Cambridge Assessment International Education

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CHEMISTRY **0620/33**

Paper 3 Theory (Core) **May/June 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 **20** pages. Any blank pages are indicated.

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1 Fig. 1.1 shows the structures of seven substances, **A**, **B**, **C**, **D**, **E**, **F** and **G**.

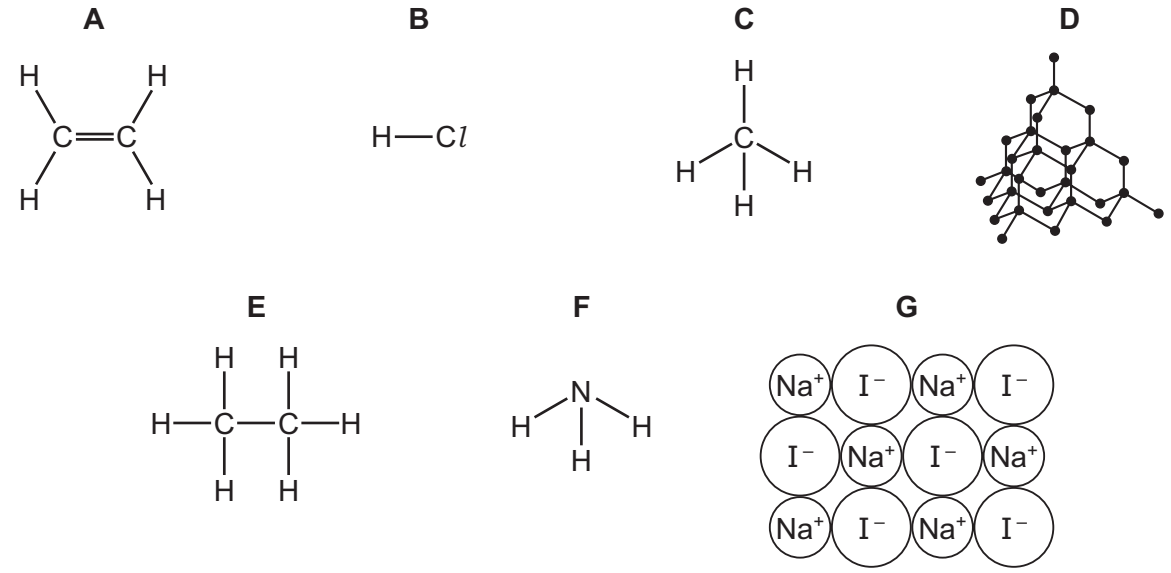


Fig. 1.1

(a) Answer the following questions using only the structures in Fig. 1.1.
Each structure may be used once, more than once or not at all.

View solution

State which structure represents:

(i) a compound that is the main constituent of natural gas

..... [1]

(ii) the monomer used to produce poly(ethene)

View solution

..... [1]

(iii) a giant covalent structure

View solution

..... [1]

(iv) a compound that has a high melting point

View solution

..... [1]

(v) a waste gas from digestion in animals

View solution

..... [1]

(vi) a solid at room temperature that conducts electricity when dissolved in water.

..... [1]

View solution

(b) Complete Fig. 1.2 to show the dot-and-cross diagram for structure **B**.
Show the outer electron shells only.

View solution

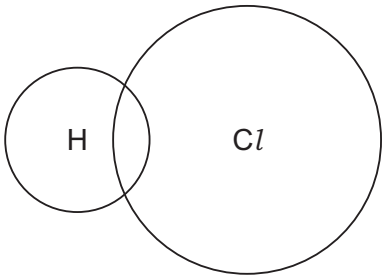


Fig. 1.2

[2]

[Total: 8]

2 **(a)** Intracellular fluid is the solution between the cells in the human body.

View solution

Table 2.1 shows the masses, in mg, of some ions in 100 cm^3 of intracellular fluid.

Table 2.1

name of ion	formula of ion	mass of ion in 100 cm^3 of intracellular fluid / mg
calcium	Ca^{2+}	6
chloride	Cl^-	7
hydrogencarbonate	HCO_3^-	49
phosphate	PO_4^{3-}	547
magnesium	Mg^{2+}	31
potassium	K^+	624
sodium	Na^+	23
sulfate	SO_4^{2-}	96

Answer these questions using information from Table 2.1.

(i) Name the positive ion that is present in the lowest concentration.

..... [1]

(ii) Name the ion that contains an element in Group IV of the Periodic Table.

View solution

..... [1]

(b) Describe a test for sulfate ions.

View solution

test .....

.....

observations .....

.....

[2]

(c) Small amounts of ammonium ions and chloride ions are formed in some cells of the body.

View solution

State the formula of the compound formed from ammonium ions and chloride ions.

..... [1]

(d) Choose from the list the salt that is insoluble in water.

View solution

Tick (✓) **one** box.

copper(II) nitrate	☐
lead(II) chloride	☐
potassium nitrate	☐
sodium chloride	☐

[1]

(e) Table 2.2 shows some properties of the Group I metals.

View solution

Table 2.2

metal	hardness / MPa	observations on reaction with water
lithium	5.0	bubbles form very slowly and no flame
sodium	0.69	bubbles form very slowly and no flame
potassium		bubbles form very rapidly and flame
rubidium	0.22	

Use the information in Table 2.2 to:

- predict the hardness of potassium

.....

- describe the observations when rubidium reacts with water.

.....

[2]

(f) Sodium reacts with hydrogen to produce sodium hydride, NaH.

View solution

Complete the symbol equation for this reaction.

$$2Na + \text{.....} \rightarrow \text{.....}NaH$$

[2]

[Total: 10]

3 **(a)** Molten calcium bromide is electrolysed.

View solution

(i) Define the term electrolysis.

.....

..... [2]

(ii) Name an inert metal that can be used for the electrodes. View solution

..... [1]

(iii) Name the product formed at each electrode.

View solution

positive electrode .....

negative electrode .....

[2]

(b) Calcium reacts with water. An alkaline solution is produced.

View solution

(i) Name the ion which causes a solution to be alkaline.

..... [1]

(ii) Choose the pH value of an alkaline solution.

View solution

Draw a circle around your chosen answer.

pH 1 **pH 5** **pH 7** **pH 9** [1]

(iii) Dilute hydrochloric acid is added to a solution of litmus in alkaline solution until the acid is in excess.

State the colour change of the litmus.

View solution

from ..... to ..... [2]

(c) Calcium carbonate is added to the blast furnace in the production of iron.
Calcium carbonate breaks down when heated to produce calcium oxide and a gas that turns limewater milky.

(i) Name the gas that turns limewater milky.

View solution

..... [1]

(ii) Name the type of chemical reaction that takes place when calcium carbonate is heated.

..... [1]

[Total: 11]

4 **(a)** Chlorophyll is a coloured compound found in plants. Chlorophyll is needed for photosynthesis.

(i) Complete the word equation for photosynthesis.

View solution

carbon dioxide	+	water	→	.....	+	.....

[2]

(ii) State one **other** condition that is essential for photosynthesis. View solution

..... [1]

(b) Several other coloured compounds are found in plant leaves. View solution

A student extracts a mixture of coloured compounds from a plant leaf.

Fig. 4.1 shows the apparatus used to separate the coloured compounds.

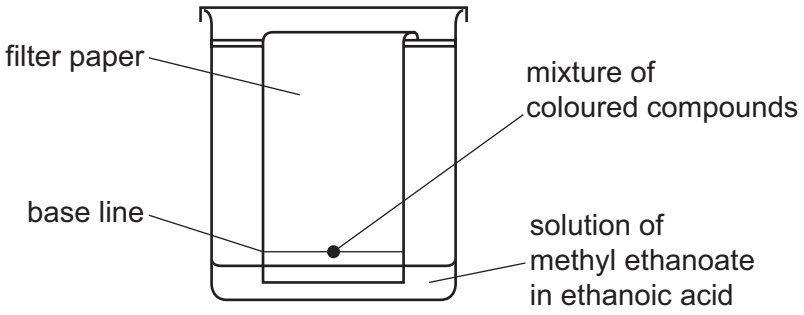


Fig. 4.1

(i) Name this method of separation.

..... [1]

(ii) Suggest why the base line is drawn in pencil and **not** in ink. View solution

..... [1]

(iii) The liquid used to separate the coloured compounds is a solution of methyl ethanoate in ethanoic acid.

State the meaning of the term solution. View solution

.....

..... [1]

(c) Fig. 4.2 shows the displayed formula of a compound found in plant cells.

View solution

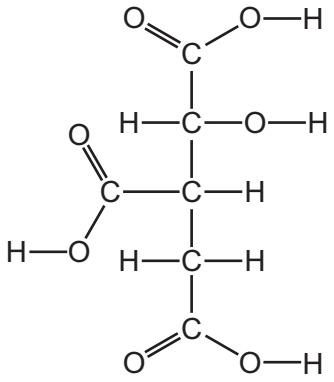


Fig. 4.2

On Fig. 4.2, draw a circle around the alcohol functional group. [1]

[Total: 7]

5 **(a)** An atom of phosphorus is represented by the symbol shown.

View solution

$$^{31}_{15}P$$

Describe this atom of phosphorus in terms of:

- the position of the electrons, neutrons and protons in the atom

.....

.....

- the number of neutrons and the number of protons

.....

.....

- the electronic configuration.

.....

[5]

(b) Complete the symbol equation for the reaction of phosphorus with oxygen.

View solution

.....P + ...O_2 → P_4O_{10} [2]

(c) Fig. 5.1 shows the displayed formula of a compound of phosphorus.

View solution

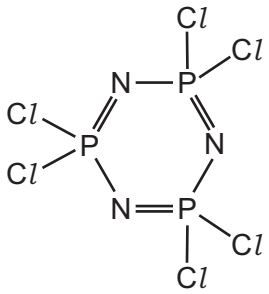


Fig. 5.1

Deduce the molecular formula of this compound.

..... [1]

(d) Another compound of phosphorus has the formula Na_3PO_4.

View solution

Complete Table 5.1 to calculate the relative formula mass of Na_3PO_4.

Table 5.1

type of atom	number of atoms	relative atomic mass	
sodium	3	23	$3 \times 23 = 69$
phosphorus		31	
oxygen		16	

relative formula mass = ... [2]

(e) Phosphates in rivers can cause deoxygenation of water.

View solution

State **one** source of phosphates in river water.

..... [1]

[Total: 11]

6 Dilute hydrochloric acid reacts with small pieces of calcium carbonate.

$$2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$$

View solution

(a) State the meaning of the state symbol (aq).

..... [1]

(b) Fig. 6.1 shows how the mass of small pieces of calcium carbonate changes as the reaction proceeds. The calcium carbonate is in excess.

View solution

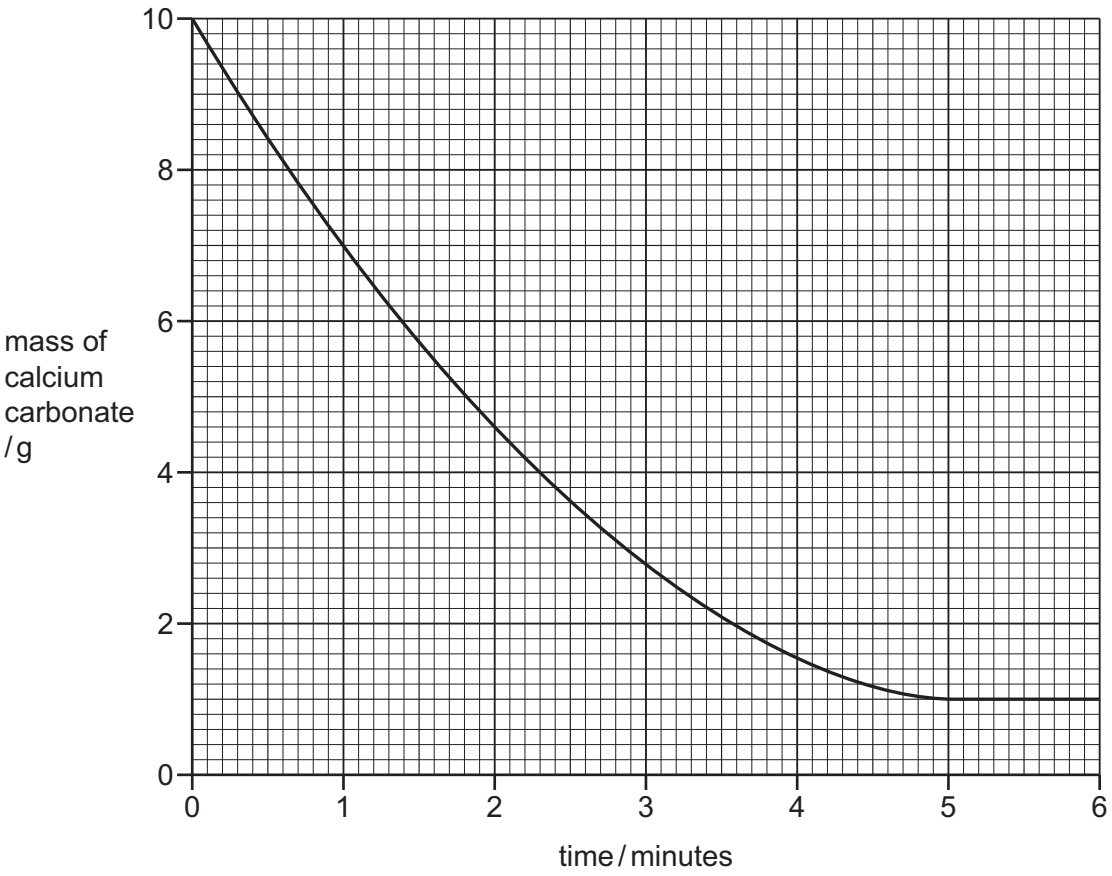


Fig. 6.1

(i) Deduce the mass of calcium carbonate two minutes from the start of the reaction.

..... [1]

(ii) Explain how the graph shows that the calcium carbonate is in excess.

View solution

..... [1]

(iii) The experiment is repeated at a higher temperature.

All other conditions stay the same.

Draw a line on Fig. 6.1 to show how the mass of calcium carbonate changes at a higher temperature as the time increases. [2]

View solution

(c) (i) Describe the effect, if any, on the rate of reaction when large pieces of calcium carbonate are used instead of small pieces of calcium carbonate.

All other conditions stay the same.

View solution

..... [1]

(ii) Increasing the concentration of dilute hydrochloric acid increases the rate of reaction of dilute hydrochloric acid with calcium carbonate.

Choose the correct unit of concentration from the list.

Draw a circle around your chosen answer.

View solution

dm^3/g **g/dm^2** **mol/dm** **mol/dm^3** [1]

(d) Concentrated hydrochloric acid gives off hydrogen chloride gas.
Hydrogen chloride is an acidic gas that turns damp universal indicator paper red.

View solution

A long glass tube is set up as shown in Fig. 6.2.

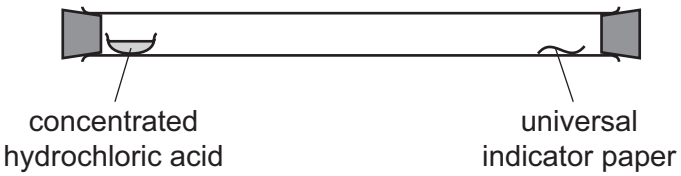


Fig. 6.2

At first, the universal indicator paper does not change colour.
The universal indicator paper turns red after a short time.

Explain these results in terms of kinetic particle theory.

.....

.....

.....

..... [3]

(e) Hydrogen chloride breaks down to form hydrogen and chlorine at 1500 °C.
The reaction in endothermic.

View solution

State the meaning of the term endothermic.

..... [1]

[Total: 11]

7 Chromium and iron are transition elements. They are ductile and have high melting and boiling points.

(a) State three **other** physical properties of chromium.

View solution

1 .....

2 .....

3 .....

[3]

(b) The formula for rust is $Fe_2O_3 \cdot xH_2O$.

View solution

(i) State the chemical name of rust.

..... [2]

(ii) An iron object is coated with plastic.

View solution

Explain how this prevents the iron from rusting.

.....

..... [2]

(c) Chromium behaves as a typical metal when it reacts with sulfuric acid.

View solution

Complete the word equation for this reaction.

chromium	+	sulfuric acid	→	....	+	.....

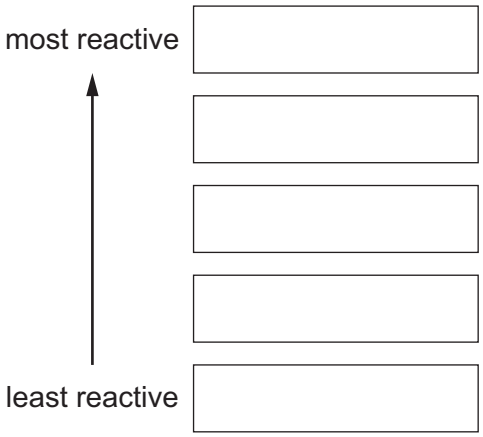
[2]

(d) The list shows five metals.

View solution

aluminium **calcium** **copper** **iron** **zinc**

Put these metals in order of their reactivity.
Put the most reactive metal at the top.



[2]

(e) Zinc can be produced by heating zinc oxide with carbon.

View solution

$$ZnO + C \rightarrow Zn + CO$$

Describe how this equation shows that zinc oxide is reduced.

.....

..... [1]

[Total: 12]

8 This question is about hydrocarbons.

(a) Table 8.1 shows the names, formulae and boiling points of methane, ethane, propane and butane.

View solution

Table 8.1

name	formula	boiling point / °C
methane	CH_4	–164
ethane	C_2H_6	–88
propane	C_3H_8	–42
butane	C_4H_{10}	0

Use the information in Table 8.1 to answer these questions.

(i) Name the homologous series that includes methane, ethane, propane and butane.

..... [1]

(ii) State the trend in the boiling point of this homologous series as the number of carbon atoms increases.

..... [1]

(iii) Deduce the general formula of this homologous series.

..... [1]

(b) Complete the word equation for the complete combustion of ethane.

View solution

ethane + oxygen → ..... + ...
.....

[2]

(c) Long-chain hydrocarbons can be cracked to produce alkenes and hydrogen.

View solution

(i) State **two** conditions for cracking.

1 .....

2 .....

[2]

(ii) The diesel oil fraction from the fractional distillation of petroleum can be used for cracking.

Give one **other** use of the diesel oil fraction.

View solution

..... [1]

(d) Alkene molecules can react together to produce polymers.

View solution

Define the term polymer.

.....

..... [2]

[Total: 10]

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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.).