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7501565664

CHEMISTRY **0620/31**

Paper 3 Theory (Core) **October/November 2020**

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. Blank pages are indicated.

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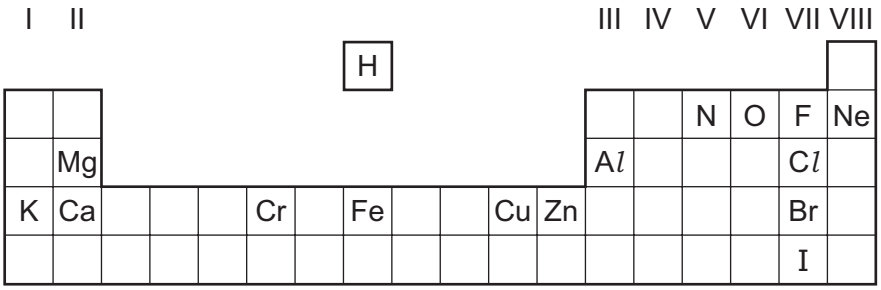
1 **(a)** The diagram shows part of the Periodic Table.



Answer the following questions using only the symbols of the elements in the diagram. Each symbol may be used once, more than once or not at all.

State the symbol of the element that:

(i) is a monoatomic gas at room temperature

..... [1]

(ii) is a liquid at room temperature

..... [1]

(iii) forms a stable ion of type X^{2-}

..... [1]

(iv) is extracted from hematite

..... [1]

(v) forms an ion whose aqueous solution gives a grey-green precipitate on addition of aqueous ammonia.

..... [1]

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(b) Magnesium has several naturally occurring isotopes.

(i) State the meaning of the term *isotopes*.

.....

..... [2]

(ii) An isotope of magnesium is shown.

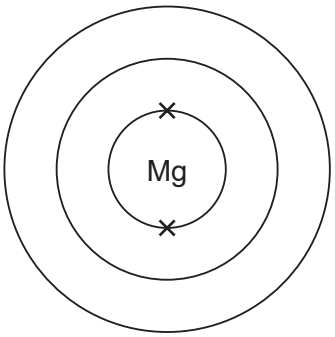
$^{26}_{12}Mg$

Deduce the number of protons and neutrons in this isotope.

number of protons .....

number of neutrons .....
[2]

(c) Complete the electronic structure of a magnesium atom.



[1]

[Total: 10]

2 The table shows the mass of air pollutants, in nanograms, in 1000 cm^3 samples of air taken over a four month period.

	mass of pollutant in 1000 cm^3 of air / nanograms				
month	oxides of nitrogen	sulfur dioxide	carbon monoxide	ozone	particulates
April	108.2	0.6	1.3	24.6	17.8
May	121.6	1.8	1.6	23.2	19.2
June	126.7	1.6	1.9	22.8	20.0
July	163.9	4.5	2.2	20.1	22.0

(a) Answer these questions using only the information in the table.

(i) Name the pollutant that shows a decrease in concentration between April and July.

..... [1]

(ii) Name the pollutant present in the lowest concentration in May.

..... [1]

(iii) Calculate the mass of sulfur dioxide in 250 cm^3 of the sample of air taken in April.

..... nanograms [1]

(b) Oxides of nitrogen are produced when oxygen combines with nitrogen during thunderstorms.

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

..... [1]

(ii) Give **one** adverse effect of oxides of nitrogen on health.

..... [1]

(iii) Complete the chemical equation for the reaction of nitrogen with oxygen to form nitrogen dioxide.

..... + $2O_2$ → .....NO_2 [2]

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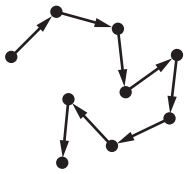
(c) Particulates are tiny solid particles in the air.

The movement of these particles is shown by the arrows in the diagram.



State the name given to this random motion of particles.

..... [1]

[Total: 8]

3 Some properties of four substances, **A**, **B**, **C** and **D**, are shown in the table.

substance	strength	ductility (how easy it is to pull into a wire)	hardness	conductivity of heat
A	weak	poor	hard	poor
B	strong	not ductile	very hard	good
C	very strong	very good	hard	good
D	weak	poor	soft	good

Answer these questions using only the information in the table.

(a) State which substance, **A**, **B**, **C** or **D**, is best used in the core of an overhead electricity cable.

Explain your answer.

substance .....

explanation .....

.....

[3]

(b) State which substance, **A**, **B**, **C** or **D**, is best used for the tip of a drill.

Explain your answer.

substance .....

explanation .....

.....

[3]

[Total: 6]

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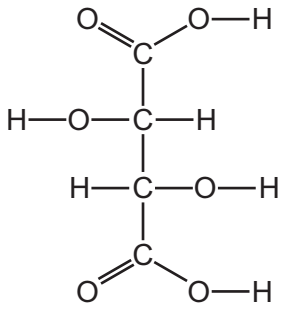
4 The structure of tartaric acid is shown.



(a) (i) On the structure, draw a circle around **one** alcohol functional group. [1]

(ii) Deduce the formula of tartaric acid to show the number of carbon, hydrogen and oxygen atoms.

..... [1]

(iii) Complete the table to calculate the relative molecular mass of tartaric acid.
Use your Periodic Table to help you.

type of atom	number of atoms	relative atomic mass	
carbon		12	
hydrogen	6	1	$6 \times 1 = 6$
oxygen		16	

relative molecular mass = ... [2]

(b) Acids react with bases such as calcium hydroxide.

(i) Complete the word equation for the reaction of nitric acid with calcium hydroxide.

nitric acid	+	calcium hydroxide	→	....	+	.....

[2]

(ii) An aqueous solution of calcium hydroxide is alkaline.

Identify which **one** of these pH values represents the pH of an alkaline solution.

Draw a circle around the correct answer.

pH 1 **pH 4** **pH 7** **pH 10** [1]

(iii) One way of determining pH is to use a pH meter.

Describe one **other** way of determining pH.

.....

..... [2]

(iv) Farmers spread calcium hydroxide (slaked lime) on fields where crops are grown.

Explain why.

.....

..... [1]

(c) Calcium carbonate undergoes thermal decomposition.

$$CaCO_3 \rightarrow CaO + CO_2$$

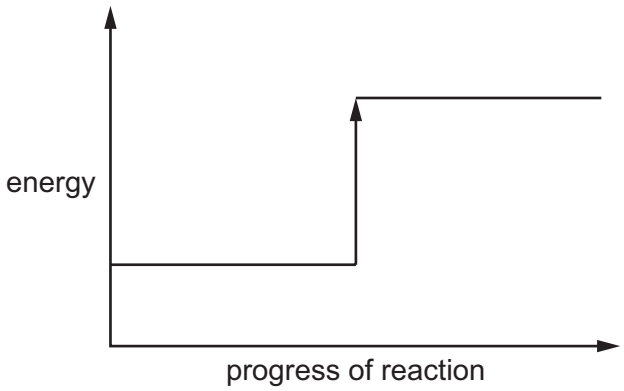
(i) State the meaning of the term *thermal decomposition*.

.....

..... [2]

(ii) Complete the energy level diagram for the thermal decomposition of calcium carbonate by writing these words on the diagram:

- reactant
- products.



[1]

(iii) Explain, using information on the energy level diagram, how you know that this reaction is endothermic.

..... [1]

[Total: 14]

5 Ethene is an alkene.

(a) Draw the structure of ethene to show all of the atoms and all of the bonds.

[1]

(b) Ethene reacts with aqueous bromine.

State the colour change observed when ethene reacts with aqueous bromine.

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

(c) Ethene reacts with steam.

(i) Name and give the formula of the product of this reaction.

name .....

formula .....
[2]

(ii) Identify the type of chemical reaction that occurs when ethene reacts with steam.

Draw a circle around the correct answer.

addition **fermentation** **polymerisation** **neutralisation** [1]

(d) Alkenes are produced by cracking hydrocarbons.

Complete the chemical equation for the cracking of the hydrocarbon, $C_{16}H_{34}$, to produce an alkene and one other product.

$$C_{16}H_{34} \rightarrow C_6H_{12} + ...$$ [1]

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[Turn over

(e) Poly(ethene) is produced by combining many ethene molecules.

(i) Name the general term used to describe the small molecules which combine to form a polymer.

..... [1]

(ii) Nylon is a polymer.

State **one** use for nylon.

..... [1]

(iii) Describe **one** pollution problem caused by non-biodegradable plastics.

..... [1]

[Total: 10]

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6 Electrolysis is used to extract metals from metal compounds.

(a) Describe the electrolysis of molten lead(II) bromide.
In your answer include:

- a labelled diagram of the apparatus used
- the names of the products formed at the positive and the negative electrodes.

positive electrode .....

negative electrode .....

[5]

(b) Use the kinetic particle model to describe the arrangement and motion of the particles in molten (liquid) lead.

arrangement .....

motion .....

[2]

(c) Lead is a metal which is soft and has a relatively low melting point.

State two **other** physical properties of metals such as lead.

1 .....

2 .....

[2]

(d) Lead is formed when red lead oxide, Pb_3O_4, is heated with carbon.

$$Pb_3O_4 + 4C \rightarrow 3Pb + 4CO$$

Explain how this equation shows that Pb_3O_4 has been reduced.

..... [1]

[Total: 10]

7 Catalysts increase the rate of chemical reactions.

(a) Name the type of metals often used as catalysts.

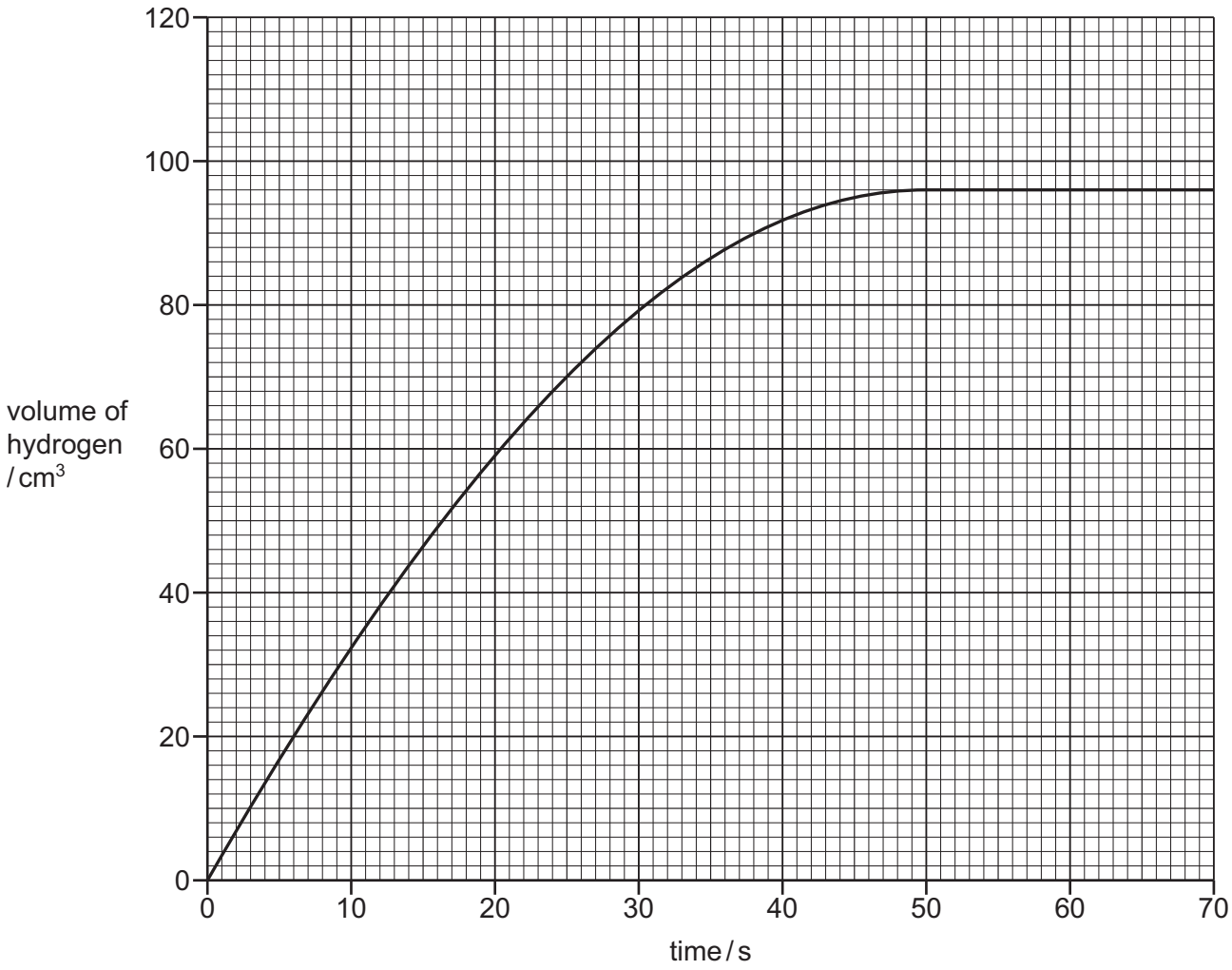
..... [1]

(b) A student investigated the reaction of zinc powder with excess dilute hydrochloric acid in the absence of a catalyst.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

The student measured the volume of hydrogen gas produced at 10 second intervals.

The graph shows the results.



Answer these questions using information from the graph.

(i) Deduce the volume of hydrogen produced in the first 25 seconds of the experiment.

volume = ... cm^3 [1]

(ii) Explain why no more hydrogen is produced after 50 seconds.

..... [1]

(iii) The experiment is repeated using a catalyst.

Draw a line **on the grid** to show how the volume of hydrogen changes with time when a catalyst is used.

All other conditions stay the same. [2]

(iv) Describe what effect the following changes have on the rate of the reaction.

- The concentration of hydrochloric acid is decreased.

  All other conditions stay the same.

  .....

- Large pieces of zinc are used.

  All other conditions stay the same.

  .....
  [2]

(c) (i) Describe a test for hydrogen.

test .....

result .....
[2]

(ii) State **one** use of hydrogen.

..... [1]

[Total: 10]

8 This question is about metals and compounds of metals.

(a) Identify two correct statements about transition elements.

Tick **two** boxes.

All transition elements are metals which are brown in colour.	☐
Transition elements have high densities.	☐
Compounds of transition elements are white in colour.	☐
Transition elements have high melting points.	☐
Transition elements are found between Groups IV and V of the Periodic Table.	☐

[2]

(b) The table compares the ease of reduction of some metal oxides with carbon.

metal oxide	ease of reduction with carbon
cobalt(II) oxide	reduced at 450 °C
copper(II) oxide	reduced below 450 °C
magnesium oxide	reduced above 1400 °C
manganese(II) oxide	reduced at 1400 °C

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

least reactive ⟶ most reactive

[2]

(c) Crystals of copper(II) sulfate, $CuSO_4 \cdot 5H_2O$, can be prepared by heating excess copper(II) oxide powder with dilute sulfuric acid.

(i) Describe how to prepare a sample of pure dry copper(II) sulfate crystals after the reaction is complete.

In your answer describe how to:

- remove the excess copper(II) oxide from the reaction mixture
- crystallise the copper(II) sulfate
- dry the crystals.

.....

.....

.....

.....

.....

.....

.....

..... [4]

(ii) Identify the word that best describes copper(II) sulfate.

Draw a circle around the correct answer.

acid **halogen** **polymer** **salt** [1]

(d) A few drops of water are added to a sample of solid anhydrous copper(II) sulfate, $CuSO_4$.

(i) The reaction is reversible.

$$CuSO_4 + 5H_2O \boxed{} CuSO_4 \cdot 5H_2O$$

Draw in the box, the sign for a reversible reaction. [1]

(ii) State the colour change observed when water is added to anhydrous copper(II) sulfate.

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

[Total: 12]

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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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).