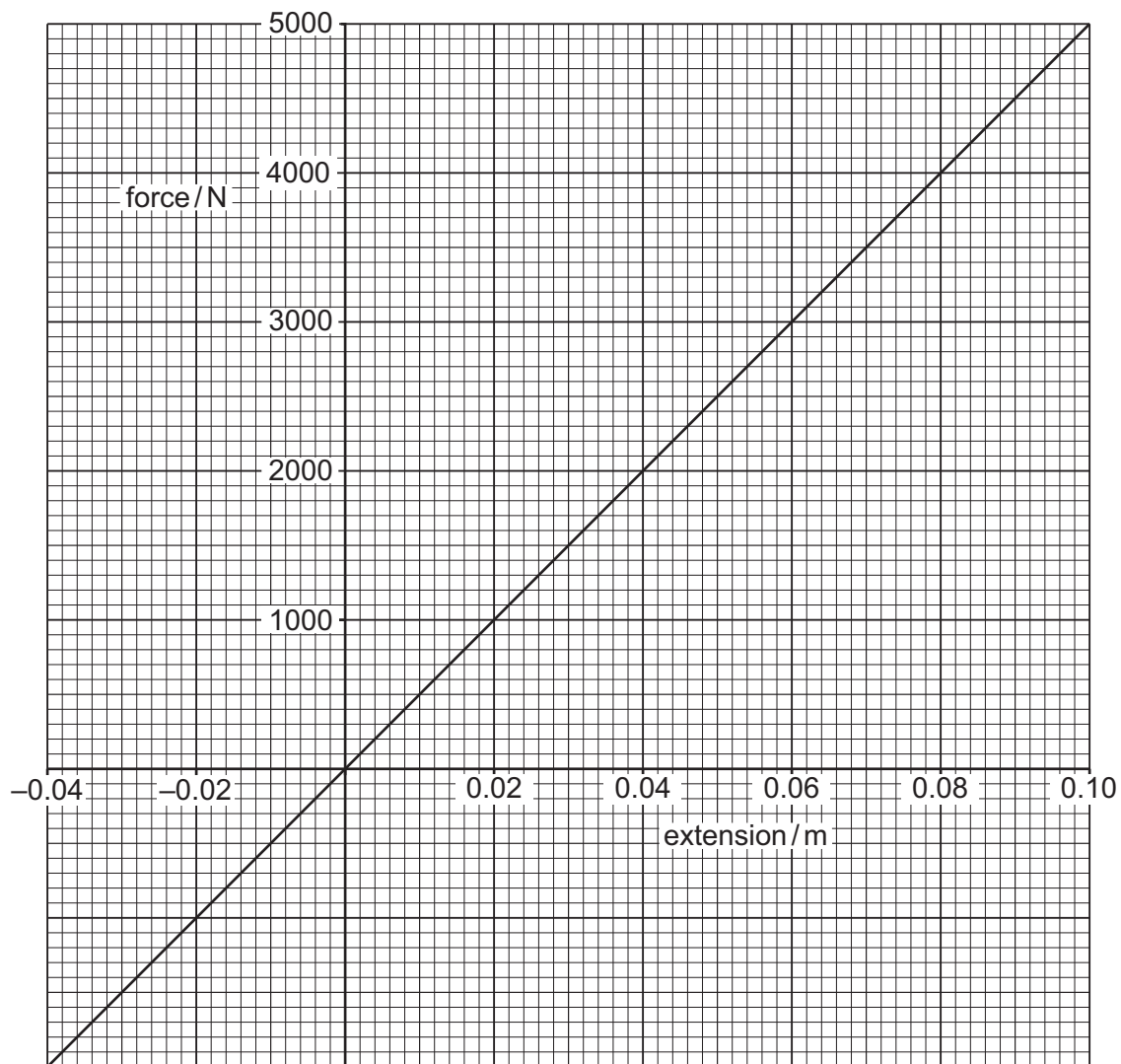


Fig. 1.1

(a) Calculate the spring constant k of the spring.

$$k = \dots\dots\dots [2]$$

(b) A student states that the spring has **not** reached the limit of proportionality when a force of 4500 N is applied to it.

State how the graph shows that this statement is true.

.....
 [1]





- (c) Springs can be compressed by forces. The spring described by Fig. 1.1 is compressed by a force F and has an extension of -0.025 m.

Determine F .

$$F = \dots\dots\dots [2]$$

- (d) State whether force is a scalar quantity or a vector quantity. Explain your answer.

.....
 [1]

[Total: 6]



- 2 Trolley A and trolley B are on a horizontal, frictionless bench. Trolley A moves to the right with a constant velocity $u = 0.44 \text{ m/s}$. Trolley B is stationary.

Fig. 2.1 shows trolley A before it collides with trolley B.

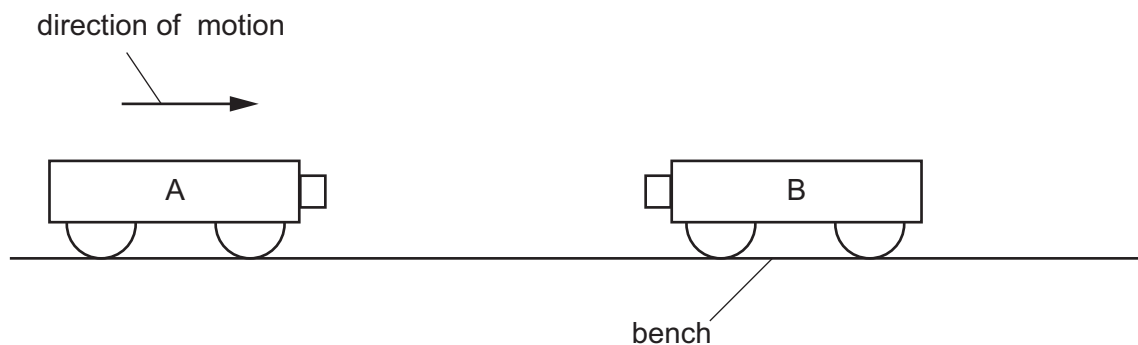


Fig. 2.1 (not drawn to scale)

- (a) State the momentum of trolley B before the collision. Explain your answer.

statement

explanation

[1]

- (b) After the collision, the two trolleys are joined together and travel with a constant velocity $v = 0.18 \text{ m/s}$ to the right. The mass of trolley A is 0.75 kg .

Calculate the mass of trolley B.

mass of trolley B = [3]





- (c) (i) The trolleys move onto a rough surface which exerts a constant force F on the trolleys and brings them to rest in 2.6 s.

Calculate F .

$$F = \dots\dots\dots [2]$$

- (ii) A different rough surface exerts a smaller resistive force on the trolleys. State how this affects the time taken to bring the trolleys to rest. Explain your answer.

statement

explanation

.....

[1]

[Total: 7]



3 Fig. 3.1 shows a mains electric heater used to heat a small room.

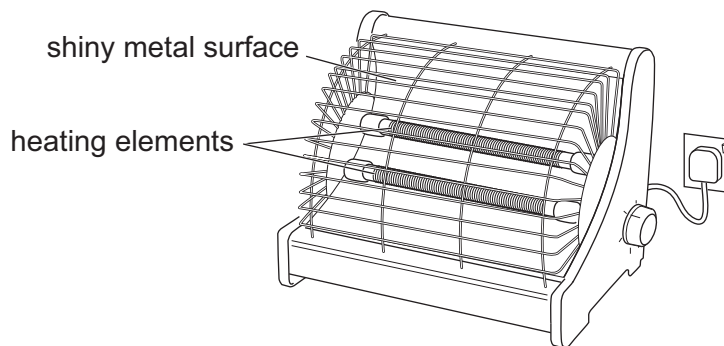


Fig. 3.1

- (a) State the region of the electromagnetic spectrum which radiates thermal energy from the heater.

..... [1]

- (b) Explain why the shiny metal surface behind the heating elements increases the thermal energy radiated into the room.

.....

 [2]

- (c) The metal outer casing of the heater is earthed. State why this is an important safety feature.

.....
 [1]





- (d) The mains voltage is 230 V. The two identical heating elements are connected in parallel. Each heating element has a resistance of $89\ \Omega$.

(i) Calculate the current in **one** heating element.

current = [2]

- (ii) Show that the electrical power of the heater is approximately 1200 W. State any equation you use in words or symbols.

[2]

- (iii) The heater is 95% efficient at converting electrical work done to thermal energy.

Calculate the thermal energy emitted by the heater in (d)(ii) in 60 s. Give your answer to **two** significant figures.

thermal energy = [3]

[Total: 11]





- 4 A train has a maximum speed of 200 km/h. It accelerates from rest with constant acceleration of 0.70 m/s^2 .

(a) (i) Define acceleration.

.....
 [1]

(ii) Show that the maximum speed of the train is approximately 56 m/s.

[2]

(iii) Calculate the time taken for the train to reach its maximum speed.

time = [2]

(b) (i) The train has a total mass of 440 000 kg. Calculate the force which causes the acceleration of the train.

force = [2]

(ii) The train travels into a headwind. The force of this headwind opposes the motion of the train. State and explain the effect of this force on the motion of the train.

statement

explanation

[1]

[Total: 8]



- 5 A light-dependent resistor (LDR) has a low resistance in high light intensity and a high resistance in the dark.

(a) Sketch a graph of resistance (y -axis) against light intensity (x -axis) for an LDR.

[2]

- (b) Fig. 5.1 shows part of the electric circuit used to turn on a light when it is dark.

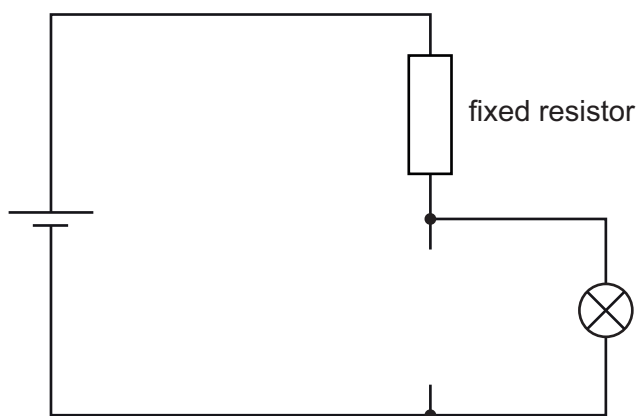


Fig. 5.1

- (i) Complete the circuit in Fig. 5.1 with the symbol for a light-dependent resistor (LDR). [1]
- (ii) Explain why the lamp is off in the light and the lamp is on in the dark. Use ideas about potential difference (p.d.) in your answer.

.....

.....

.....

..... [3]

[Total: 6]





- 6 Fig. 6.1 shows an object O which is 5.0 cm away from the centre of a thin, converging lens L. The focal length of L is 3.0 cm. Fig. 6.1 is drawn to full scale.

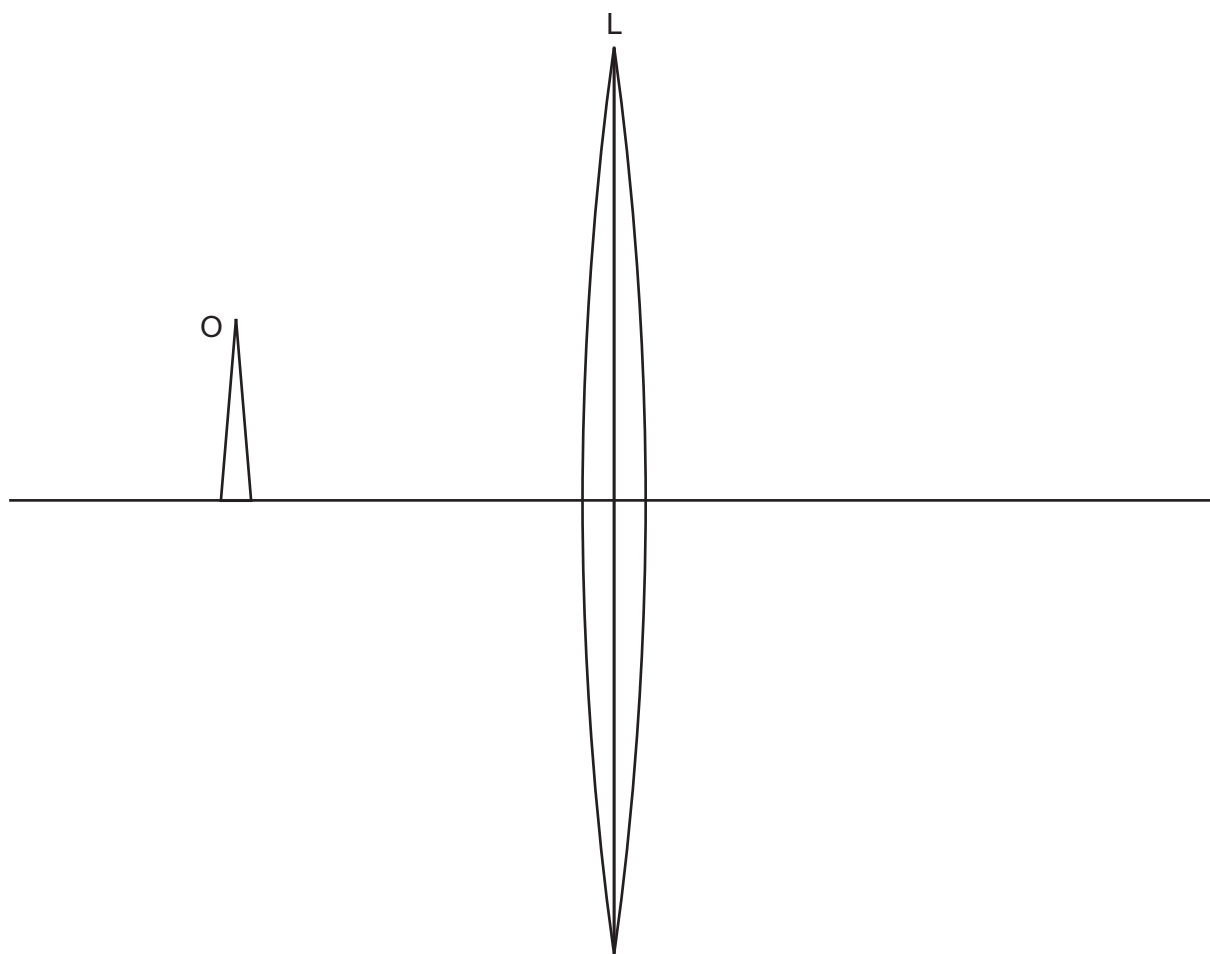


Fig. 6.1

- (a) (i) On Fig. 6.1, label the principal axis with a P. [1]
- (ii) On Fig. 6.1, place a letter X at a focal point. [1]
- (iii) On Fig. 6.1, draw two rays from O to locate the tip of the image produced by the lens. [2]





- (iv) In Table 6.1, place a tick in the right-hand column next to **all** the terms that describe the image in (a)(iii).

Table 6.1

diminished	
enlarged	
inverted	
real	
same size	
upright	
virtual	

[3]

- (b) The object moves closer to L. The new distance between L and the object is less than the focal length of L.

Describe how the new image is different from the image in (a)(iv).

.....

.....

..... [2]

[Total: 9]





- 7 (a) Fig. 7.1 is a scale drawing of light waves approaching a narrow slit.

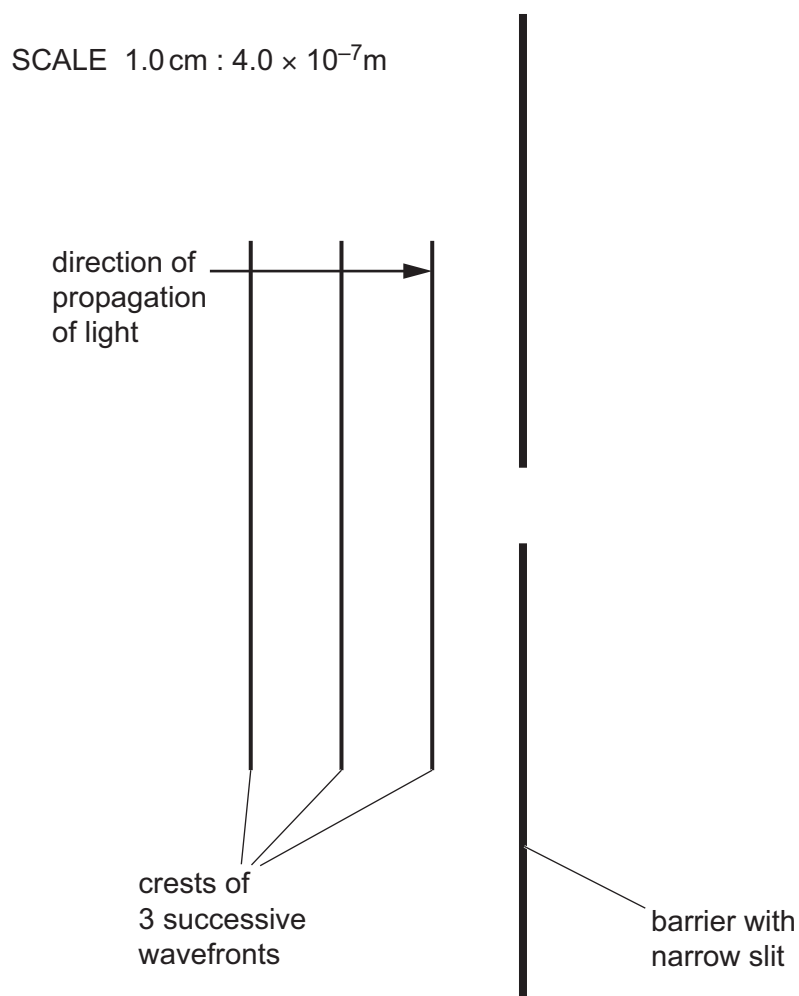


Fig. 7.1

- (i) Name the wave effect produced by the narrow slit.

..... [1]

- (ii) Using Fig. 7.1, determine the wavelength of the light. Give your answer to **two** significant figures.

wavelength = [2]

- (iii) On Fig. 7.1, draw **three** wavefronts that have passed through the narrow slit. [3]



(b) A foghorn emits a sound with frequency 380 Hz. The sound is heard by a ship 2.5 km away from the foghorn. The speed of sound in air is 330 m/s.

- (i) Show that the wavelength of the sound is approximately 0.9 m.
State any equation you use in words or symbols.

[2]

- (ii) Calculate the time it takes for sound to travel to the ship from the foghorn.

time = [2]

[Total: 10]





- 8 Fig. 8.1 shows a metal rod suspended in the magnetic field produced by a pair of permanent magnets. The metal rod is connected to a cell and there is a current in the metal rod.

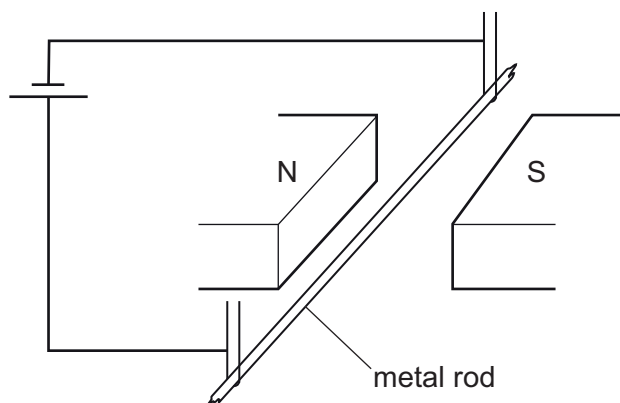


Fig. 8.1

- (a) State the direction of the force on the metal rod due to the current.

Explain your answer.

direction of force

explanation

.....

.....

[3]

- (b) The connections to the cell are reversed.

State how this change affects the force on the metal rod.

..... [1]





(c) Two magnets and a cell are used to make a simple electric motor as shown in Fig. 8.2.

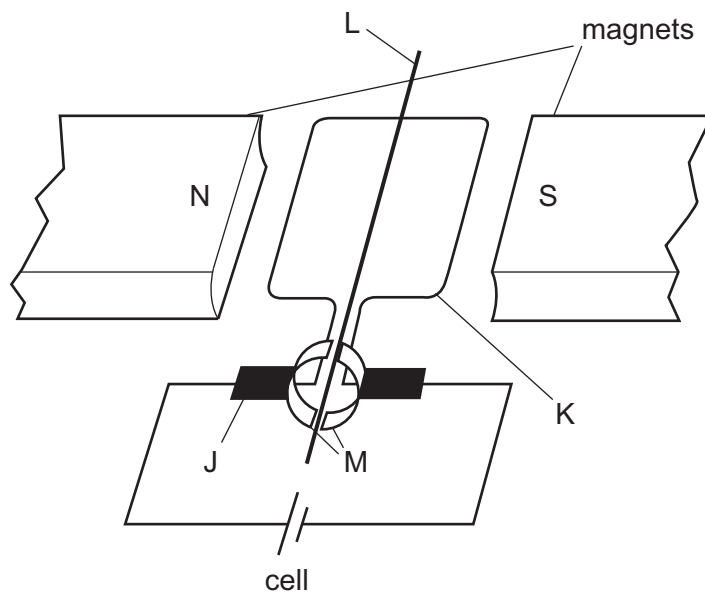


Fig. 8.2

Describe the function of parts J, K, L and M.

J

.....

K

.....

L

.....

M

.....

[4]

[Total: 8]





- 9 Strontium-90 is a radioactive isotope of strontium. The nuclide notation for strontium-90 is:



- (a) (i) Explain what isotopes are.

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

- (ii) Complete Table 9.1 for strontium-90.

Table 9.1

particle	number in one atom	location
	38	outside nucleus
neutron		
	38	inside nucleus

[2]



(b) Strontium-90 is used to measure the thickness of metal sheets in industry. Strontium-90 decays by emitting beta (β) particles which pass through a metal sheet to a detector.

- (i) One metal sheet is 0.75 mm thick. Suggest why strontium-90 is a suitable radioactive source to measure the thickness of the metal sheets.

.....

 [2]

- (ii) The half-life of strontium-90 is approximately 27 years. Fig. 9.1 shows the shape of a decay curve.

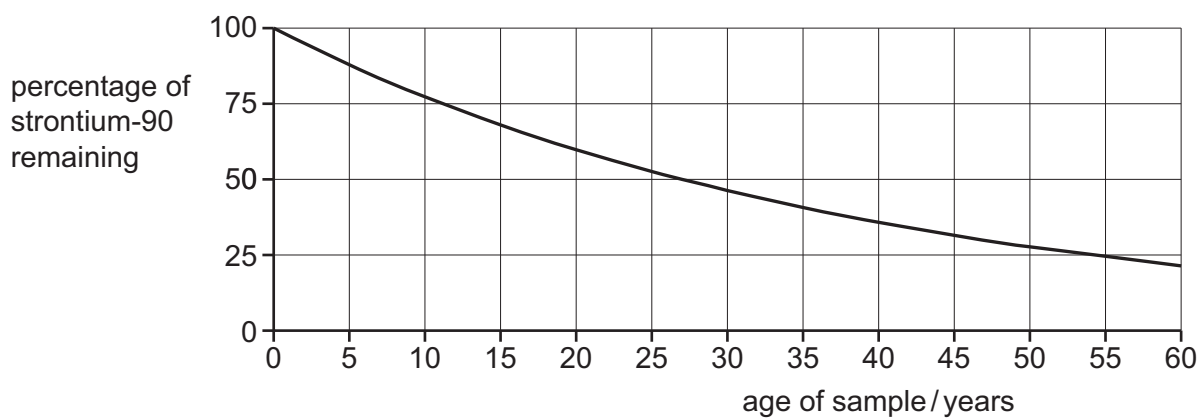


Fig. 9.1

The strontium-90 source is replaced with a new source after 15 years. Using Fig. 9.1, suggest why a strontium-90 source that is more than 15 years old needs to be replaced with a new source.

.....
 [2]

[Total: 7]



- 10 Fig. 10.1 shows the path of the Earth as it orbits the Sun. X is a position on the Earth where scientists observe the apparent motion of the Sun throughout the year.

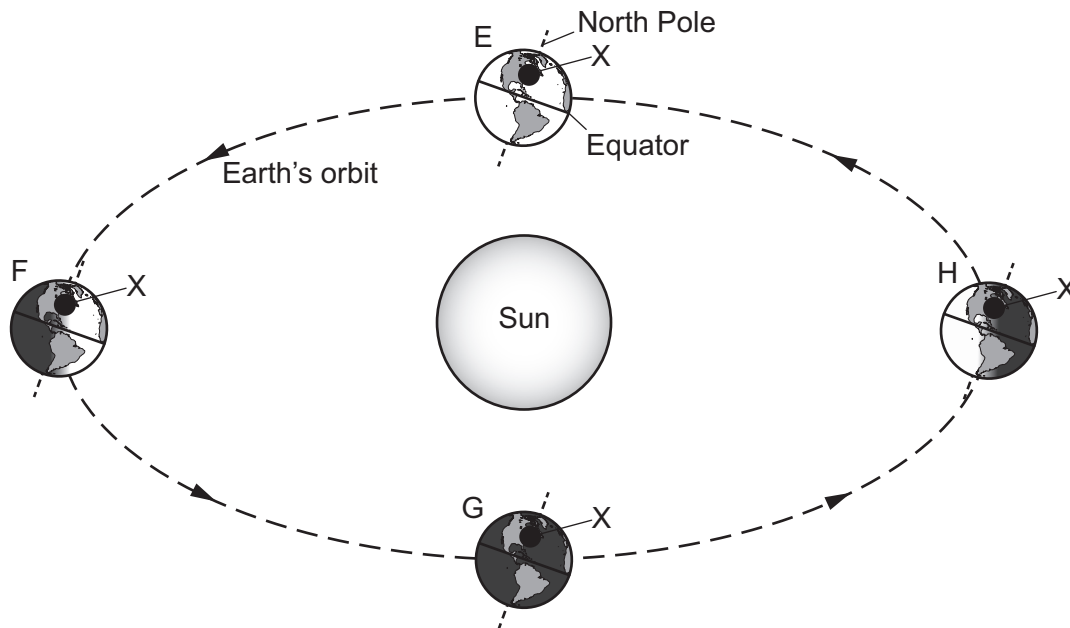


Fig. 10.1

- (a) Determine how many days it takes the Earth to move around its orbit from F to G. Explain your answer.

number of days =

explanation

[2]

- (b) Fig. 10.1 shows four positions E, F, G and H of the Earth in its orbit of the Sun.

(i) Identify the position of the Earth when it is summer at X. [1]

(ii) Identify the position of the Earth when it is winter at X. [1]



- (c) The orbital speed of the Earth around the Sun is approximately $3.0 \times 10^4 \text{ m/s}$.

Calculate the average radius of the Earth's orbit.

radius = [3]

- (d) Earth is a planet in the Solar System. State **one other** type of naturally occurring object that is present in the Solar System.

..... [1]

[Total: 8]





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