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4926358439

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 2023**

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 **16** pages.

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1 A list of symbols and formulae is shown.

Br_2
CH_4
C_2H_4
Cl^-
CO_2
Cr^{3+}
Cu^{2+}
H_2
K^+
N_2
N^{3-}
O_2
SO_4^{2-}

Answer the following questions about these symbols and formulae.
Each symbol or formula may be used once, more than once or not at all.

State which symbol or formula represents:

(a) a molecule containing only five atoms

..... [1]

(b) a diatomic molecule of an element in Group VII of the Periodic Table

..... [1]

(c) an ion formed when an atom gains one electron

..... [1]

(d) an ion which forms a green precipitate when a few drops of aqueous sodium hydroxide are added to it

..... [1]

(e) a compound produced by the thermal decomposition of calcium carbonate

..... [1]

(f) a product of photosynthesis.

..... [1]

[Total: 6]

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2 **(a)** A sample of soil is shaken with distilled water.

Draw a diagram to show the filtration apparatus used to separate the soil from the solution obtained by shaking the soil with distilled water.

On your diagram, label:
- the filtrate
- the residue.

[3]

(b) Table 2.1 shows the masses of some of the ions in 1000 cm^3 of the solution obtained by filtering a sample of soil with distilled water.

Table 2.1

name of ion	formula of ion	mass of ion in 1000 cm^3 of solution / mg
ammonium	NH_4^+	25.0
calcium	Ca^{2+}	0.4
chloride	Cl^-	0.5
iron(II)	Fe^{2+}	27.0
magnesium	Mg^{2+}	4.0
nitrate	NO_3^-	23.0
phosphate	PO_4^{3-}	15.5
potassium	K^+	29.0
sodium	Na^+	2.0
	SO_4^{2-}	6.0

Answer these questions using the information in Table 2.1.

(i) Name the negative ion that has the lowest concentration.

..... [1]

(ii) State the name of the SO_4^{2-} ion.

..... [1]

(iii) Calculate the mass of phosphate ions in 200 cm^3 of the solution.

mass = ... mg [1]

(c) Complete Fig. 2.1 to show:
- the electronic configuration of a sodium ion
- the charge on the ion.

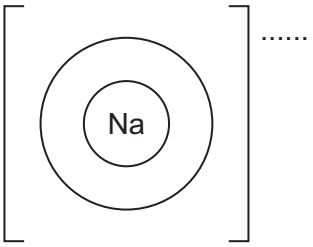


Fig. 2.1

[2]

(d) Water from natural sources contains dissolved gases.

Choose from the list the gas which is essential for aquatic life.

Draw a circle around your chosen answer.

argon **hydrogen** **nitrogen** **oxygen** [1]

(e) Polluted water may contain sewage or nitrates.

State **one** harmful effect of each of these water pollutants.

sewage .....

nitrates .....
[2]

[Total: 11]

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3 This question is about compounds of nitrogen.

(a) Complete the dot-and-cross diagram in Fig. 3.1 of a molecule of ammonia.

Show outer shell electrons only.

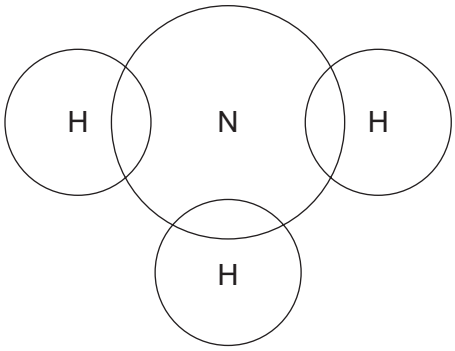


Fig. 3.1

[2]

(b) Oxides of nitrogen are air pollutants.

(i) State **one** source of oxides of nitrogen in the air.

..... [1]

(ii) State **one** adverse effect of oxides of nitrogen.

..... [1]

(c) State whether nitrogen dioxide is an acidic or basic oxide.

Give a reason for your answer.

.....

..... [1]

[Total: 5]

4 This question is about metals and compounds of metals.

(a) Table 4.1 shows some properties of five metals, **A**, **B**, **C**, **D** and **E**.

Table 4.1

metal	density in g/cm^3	melting point in °C	colour of metal chloride
A	5.90	30	white
B	5.96	1890	green
C	11.34	328	white
D	8.90	1455	yellow
E	1.53	39	white

State which **two** of these metals, **A**, **B**, **C**, **D** and **E**, are transition elements.

Give two reasons for your answer using only the information in Table 4.1.

metals ..... and .....

reason 1 .....

reason 2 .....

[3]

(b) Choose the metal chloride that is insoluble in water.

Tick (✓) **one** box.

magnesium chloride ☐

potassium chloride ☐

silver chloride ☐

sodium chloride ☐

[1]

(c) Magnesium chloride is produced when magnesium burns in chlorine.

$$Mg + Cl_2 \rightarrow MgCl_2$$

Fig. 4.1 shows an incomplete reaction pathway diagram for this reaction.

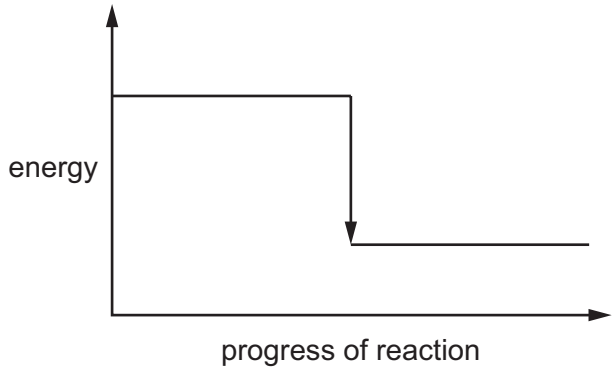


Fig. 4.1

(i) Complete Fig. 4.1 by writing these formulae on the diagram:
- $Mg + Cl_2$
- $MgCl_2$.

[1]

(ii) Explain how Fig. 4.1 shows that the reaction is exothermic.

.....

..... [1]

(d) Table 4.2 shows the reactions of four different metals with steam.

Table 4.2

metal	reaction with steam
iron	reacts slowly
magnesium	reacts very rapidly
nickel	reacts very slowly
niobium	does not react

Put the four metals in order of their reactivity.
Put the least reactive metal first.

least reactive ⟶ most reactive

[2]

(e) A compound of nickel has the molecular formula NiP_4F_{12}.

Complete Table 4.3 to calculate the relative molecular mass of NiP_4F_{12}.

Table 4.3

atom	number of atoms	relative atomic mass	
fluorine	12	19	$12 \times 19 = 228$
nickel		59	
phosphorus		31	

relative molecular mass = ... [2]

[Total: 10]

5 Potassium iodide is an ionic compound.

(a) State **two** properties of an ionic compound.

1 .....

2 .....
[2]

(b) Molten potassium iodide is electrolysed using graphite electrodes.

(i) Name the products formed at the positive and negative electrodes.

positive electrode .....

negative electrode .....
[2]

(ii) State the name of the positive electrode in an electrolysis experiment.

..... [1]

(c) Deduce the number of protons and neutrons in the iodide ion shown.

$^{127}_{53}I^-$

number of protons .....

number of neutrons .....
[2]

(d) Aqueous chlorine reacts with aqueous potassium iodide.

(i) Complete the symbol equation for this reaction.

$Cl_2 + 2KI \rightarrow ..... + ...KCl$ [2]

(ii) Choose from the list the name of this type of reaction.

Draw a circle around your chosen answer.

addition **combustion** **displacement** **neutralisation** [1]

(iii) State the colour of chlorine gas at room temperature and pressure.

..... [1]

[Total: 11]

6 **(a)** Fig. 6.1 shows the displayed formula of a molecule of crotyl alcohol.

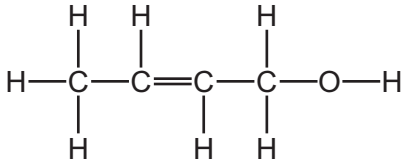


Fig. 6.1

(i) On Fig. 6.1 draw a circle around the alcohol functional group. [1]

(ii) Describe the feature of crotyl alcohol that shows it is an unsaturated compound.

..... [1]

(iii) Deduce the molecular formula of crotyl alcohol.

..... [1]

(iv) Crotyl alcohol is soluble in water.

The boiling point of crotyl alcohol is 121 °C.
The boiling point of water is 100 °C.

Suggest how fractional distillation can be used to separate a mixture of crotyl alcohol and water.

.....

.....

..... [2]

(b) Ethanol is also an alcohol.

Describe **two** conditions for the manufacture of ethanol by the fermentation of aqueous glucose.

1 .....

2 .....
[2]

(c) Ethanol can be converted to ethene.

Choose from the list the general formula for the homologous series to which ethene belongs.

Draw a circle around your chosen answer.

C_nH_n C_nH_{2n} C_nH_{2n+2} $C_{2n}H_n$ [1]

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(d) Ethene can be converted to ethane.

(i) Ethane is an alkane.

Name the type of bonding in alkanes.

..... [1]

(ii) Draw the displayed formula of a molecule of ethane.

[1]

(iii) Complete this sentence.

Alkanes are unreactive except in terms of combustion and substitution by

..... . [1]

(iv) Complete the symbol equation for the complete combustion of methane.

$$CH_4 + ...O_2 \rightarrow ..... + 2H_2O$$ [2]

[Total: 13]

7 This question is about iron.

(a) Iron is extracted from iron ore in a blast furnace.

(i) Name the main ore of iron.

..... [1]

(ii) The main ore of iron contains iron(III) oxide.

Describe the extraction of iron from iron ore in the blast furnace.

In your answer, describe:

- the production of carbon monoxide

.....

.....

.....

- the role of carbon monoxide

.....

- the role of calcium carbonate, added to the blast furnace.

.....

.....

.....
[4]

(iii) Iron collects at the base of the blast furnace as a liquid.

Describe the arrangement and motion of the particles in a liquid.

arrangement .....

.....

motion .....

.....
[2]

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(b) The equation for the reaction of iron with steam is shown.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

Describe how this equation shows that iron is oxidised.

..... [1]

(c) Rust is hydrated iron(III) oxide.

(i) Define the term hydrated.

.....

..... [1]

(ii) Name the **two** substances needed for iron to rust.

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

(d) Crystals of iron(II) chloride can be prepared by adding excess iron to dilute hydrochloric acid.

(i) Suggest how the unreacted iron is removed from the reaction mixture.

..... [1]

(ii) Describe how dry crystals of iron(II) chloride are made from a dilute solution of iron(II) chloride.

.....

.....

..... [2]

[Total: 14]

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[Turn over

8 A student investigates the reaction of iron powder with dilute hydrochloric acid at 20 °C. The hydrochloric acid is in excess.

(a) Fig. 8.1 shows the volume of hydrogen gas released as the reaction proceeds.

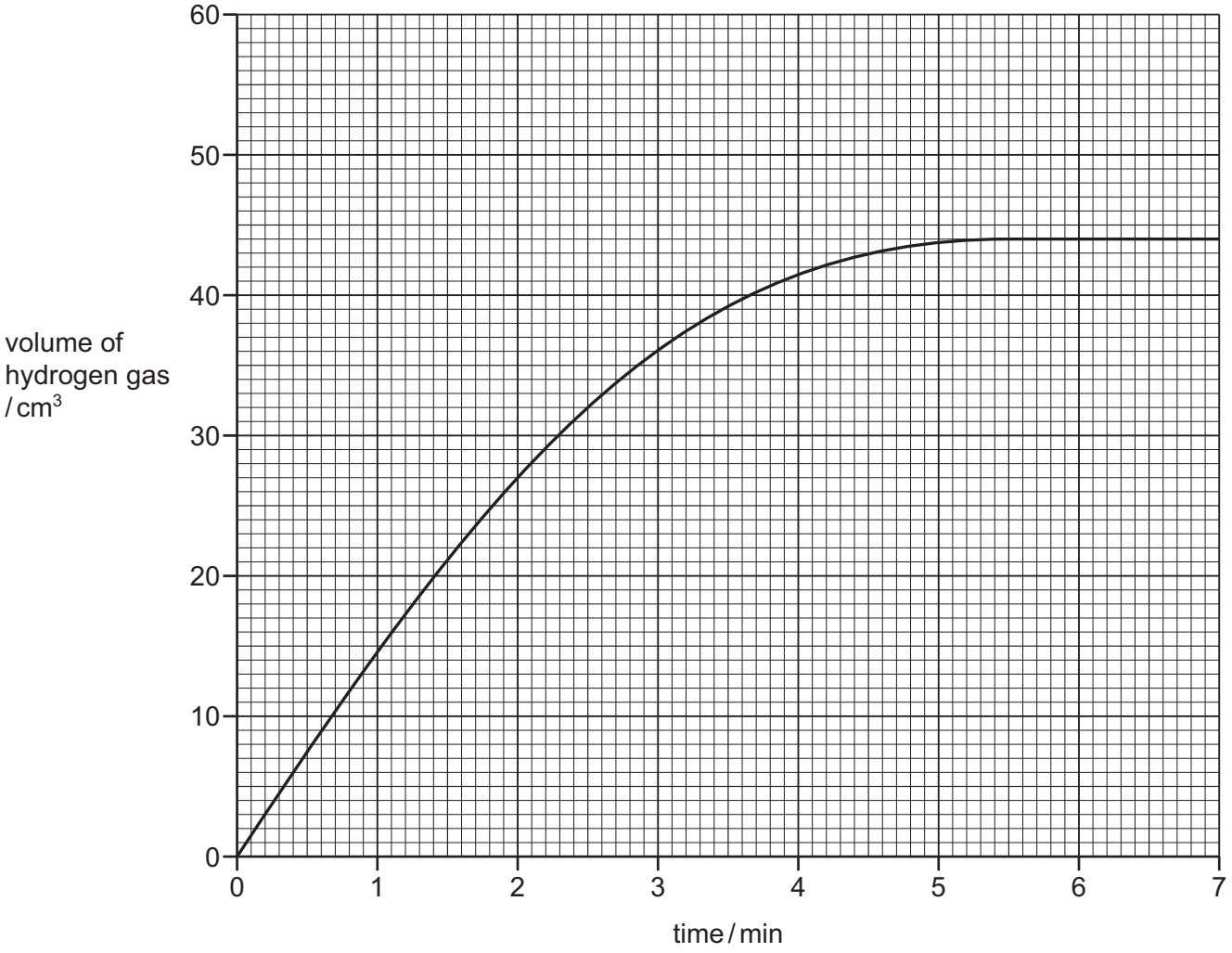


Fig. 8.1

(i) Deduce the volume of hydrogen gas released after 2 minutes.

volume of hydrogen gas = ... cm^3 [1]

(ii) The student repeats the experiment using dilute hydrochloric acid of a higher concentration.

All other conditions stay the same.

Draw a line on the grid in Fig. 8.1 to predict how the volume of hydrogen gas changes when dilute hydrochloric acid of a higher concentration is used. [2]

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(b) (i) The student repeats the experiment with large pieces of iron.

All other conditions stay the same.

Describe how the rate of reaction differs when large pieces of iron are used.

..... [1]

(ii) The student repeats the experiment with iron powder at a temperature of 15 °C.

All other conditions stay the same.

Describe how the rate of reaction differs when a temperature of 15 °C is used.

..... [1]

(c) Hydrochloric acid also reacts with aqueous sodium hydroxide.

(i) Complete the word equation for this reaction.

hydrochloric acid	+	sodium hydroxide	→	....	+	.....

[2]

(ii) Write the formula of the ion present in all acids.

..... [1]

(iii) Choose from the list a possible pH value of aqueous sodium hydroxide.

Draw a circle around your chosen answer.

pH 2 **pH 4** **pH 7** **pH 13** [1]

(iv) State the colour of methyl orange in aqueous sodium hydroxide.

..... [1]

[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.).