CAMBRIDGE
International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/42**

Paper 4 Theory (Extended) **February/March 2026**

2 hours

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. Do **not** use correction fluid or tape.
- 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 120.
- 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 **28** pages.

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[Turn over

1 **(a)** Reproduction is one of the characteristics of living organisms.

State **two** other characteristics of living organisms.

1 .....

2 .....

[2]

(b) **(i)** Figure 1.1 shows part of the human male reproductive system.

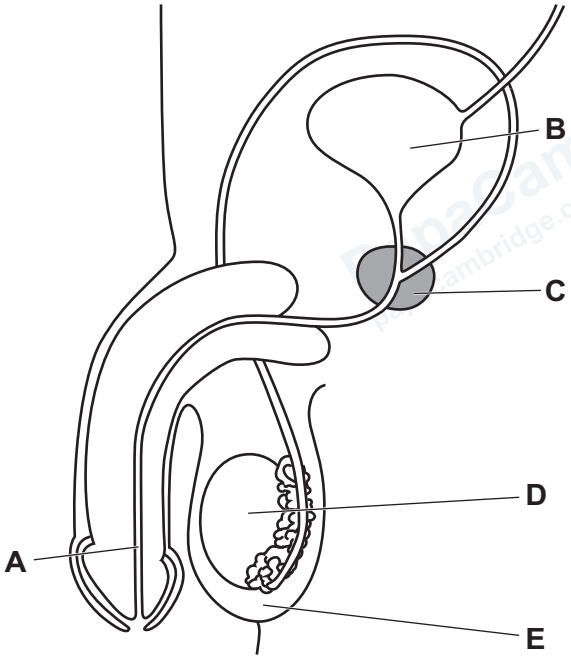


Figure 1.1.

Using letters **A–E** in Figure 1.1, identify the part:

- where testosterone is made .....
- that produces fluid to transport sperm. .....

[2]

(ii) Testosterone is a hormone.

Complete the description of a hormone.

A hormone is a chemical substance, produced by a .....

and carried by the ..... which alters the activity

of one or more specific ..... organs.

[2]

(iii) Sperm are the male gametes.

Explain two ways a sperm is adapted for its function.

1 .....

.....

2 .....

.....

[2]

(c) Plants also reproduce sexually by fertilisation of gametes.

Describe the process of fertilisation in plants.

.....

.....

..... [2]

[Total: 10]

2 **(a)** **(i)** Osmosis and diffusion are processes that involve movement of particles.

State **one** similarity and **one** difference between osmosis and diffusion.

similarity .....

.....

.....

difference .....

.....

..... [2]

(ii) Active transport is another type of movement of particles.

Describe active transport.

.....

.....

..... [2]

(b) Respiration is a process in human cells.

Table 2.1 shows some statements about aerobic respiration and anaerobic respiration in muscle cells during vigorous exercise.

Place ticks (✓) in Table 2.1 to show which statements are about aerobic respiration only, anaerobic respiration only or both aerobic and anaerobic respiration.

Table 2.1

	aerobic respiration only	**anaerobic respiration only**	**both aerobic and anaerobic respiration**
produces carbon dioxide			
produces water			
releases energy			
uses glucose			
uses oxygen			

[4]

(c) During anaerobic respiration an oxygen debt builds up.

Outline how the oxygen debt is removed after exercise.

.....

.....

.....

.....

.....

..... [3]

[Total: 11]

3 **(a)** Chemical digestion involves enzymes.

List **all** the chemical elements that make up an enzyme molecule.

..... [1]

(b) **(i)** The enzyme amylase is secreted from salivary glands in the human digestive system.

State **two** other places in the human digestive system where amylase is secreted.

1 .....

2 .....

[2]

(ii) Amylase breaks down starch.

State the name of the molecules produced in the breakdown of starch by amylase.

..... [1]

(iii) Describe the test for starch.

Include the colour change observed for a positive result.

test .....

colour change:

starting colour .....

final colour .....

[2]

(c) Figure 3.1 is a graph showing the effect of temperature on amylase activity.

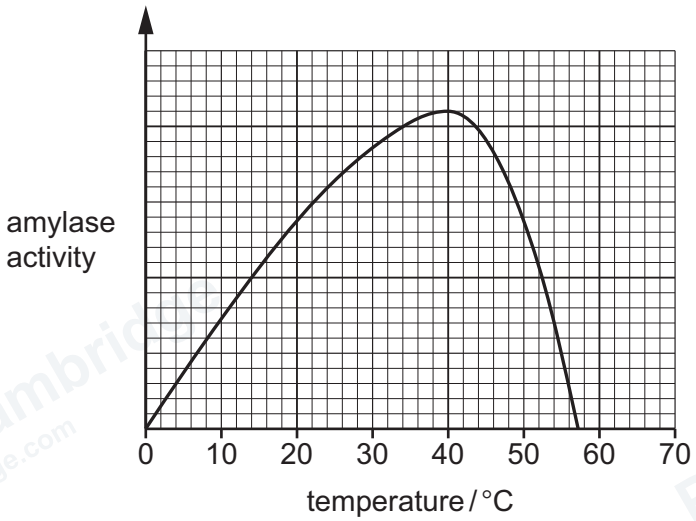


Figure 3.1

Explain the effect of increasing temperature from 0 °C to 40 °C on amylase activity shown in Figure 3.1.

.....

.....

.....

.....

.....

..... [3]

(d) Explain why amylase is **not** active in the stomach.

Use ideas about pH.

.....

.....

.....

..... [2]

[Total: 11]

4 **(a)** **(i)** Circle the word that describes a unit containing a community of organisms and their environment interacting together.

biodiversity **ecosystem** **habitat** **population** [1]

(ii) Name the principal source of energy input to biological systems.

..... [1]

(b) Figure 4.1 shows part of a woodland food web.

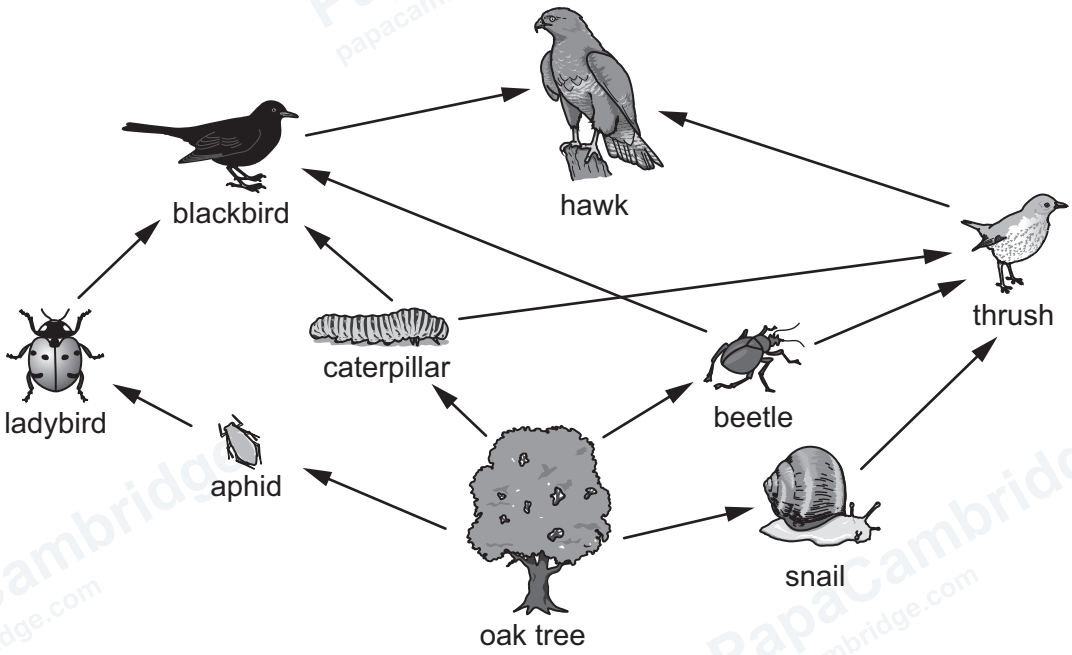


Figure 4.1

(i) Use Figure 4.1 to draw a food chain including the blackbird as a tertiary consumer.

.....

.....

..... [2]

(ii) Use Figure 4.1 to identify **two** herbivores.

..... and .....

[2]

(c) Explain why food chains usually have fewer than five trophic levels.

.....

.....

..... [2]

[Total: 8]

5 **(a)** Chromatography is used to separate mixtures of soluble coloured substances.

(i) State what is meant by soluble.

..... [1]

(ii) Figure 5.1 shows the results of a chromatography experiment.

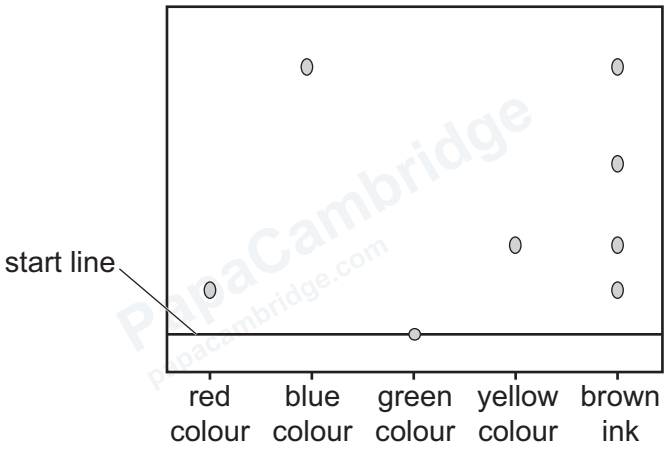


Figure 5.1

State **two** conclusions that can be made from Figure 5.1 about the brown ink.

1 .....

.....

2 .....

.....

[2]

(iii) A student calculates the R_f value of a colour to be 0.48.

The colour travels 3.6 cm from the start line.

Calculate the distance the solvent travels.

distance the solvent travels = ... cm [3]

(b) Clean, dry air is a mixture of gases.

State the percentage of clean, dry air which is nitrogen.

.....% [1]

(c) Nitrogen is used in the manufacture of fertilisers.

A bag of fertiliser contains 7.36 kg of ammonium nitrate, NH_4NO_3.

Calculate the number of moles of ammonium nitrate in the bag of fertiliser.

[M_r: NH_4NO_3, 80]

moles of ammonium nitrate = ... [3]

[Total: 10]

6 A student investigates the reaction between aqueous copper(II) sulfate and magnesium metal.

The student measures the temperature of the aqueous copper(II) sulfate.

Magnesium metal is then added, and the student records the temperature of the mixture.

The reaction is **exothermic**.

(a) State what, if anything, happens to the temperature of the mixture.

..... [1]

(b) Figure 6.1 shows a reaction pathway diagram for an exothermic reaction.

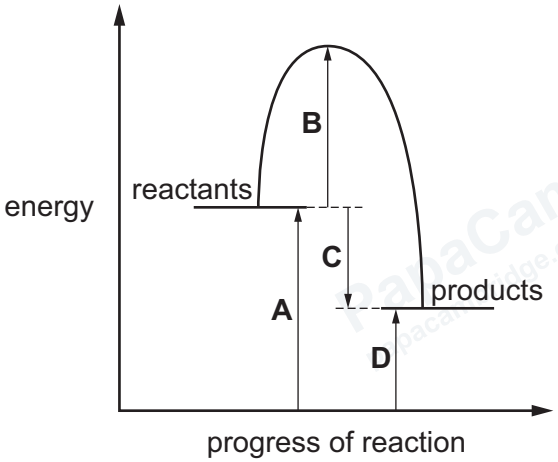


Figure 6.1

(i) State which letter represents the activation energy, E_a, for the reaction.

..... [1]

(ii) State which letter represents the overall energy change for the reaction.

..... [1]

(c) The student repeats their experiment using a more concentrated aqueous copper(II) sulfate solution.

The reaction is faster.

Explain why, using collision theory.

.....

.....

..... [2]

(d) The equation for the reaction between aqueous copper(II) sulfate and magnesium metal is shown.

$$CuSO_4 + Mg \rightarrow MgSO_4 + Cu$$

Calculate the mass of magnesium needed to make 31 g of magnesium sulfate, $MgSO_4$.

[A_r: Mg, 24; O, 16; S, 32]

mass of magnesium = ... g [2]

(e) The ionic equation for the reaction between aqueous copper(II) sulfate and magnesium metal is shown.

$$Cu^{2+} + Mg \rightarrow Mg^{2+} + Cu$$

This is a redox reaction as the reaction involves simultaneous oxidation and reduction.

Explain, in terms of electrons, which reactant is oxidised, and which is reduced.

oxidised .....

reduced .....

explanation .....

.....

.....

[3]

[Total: 10]

7 Figure 7.1 shows the structural formula of propene.

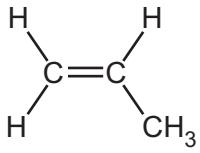


Figure 7.1

(a) Propene is an unsaturated hydrocarbon.

Explain why.

.....

.....

.....

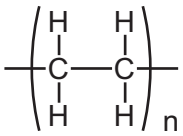
.....

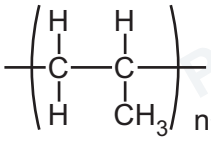
[3]

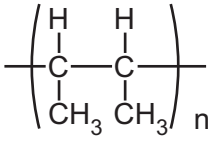
(b) Poly(propene) is made from propene.

Identify the structure that is the repeat unit of poly(propene).

Tick (✓) **one** box.

 ☐

 ☐

 ☐

[1]

(c) Poly(propene) is made in three stages:

stage 1 – large alkane molecules are separated from petroleum.
stage 2 – propene molecules are made from large alkane molecules.
stage 3 – many propene molecules are joined together.

State the name of each stage.

Choose from the list.

combustion
cracking
electrolysis
fractional distillation
polymerisation

stage 1 .....

stage 2 .....

stage 3 .....

[3]

(d) Ethanol, C_2H_5OH, can be used as a fuel for cars.

Ethanol burns to make carbon dioxide and water.

$$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$$

1.80 dm^3 of carbon dioxide is made when a sample of ethanol is completely burned in 6.4 dm^3 of oxygen.

Calculate the volume of **unreacted oxygen**.

Give your answer **in cm^3**.

volume of unreacted oxygen = ... cm^3 [4]

[Total: 11]

Turn over

8 Metals are extracted from their ores.

(a) Complete the sentences about the extraction of iron and aluminium.

Choose words from the list.

bauxite
blast furnace
electrolysis
fractionating column
limestone
oxidation
reduction
thermal decomposition

Iron is extracted from hematite by ..... of iron(III) oxide in the ....

The main ore of aluminium is ..... and aluminium is extracted by..... .

[3]

(b) Iron(III) oxide contains iron(III) ions, Fe^{3+}, and oxide ions, O^{2-}.

Deduce the formula of iron(III) oxide.

formula ..... [1]

(c) Aqueous sodium hydroxide is used to test for aqueous iron(III) ions, Fe^{3+}.

State the colour of the precipitate that is made.

..... [1]

(d) Iron can be protected from rusting by covering the iron with a layer of zinc, as shown in Figure 8.1.

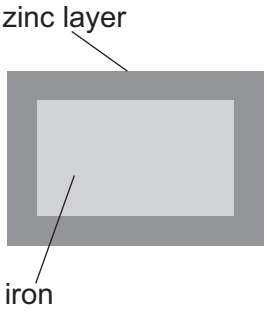


Figure 8.1

(i) Describe how the layer of zinc acts as a **barrier** and stops the iron rusting.

.....

.....

..... [2]

(ii) If the layer of zinc is scratched, as shown in Figure 8.2, the iron is still protected from rusting.

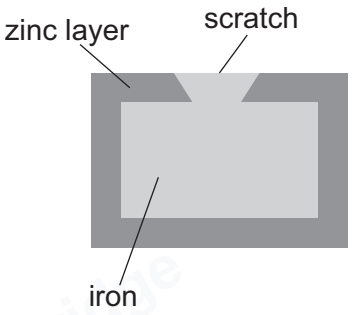


Figure 8.2

Explain why the iron is still protected from rusting.

Use ideas about the reactivity series and about electrons.

.....

.....

..... [2]

[Total: 9]

9 **(a)** **(i)** State the boiling temperature of pure water at standard atmospheric pressure. Include the unit.

.....

..... [1]

(ii) Describe evaporation in terms of particles.

.....

.....

.....

..... [2]

(iii) Explain why an increase in temperature of a liquid changes the rate of evaporation.

.....

.....

..... [2]

(b) **(i)** Complete the sentences using the words from the list.

radiation **conduction** **convection**

Thermal energy transfer takes place by ..... in all solids.

Thermal energy transfer takes place by ..... in all liquids and in all gases.

Thermal energy transfer takes place by ..... in a vacuum.

[2]

(ii) Figure 9.1 shows an ice cube submerged in water and held in place with a plastic gauze. The boiling tube is heated half-way along its length with a Bunsen burner flame.

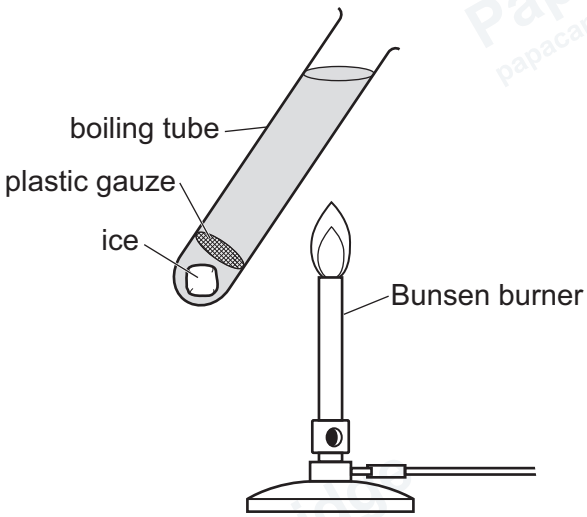


Figure 9.1

Explain why the ice cube does not melt rapidly when the water at the top of the boiling tube is boiling.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

10 (a) (i) Describe a transverse wave.

.....

.....

..... [2]

(ii) State **one** example of a transverse wave.

..... [1]

(b) A sound wave undergoes diffraction when passing through a narrow gap.

(i) Describe diffraction.

.....

..... [1]

(ii) The width of the narrow gap is decreased.

Describe the effect on the diffraction of the sound wave.

.....

..... [1]

(c) A light ray travelling in air is incident on the surface of water.

The angle of incidence of the light ray in air is 60° and the angle of refraction in water is 41°.

Calculate the refractive index of the water.

refractive index = ... [2]

(d) A light ray travels in water and is incident on a boundary with air.

Complete Figure 10.1, to show how total internal reflection occurs at the surface.

Label any relevant angles and the normal.

Figure 10.1

[3]

[Total: 10]

11 (a) (i) A lamp has a current of 1.2 A.

Calculate the charge which flows through the lamp in 1.0 min.

State the unit.

charge = ... unit ..... [3]

(ii) Describe the nature of direct current (d.c.) and alternating current (a.c.).

d.c. .....

.....

a.c. .....

.....

[2]

(b) Figure 11.1 shows an electric kettle with a metal casing.

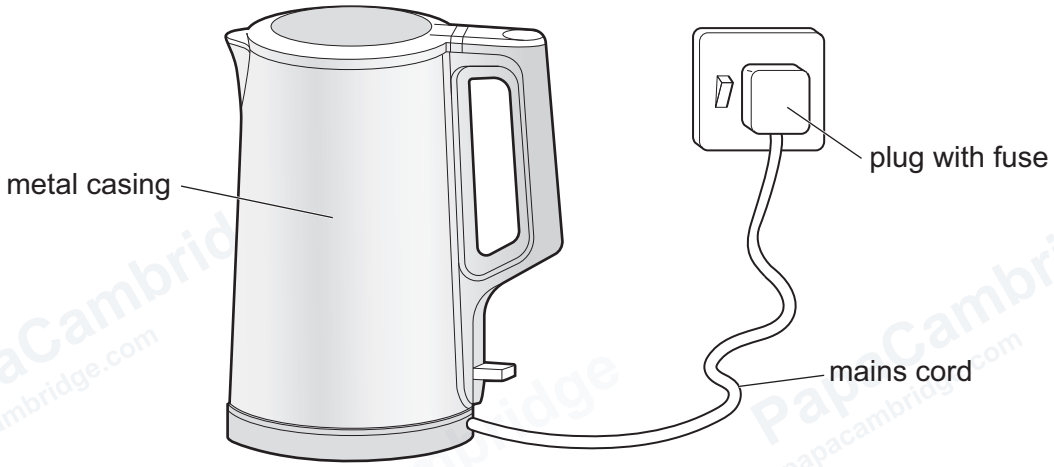


Figure 11.1

Explain why the metal casing must be earthed.

.....

.....

.....

..... [3]

(c) (i) Figure 11.2 shows a wire carrying a current out of the page.

Draw, on Figure 11.2, the pattern of the magnetic field lines around the wire.

Figure 11.2

[2]

(ii) Figure 11.3 shows a current-carrying copper rod placed in a magnetic field.

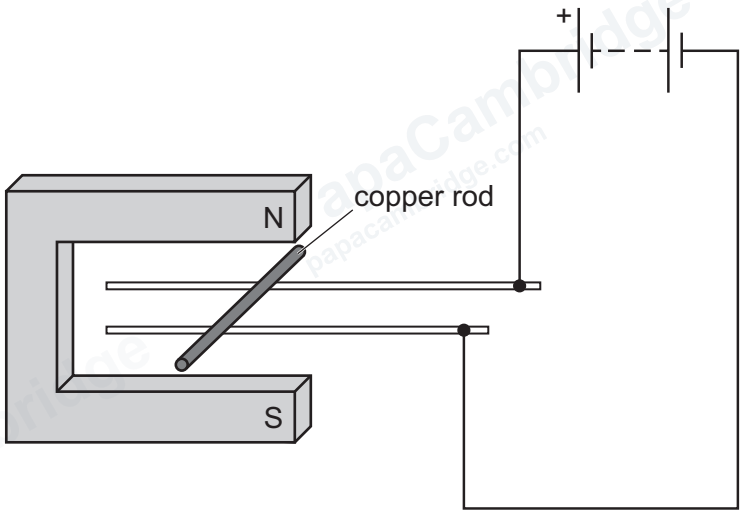


Figure 11.3

State the direction of the force on the copper rod.

..... [1]

[Total: 11]

12 **(a)** **(i)** Complete the sentence about energy resources.

The Sun is the main source of energy for all our energy resources except nuclear,

..... and .....

[2]

(ii) Nuclear fusion occurs in the Sun.

Describe the process of nuclear fusion.

.....

..... [1]

(b) Give **two** of the statements from the Big Bang Theory.

1 .....

.....

2 .....

.....

[2]

(c) The moment of a force is the product of the force and the perpendicular distance from the pivot.

A uniform beam has a weight of 5.2 N and a length of 1.00 m. The beam is pivoted about one end.

A spring with a spring constant of 27 N / m is attached to the beam at a distance of 0.40 m from the pivot, as shown in Figure 12.1. The top end of the spring is fixed to a support.

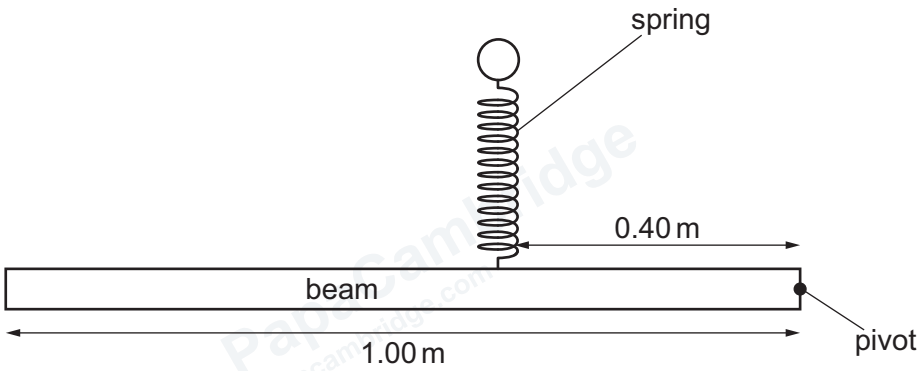


Figure 12.1

The beam is horizontal.

Use the principle of moments to calculate the extension of the spring.

extension = ... m [4]

[Total: 9]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9											5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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