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PHYSICAL SCIENCE

0652/41

Paper 4 Theory (Extended)

October/November 2024

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.

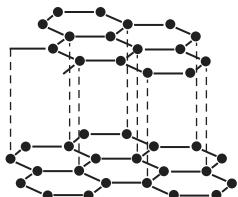
INFORMATION

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

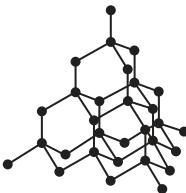
This document has **24** pages. Any blank pages are indicated.



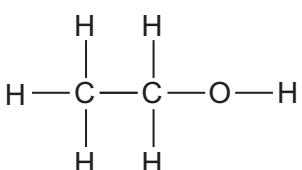
1 (a) Fig. 1.1 shows the structures of some substances, A–F.



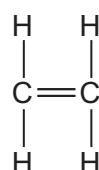
A



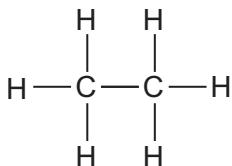
B



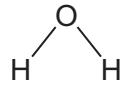
C



D



E



F

Fig. 1.1

Use the letters A–F to answer the questions that follow.

Each letter may be used once, more than once or not at all.

State which substance:

(i) has the molecular formula C_2H_6

..... [1]

(ii) reacts with bromine in an addition reaction

..... [1]

(iii) is an alkane

..... [1]

(iv) is formed by fermentation

..... [1]

(v) is a product of the complete combustion of methane

..... [1]

(vi) has a giant structure and is used as a lubricant.

..... [1]





(b) Carbon dioxide, CO_2 , is a covalent compound.

Complete Fig. 1.2 to show the dot-and-cross diagram for a molecule of CO_2 .

Show outer shell electrons only.

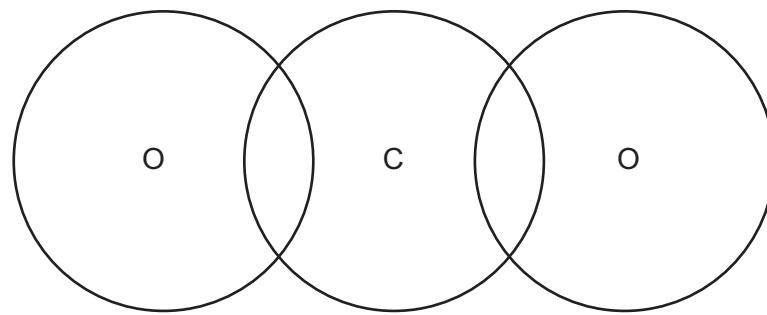


Fig. 1.2

[2]

[Total: 8]





2 (a) A long thin wire is attached to the ceiling, as shown in Fig. 2.1.

Different loads are suspended from the wire.

The extension for the different loads is measured.

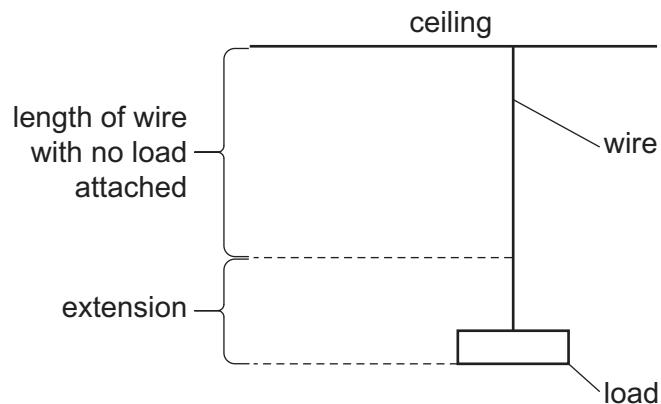


Fig. 2.1

Fig. 2.2 shows a graph of the results.

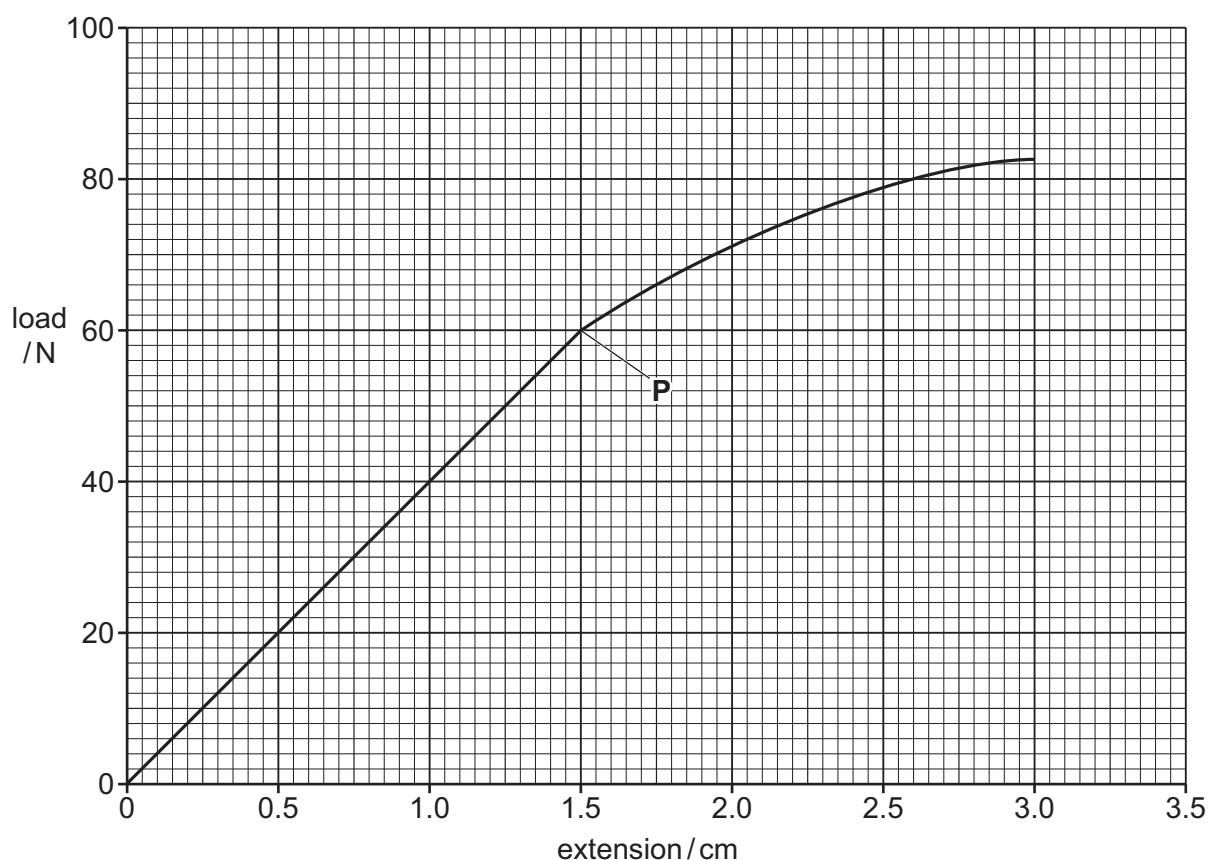


Fig. 2.2





(i) Calculate the spring constant for the wire.

Give a suitable unit.

spring constant = unit [3]

(ii) Name point P shown in Fig. 2.2.

..... [1]

(b) As the wire is stretched it becomes thinner.

Name an instrument suitable for measuring the diameter of a thin wire.

..... [1]

(c) Describe how changing the length and changing the cross-sectional area of a wire affects the electrical resistance.

length

.....

cross-sectional area

.....

[2]

[Total: 7]





3 (a) Sodium chloride, NaCl , is an ionic compound.

(i) Complete Fig. 3.1 to show the arrangement of the electrons in the ions in NaCl .

Show the charges on the two ions.

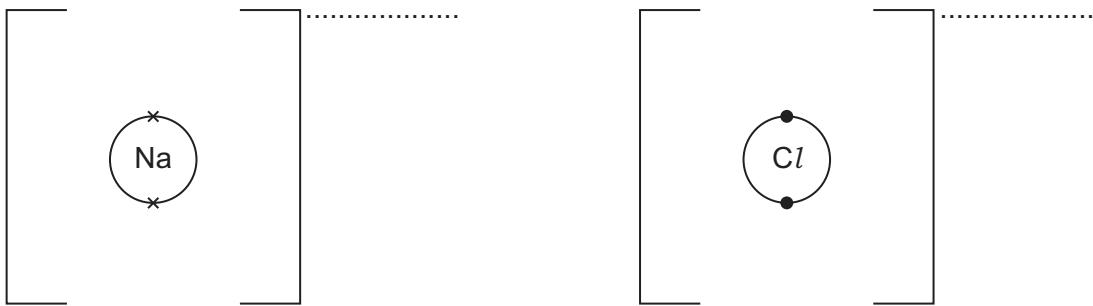


Fig. 3.1

[3]

(ii) Complete the sentences which describe the ionic structure of NaCl .

NaCl is a structure.

The ions are in a arrangement.

[2]

(b) Chlorine is an element in Period 3 of the Periodic Table.

Explain how the electronic structure of chlorine shows this information.

.....
.....

[1]

(c) Chlorine reacts with iron to form iron(III) chloride, FeCl_3 .

Write the symbol equation for this reaction.

.....

[2]

(d) Chlorine, bromine and astatine are in Group VII of the Periodic Table.

Chlorine is a pale yellow-green gas at room temperature and pressure.

Bromine is a red-brown liquid at room temperature and pressure.

Predict the colour and state of astatine at room temperature and pressure.

colour

state

[2]





(e) Explain why neon will **not** react with chlorine.

.....
.....

[1]

[Total: 11]





4 (a) A radioactive source emits three different types of radiation.

Name the **three** types of radiation.

1

2

3

[3]

(b) Fig. 4.1 shows the deflection of the three types of radiation, **A**, **B** and **C**, in the electric field between two metal plates.

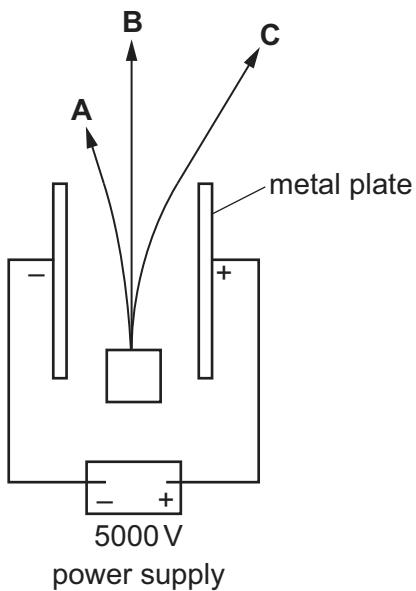


Fig. 4.1

(i) Explain why **C** deflects more than **A**.

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

(ii) Explain why **B** is **not** deflected.

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





(c) Fig. 4.2 shows a ball suspended between two metal plates.

The ball is suspended using an insulating thread.

The ball is light and is covered with thin metal foil.

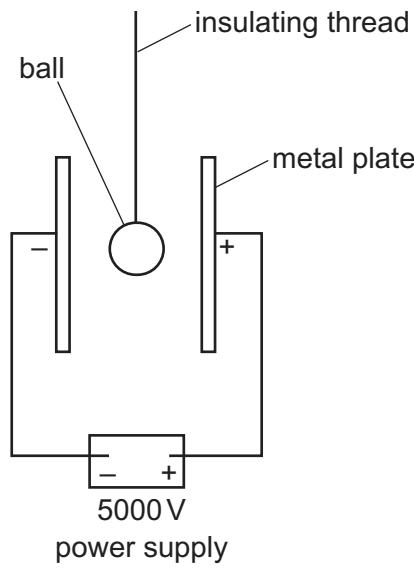


Fig. 4.2

The ball is given a positive charge and released.

The ball swings to the left and touches the negative plate.

(i) Explain in terms of transfer of particles what happens when the ball touches the negative plate.

.....
.....

[2]

(ii) The ball swings backwards and forwards hitting the plates on either side.
After touching the positive plate, the ball becomes positively charged.

State why the ball then moves towards the negative plate.

.....
.....

[1]

[Total: 8]





5 Calcium carbonate is heated strongly. Calcium oxide and carbon dioxide are produced. The reaction is endothermic.

The equation for the reaction is shown.



(a) State the type of reaction that takes place.

..... [1]

(b) Calculate the mass of CaO produced from 15.3g of CaCO_3 .
 $[A_r: \text{Ca}, 40; \text{C}, 12; \text{O}, 16]$

Use the following steps.

- Determine the relative molecular mass, M_r , of CaCO_3 .

$$M_r = \dots$$

- Use the equation for the reaction to determine the stoichiometric ratio of $\text{CaCO}_3 : \text{CaO}$.

$$\text{ratio} = \dots : \dots$$

- Calculate the mass of CaO produced from 15.3g of CaCO_3 .

$$\text{mass of CaO} = \dots \text{g}$$

[3]

(c) Explain why **one** of the products of this reaction is an atmospheric pollutant.

..... [1]





(d) Explain why it is important to treat some soils with calcium carbonate.

.....
.....
.....
.....

[2]

(e) Circle the term that classifies calcium oxide.

acidic

amphoteric

basic

neutral

[1]

[Total: 8]





6 Fig. 6.1 shows a type of simple d.c. electric motor which consists of a metal wheel, liquid mercury and two magnets.

A current passes through the metal wheel and through the mercury.

The wheel rotates in the direction shown.

Key

← direction of current

↖ direction of rotation of wheel

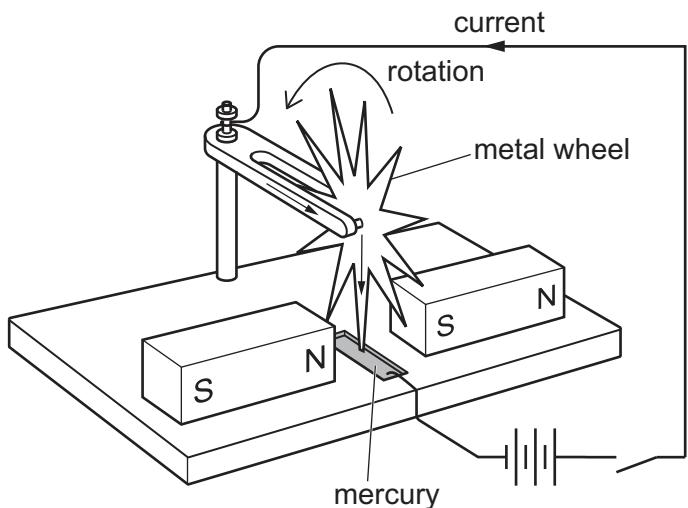


Fig. 6.1

(a) The moment of the force on the wheel is 0.72 N cm.

The distance from the centre of the wheel to the surface of the mercury is 6 cm.

Calculate the force on the wheel.

force = N [2]





(b) A student suggests four changes, **A–D**, to the motor in Fig. 6.1.

- A** Increase the current.
- B** Reverse the direction of the current.
- C** Reverse the poles of **one** magnet.
- D** Reverse the poles of **both** magnets.

(i) Circle the **two** changes which each cause the wheel to rotate in the opposite direction.

A **B** **C** **D**

[2]

(ii) Circle the change which stops the wheel rotating.

A **B** **C** **D**

[1]

(c) The battery is replaced by an ammeter as shown in Fig. 6.2.

Key

→ direction of current

↖ direction of rotation of wheel when turned by hand

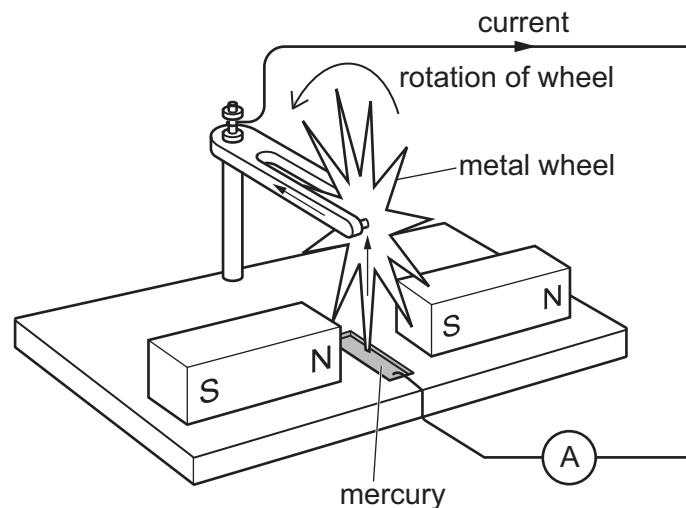


Fig. 6.2

The wheel is turned by hand in the same direction as in Fig. 6.1.

An electromotive force (e.m.f.) is induced.

The e.m.f. causes a current in the opposite direction to the current in Fig. 6.1.

Explain why this current must be in the opposite direction to Fig. 6.1.

.....

.....

.....

[1]

[Total: 6]

[Turn over]





7 Magnesium reacts with dilute hydrochloric acid.

(a) Suggest the pH of dilute hydrochloric acid.

pH = [1]

(b) Describe the difference between acids and bases in terms of transfer of protons.

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

(c) The magnesium and dilute hydrochloric acid react together in a conical flask.

(i) Bubbles of gas are observed during the reaction.

Name the gas produced.

..... [1]

(ii) The reaction stops. Some magnesium is left in the conical flask.

Suggest a conclusion using this information.

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

(d) No bubbles of gas are produced when aluminium is added to dilute hydrochloric acid.

Explain this observation.

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

(e) State **two** properties of aluminium that explain why it is used in aircraft parts.

1

2

[2]

(f) Aluminium is used in the test for nitrate ions.

State the type of reaction that happens in this test.

..... [1]

[Total: 8]





8 (a) Fig. 8.1 shows transverse waves on a section of a long rubber cord.

The waves travel a distance of 2.7 m in 0.80 s.

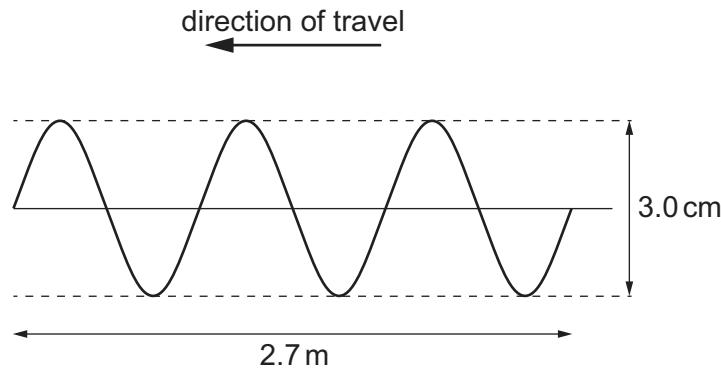


Fig. 8.1 (not to scale)

(i) On Fig. 8.1 draw an arrow (\leftrightarrow or \uparrow) to indicate the amplitude of the waves. [1]

(ii) State the number of complete waves shown in Fig. 8.1.

number of complete waves = [1]

(iii) Determine the wavelength of the waves in Fig. 8.1.

wavelength = m [1]

(iv) Calculate the frequency of the waves in Fig. 8.1.

frequency = Hz [2]

(v) Calculate the speed of the waves in Fig. 8.1.

speed of waves = m/s [2]

(b) Describe what is meant by a transverse wave.

.....

 [2]

[Total: 9]
 [Turn over]





9 Fig. 9.1 shows a fractionating column used in the fractional distillation of petroleum.

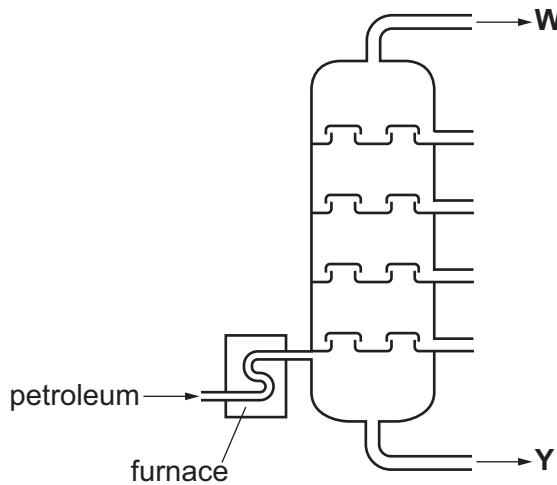


Fig. 9.1

(a) Write an **X** in the hottest part of the fractionating column. [1]

(b) Name the fraction produced at **Y**.

..... [1]

(c) Naphtha is a fraction produced from petroleum.

State **one** use for naphtha.

..... [1]

(d) Compare the properties of the fractions produced at **W** with the fractions produced at **Y**.

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

[Total: 5]





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Question 10 starts on page 18.





10 (a) Fig. 10.1 shows a ray of light travelling through air and entering a rectangular glass block.

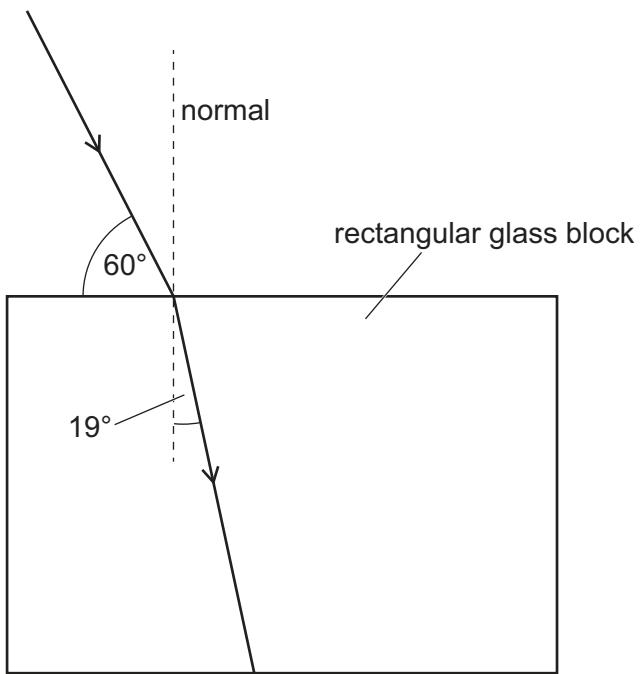


Fig. 10.1

State the angle of incidence and the angle of refraction for the ray as it enters the glass block.

angle of incidence =°

angle of refraction =°

[1]

(b) A different glass block has a refractive index of 1.6.

(i) Determine the speed of light in this glass block.

[speed of light in air = 3.0×10^8 m/s]

speed of light in glass = m/s [2]





(ii) A ray of light enters the glass block in (b)(i).

The angle of incidence is 50° .

Calculate the angle of refraction.

angle of refraction = $^\circ$ [2]

(c) Fig. 10.2 shows a ray diagram of an object, a lens and the image formed by the lens.

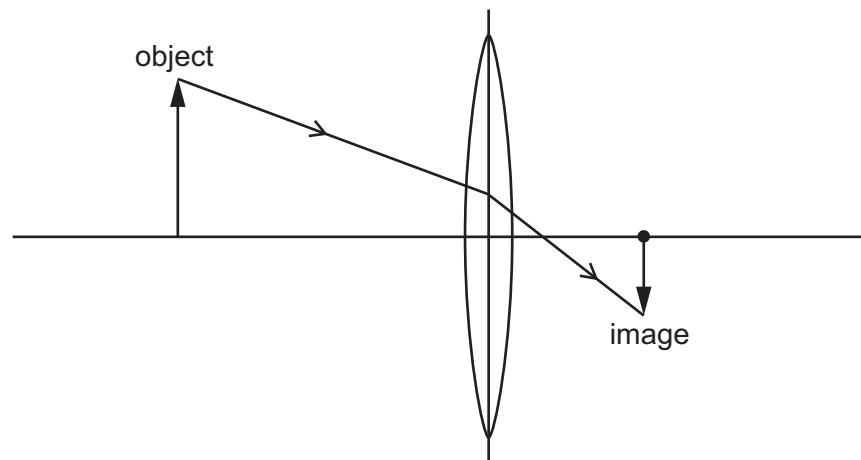


Fig. 10.2

(i) On Fig. 10.2, draw **one** ray from the top of the object to the image that passes through the focal point of the lens.

Label the focal point of the lens with **F**.

[2]

(ii) The image in Fig. 10.2 is diminished, inverted and real.

Describe the meaning of these terms.

diminished

inverted

real

[3]

[Total: 10]



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The Periodic Table of Elements

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

lanthanoids

actinoids