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PHYSICAL SCIENCE **0652/31**

Paper 3 Theory (Core) **October/November 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.

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 **20** pages. Any blank pages are indicated.

[Turn over

1 **(a)** A list of compounds that contain carbon is shown.

$CaCO_3$

CH_4

CH_3OH

C_2H_4

C_2H_6

CO

CO_2

Use the formulas of the compounds to answer the questions that follow.

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

State which compound:

(i) is a product of incomplete combustion that is a toxic gas

..... [1]

(ii) thermally decomposes at high temperatures to give a greenhouse gas

..... [1]

(iii) is a product of respiration

..... [1]

(iv) can cause explosions in mines

..... [1]

(v) reacts with dilute hydrochloric acid to form a gas that turns limewater milky

..... [1]

(vi) is an unsaturated hydrocarbon.

..... [1]

(b) Water, H_2O, is a covalent molecule.

Complete Fig. 1.1 to show the dot-and-cross diagram for a molecule of H_2O.

Show outer-shell electrons only.

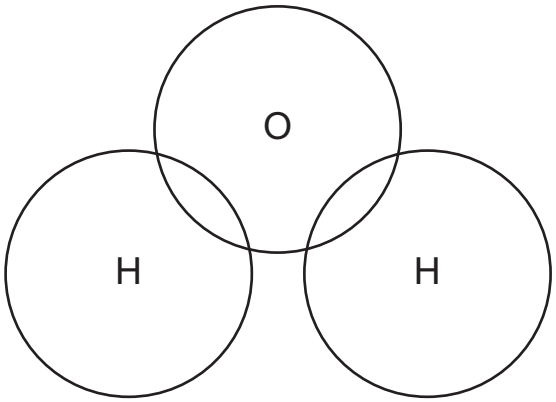


Fig. 1.1

[2]

[Total: 8]

2 Fig. 2.1 shows a drop of water falling from a tap into a beaker. Drops of water from the tap fall at regular intervals.

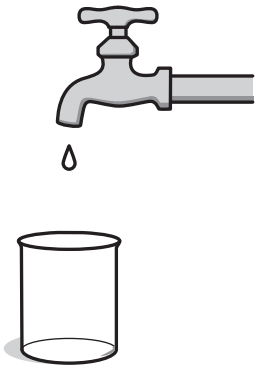


Fig. 2.1

(a) The time interval between two drops is measured using a stop-watch. The reading is shown in Fig. 2.2.

Fig. 2.2

Record this reading in seconds.

reading = ... s [1]

(b) **(i)** The time for 50 drops of water to fall from the tap into the beaker is 204 s.

Calculate the average time for one drop to fall.

average time = ... s [1]

(ii) The mass of the water collected in the beaker is 15.0 g.

The water is poured into a measuring cylinder as shown in Fig. 2.3.

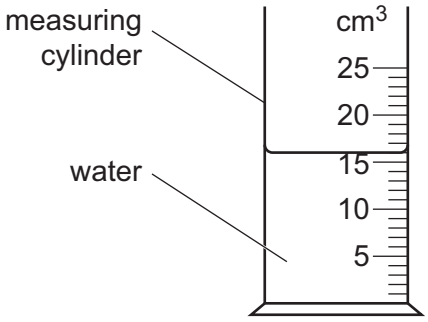


Fig. 2.3

Record the volume of water in the measuring cylinder.

volume of water = ...cm^3 [1]

(c) A sample of tap water has a mass of 25 g and a volume of 24 cm^3.

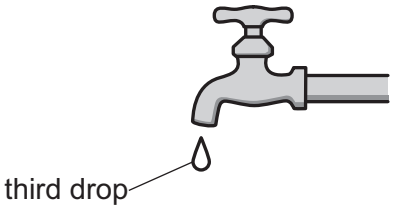
Calculate the density of the water.

Give the unit.

density = ... unit ..... [3]

(d) Another tap produces drops of water at short regular intervals.

Fig. 2.4 shows the **first** and **third** drops falling from the tap.



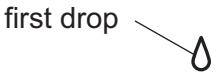


Fig. 2.4

The drops accelerate as they fall.

On Fig. 2.4 draw the approximate position of the **second** drop of water. [1]

[Total: 7]

3 This question is about salt preparation.

(a) Aqueous lead(II) nitrate and aqueous potassium sulfate are added to a beaker. The products are a precipitate of lead(II) sulfate and aqueous potassium nitrate.

(i) Write the word equation for the reaction.

..... [1]

(ii) Fig. 3.1 shows equipment used to separate the products.

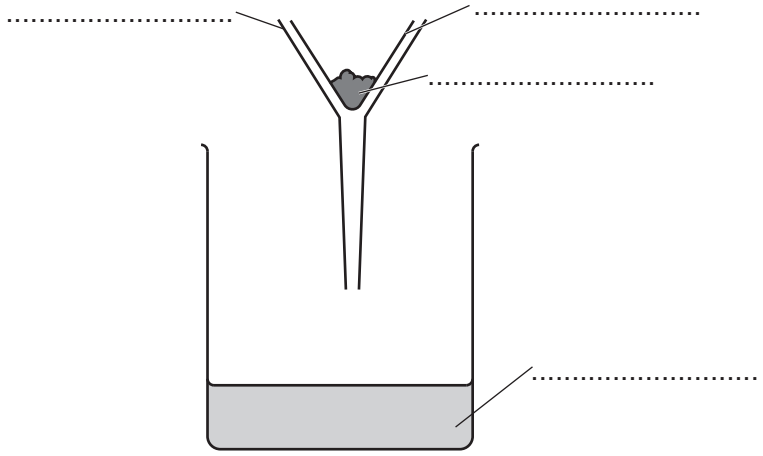


Fig. 3.1

Complete the labels on Fig. 3.1.

[4]

(b) Sodium chloride, NaCl, is prepared by the reaction of aqueous sodium hydroxide, NaOH, and dilute hydrochloric acid, HCl.

(i) Complete the symbol equation for this reaction.

$$NaOH + HCl \rightarrow NaCl + ...$$

[1]

(ii) Predict the pH of aqueous sodium hydroxide.

pH = ... [1]

[Total: 7]

4 This question is about sound.

(a) State the highest and lowest frequencies that can be heard by a healthy human ear.

Include the unit.

highest frequency = ... unit .....

lowest frequency = ... unit .....

[3]

(b) Fig. 4.1 shows two children using a string telephone.

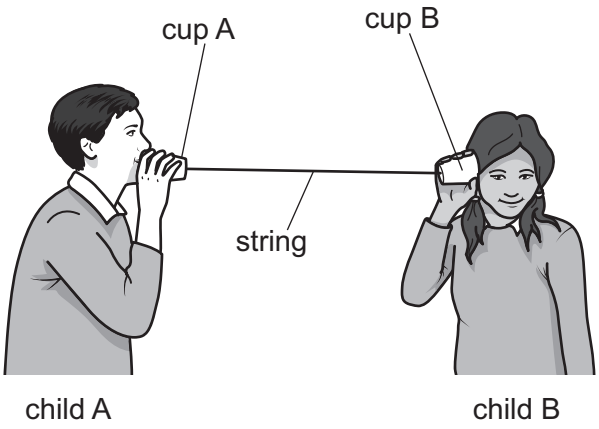


Fig. 4.1

Child A talks into cup A.

Child B holds cup B next to her ear and hears child A talking.

Use words from the box to complete the sentences.

air	**eardrum**	**energy**	**hand**
heat	**refract**	**light**	**vibrate**

Child A produces a sound wave in ..... .

The sound wave transfers ..... to cup A.

This causes the bottom of cup A and the string to ..... .

Child B hears the sound from cup B because it makes her ..... vibrate.

[4]

[Total: 7]

5 Fig. 5.1 shows a spectrum of waves.

radio waves	microwaves	infrared	visible light	ultraviolet	X-rays	gamma rays

Fig. 5.1

(a) (i) Name this spectrum of waves.

..... [1]

(ii) State a property of these waves that **increases** in the direction radio waves to gamma rays.

..... [1]

(iii) State a property that is the same for **all** of these waves.

..... [1]

(b) Two people talk on their mobile telephones.

(i) State the region of the spectrum that is used to transmit mobile telephone signals.

..... [1]

(ii) State **one** way sound waves are different from the spectrum of waves in Fig. 5.1.

.....

..... [1]

[Total: 5]

Question 6 starts on page 10

6 The halogens are in Group VII of the Periodic Table.

(a) Table 6.1 shows data about the halogens.

Table 6.1

halogen	colour at room temperature and pressure	physical state at room temperature and pressure
fluorine	pale yellow	gas
chlorine	pale yellow-green	gas
bromine	red-brown	liquid
iodine	.....	.....

Complete Table 6.1 with the colour and physical state of iodine at room temperature and pressure. [2]

(b) The halogens are diatomic molecules.

State the meaning of the term diatomic.

..... [1]

(c) Fig. 6.1 shows the symbols for two atoms of chlorine.

$^{35}_{17}Cl$ and $^{37}_{17}Cl$

Fig. 6.1

(i) Describe **one** difference between these atoms of chlorine.

.....

..... [1]

(ii) Describe **one** similarity between these atoms of chlorine.

.....

..... [1]

(d) Explain why chlorination is used in the treatment of water.

.....

..... [1]

(e) Sodium chloride, NaCl, is an ionic compound and chlorine, Cl_2, is a simple covalent molecule.

Tick (✓) to show whether each statement is true or false.

	true	false
Sodium chloride is more volatile than chlorine.	☐	☐
Sodium chloride is more soluble in water than chlorine.	☐	☐
Aqueous sodium chloride is a better conductor of electricity than chlorine.	☐	☐

[3]

[Total: 9]

7 Ionising radiation is dangerous.

(a) State an effect of ionising radiation on living things.

..... [1]

(b) Photographic film is used in radiation badges to detect ionising radiation.

When the photographic film is developed, it becomes darker if it has been exposed to ionising radiation.

Fig. 7.1 shows a simple radiation badge.

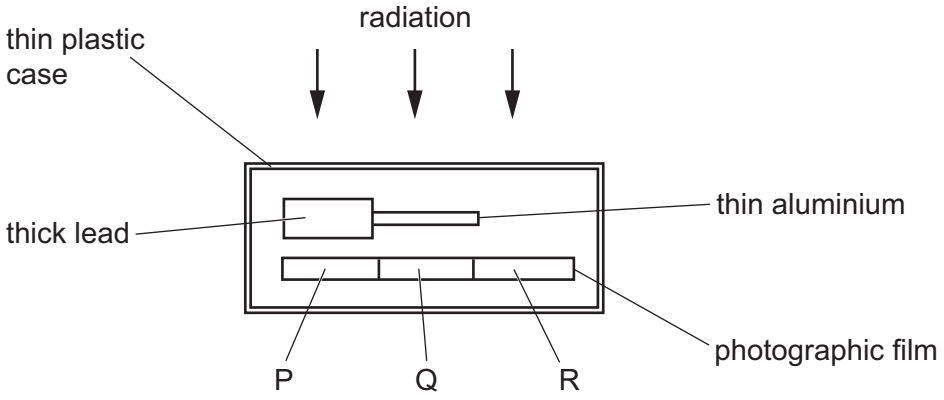


Fig. 7.1

The photographic film has three regions P, Q and R.

P is covered by thick lead, Q is covered by thin aluminium and R is only covered by the thin plastic case.

Identify the regions of the photographic film which can detect:

- alpha-particles .....
- beta-particles .....
- gamma rays. .....

[3]

[Total: 4]

8 Copper is a metal.

(a) Fig. 8.1 shows changes of state, **A** and **B**, of copper.

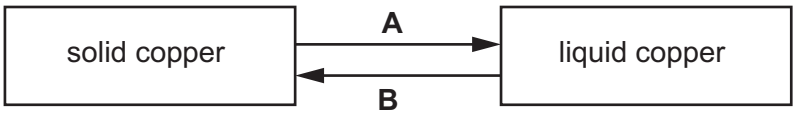


Fig. 8.1

(i) Circle the **one** term that describes changes **A** and **B**.

chemical **physical**

Give a reason for your answer.

.....

.....

[1]

(ii) Name the changes of state represented by **A** and **B** in Fig. 8.1.

A .....

B .....

[1]

(iii) Copper is a transition element.

State **three** properties of transition elements that are different from Group I metals.

1 .....

2 .....

3 .....

[3]

(iv) The equation shows a reaction of a copper compound.

$$CuO(s) + H_2(g) \rightarrow Cu(s) + H_2O(l)$$

Explain how this equation shows reduction has taken place.

.....

..... [1]

(v) Copper(II) ions give a blue-green flame in a flame test.

Describe how to do a flame test using a Bunsen burner.

.....

.....

.....

..... [2]

(b) Brass is an alloy that contains copper.

(i) Describe what is meant by the term alloy.

.....

..... [1]

(ii) State **one** reason why alloys are used instead of pure metals.

.....

..... [1]

[Total: 10]

9 **(a)** State the equation that describes the turning effect of a force about a pivot.

..... [2]

(b) A wind vane is used to show the direction of the wind.

Fig. 9.1 shows a wind vane.

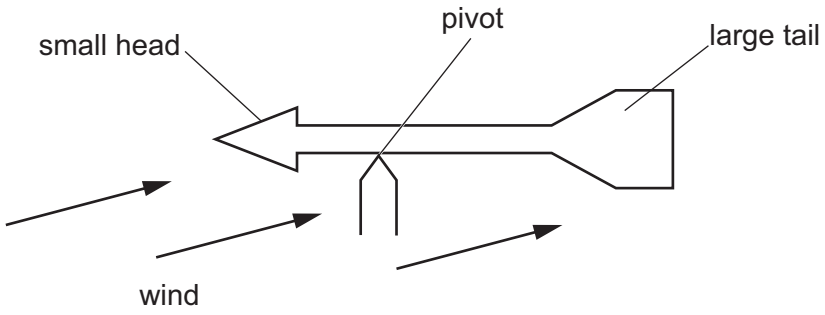


Fig. 9.1

Explain why the wind vane turns about the pivot and points towards the wind.

Your answer should refer to the magnitudes of the forces and to the position of the pivot.

.....

.....

.....

.....

.....

..... [3]

[Total: 5]

10 Petroleum is a fossil fuel.

(a) Name **two** other fossil fuels.

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

(b) State the process used to separate naphtha and gasoline from petroleum.

..... [1]

(c) Naphtha is described as a chemical feedstock.

State what is meant by a chemical feedstock.

..... [1]

(d) Gasoline is cracked to form ethene.

Describe how ethene forms poly(ethene).

.....

.....

.....

.....

.....

..... [3]

[Total: 6]

11 Fig. 11.1 shows a liquid-in-glass thermometer.

Fig. 11.1

(a) Explain how a liquid-in-glass thermometer measures air temperature.

.....

.....

.....

..... [3]

(b) Table 11.1 shows information about three substances X, Y, Z which may be used in the thermometer.

Table 11.1

substance	melting point / °C	boiling point / °C
X	1	320
Y	10	98
Z	–94	78

State which substance is suitable for use in thermometers measuring the temperature of:

- a freezer .....
- an oven. .....

[2]

[Total: 5]

12 (a) A student makes a circuit which contains:

- a battery of cells
- a switch
- a lamp which remains on
- another lamp that can be switched off and on.

Draw a suitable circuit diagram in the box.

[4]

(b) Fig. 12.1 shows the transfer of energy from the battery of cells to a lamp.

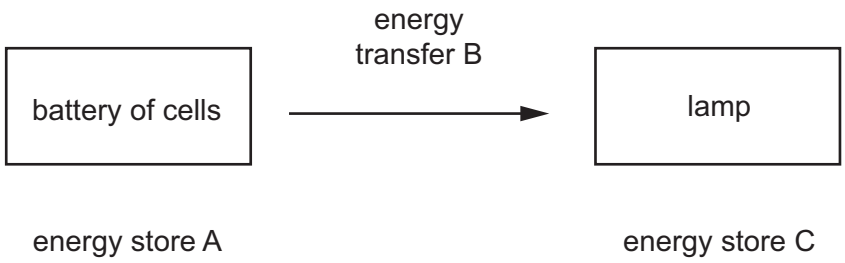


Fig. 12.1

Identify:

- energy store A .....
- energy transfer B .....
- energy store C. .....

[3]

[Total: 7]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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.).