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4750882735

CHEMISTRY **0620/32**

Paper 3 Theory (Core) **February/March 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 **20** pages. Blank pages are indicated.

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[Turn over

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

aluminium oxide
calcium bromide
calcium oxide
ethane
ethene
hydrogen chloride
methane
nitrogen dioxide
potassium iodide
potassium manganate(VII)
sodium chloride

Answer the following questions using only the compounds in the list.
Each compound may be used once, more than once or not at all.

Which compound:

(i) when in acidified solution, is used to test for sulfur dioxide

..... [1]

(ii) is the main constituent of natural gas

..... [1]

(iii) when dissolved in water, gives a yellow precipitate on addition of acidified aqueous silver nitrate

..... [1]

(iv) is used in flue gas desulfurisation to neutralise acidic gases

..... [1]

(v) is a reactant used in the manufacture of ethanol?

..... [1]

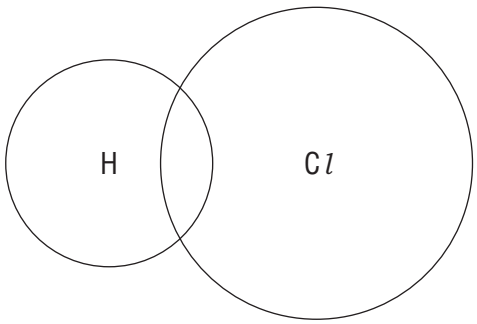
(b) What is the meaning of the term *compound*?

.....

..... [2]

(c) Complete the electronic structure of a molecule of hydrogen chloride.

Show only the outer shell electrons.

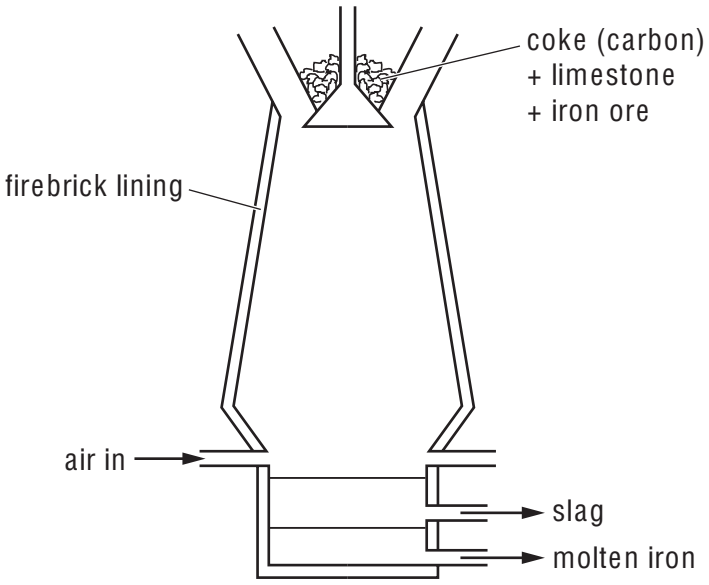


[2]

[Total: 9]

2 Iron is extracted by heating a mixture of coke (carbon), limestone and iron ore in air in a blast furnace.

A diagram of the blast furnace is shown.



(a) Name the ore of iron added to the blast furnace.

..... [1]

(b) The impurities in the iron ore are removed as slag.

(i) What information in the diagram shows that slag is less dense than molten iron?

..... [1]

(ii) Which **one** of the substances added to the blast furnace helps to remove the impurities?

Explain how it does this.

substance .....

explanation .....

.....

.....

[3]

(c) Hot air is blown into the blast furnace.

Explain why.

.....

..... [1]

(d) The chemical equation for one of the reactions in the blast furnace is shown.

$$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$$

(i) How does this equation show that Fe_2O_3 has been reduced?

..... [1]

(ii) When 16.0 g of Fe_2O_3 react with excess carbon monoxide, 11.2 g of iron are produced.

Calculate the mass of iron produced when 4.0 g of Fe_2O_3 react with excess carbon monoxide.

mass of iron = ... g [1]

(e) An isotope of iron is shown.

$$^{58}_{26}Fe$$

Deduce the number of electrons, protons and neutrons in an atom of this isotope of iron.

number of electrons .....

number of protons .....

number of neutrons .....

[3]

(f) Iron is a transition element.

Which **two** of these statements about iron are correct?

Tick **two** boxes.

Iron forms coloured compounds.	☐
Iron can act as a catalyst.	☐
Iron is brown when freshly cut.	☐
Iron has a low density.	☐
Iron has a low melting point.	☐

[2]

[Total: 13]

3 Water is essential for many industrial processes.

(a) State **one** use of water in industry.

..... [1]

(b) What is the pH of pure water?

Draw a circle around the correct answer.

pH 0 **pH 6** **pH 7** **pH 14** [1]

(c) Filtration and chlorination are two of the steps used in water treatment.

Describe the purpose of each of these steps.

filtration .....

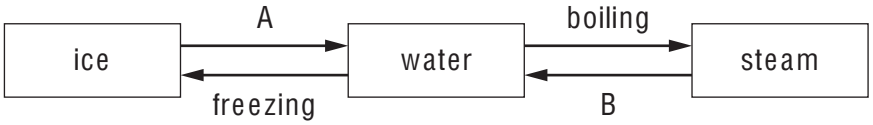
.....

chlorination .....

.....

[2]

(d) The changes of state of water are shown.



Give the names of the changes of state represented by **A** and **B**.

A .....

B .....

[2]

(e) The table compares the reactions of four metals with both steam and dilute hydrochloric acid.

metal	reaction with steam at 200 °C	observation with dilute hydrochloric acid
copper	no reaction	no bubbles formed
magnesium	rapid reaction	bubbles form rapidly
nickel	no reaction	bubbles form slowly
zinc	rapid reaction	bubbles form slowly

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

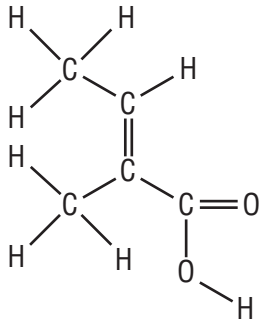
least reactive ⟶ most reactive

[2]

[Total: 8]

4 Angelic acid and ethanoic acid are both carboxylic acids.

The structure of angelic acid is shown.



(a) (i) On the structure of angelic acid, draw a circle around the functional group that shows that it is a carboxylic acid. [1]

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

..... [1]

(iii) Angelic acid is an unsaturated compound.

Describe a chemical test to distinguish between an unsaturated and a saturated compound.

test .....

result with unsaturated compound .....

result with saturated compound .....

[3]

(b) The formula of ethanoic acid is $C_2H_4O_2$.

Complete the table to calculate the relative molecular mass of ethanoic acid.

Use the Periodic Table to help you.

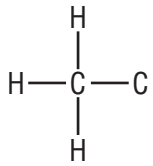
type of atom	number of atoms	relative atomic mass	
carbon	2	12	$2 \times 12 = 24$
hydrogen			
oxygen		16	

relative molecular mass = ...

[2]

(c) Ethanoic acid can be reduced to ethanol.

Complete the structure of ethanol to show all of the atoms and all of the bonds.



[1]

(d) Ethanol can be manufactured by fermentation.

Describe the process of fermentation to include:

- the names of the reactants and catalyst

.....

.....

- the conditions required

.....

.....

.....

- the name of the process used to separate the ethanol from the rest of the reaction mixture.

.....

[4]

[Total: 12]

5 The table shows some properties of four metals in Group I of the Periodic Table.

metal	melting point / °C	boiling point / °C	relative electrical conductivity
sodium	98	883	.....
potassium	63	760	14
rubidium	.....	686	8
caesium	29	669	5

(a) Complete the table to estimate:

- the melting point of rubidium
- the relative electrical conductivity of sodium.

[2]

(b) What is the physical state of caesium at 20 °C?

Give a reason for your answer.

.....

.....

..... [2]

(c) Describe the trend in the boiling points of the Group I metals.

..... [1]

(d) When potassium reacts with water, a coloured flame is seen and a gas is produced that pops with a lighted splint.

(i) Complete the chemical equation for this reaction.

$$.....K + 2H_2O \rightarrow 2KOH + ...$$ [2]

(ii) State the colour of the flame when potassium reacts with water.

..... [1]

(iii) The solution formed is alkaline.

Describe how you can use universal indicator solution to determine the pH of the solution.

.....

..... [2]

[Total: 10]

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6 This question is about the reactions of magnesium with nitric acid.

(a) The equation for the reaction of magnesium with concentrated nitric acid is shown.

$$Mg + 4HNO_3 \rightarrow Mg(NO_3)_2 + 2NO_2 + 2H_2O$$

(i) The reaction is exothermic.

What is the meaning of the term *exothermic*?

..... [1]

(ii) Which word best describes the compound $Mg(NO_3)_2$?

Draw a circle around the correct answer.

acid **base** **oxide** **salt** [1]

(iii) Oxides of nitrogen are formed when fossil fuels are burned.

What type of chemical reaction occurs when fossil fuels are burned?

Draw a circle around the correct answer.

combustion **cracking** **fermentation** **neutralisation** [1]

(iv) Oxides of nitrogen dissolve in rain water to form acid rain.

State **one** adverse effect of acid rain on buildings.

..... [1]

(b) When very dilute nitric acid reacts with magnesium powder, hydrogen is produced.

(i) Describe a practical method for investigating the rate of this reaction.

.....

.....

.....

..... [3]

(ii) What effect would each of the following have on the rate of this reaction?

- Larger pieces of magnesium are used instead of magnesium powder.

All other conditions stay the same.

.....

- The temperature of the reaction mixture is increased.

All other conditions stay the same.

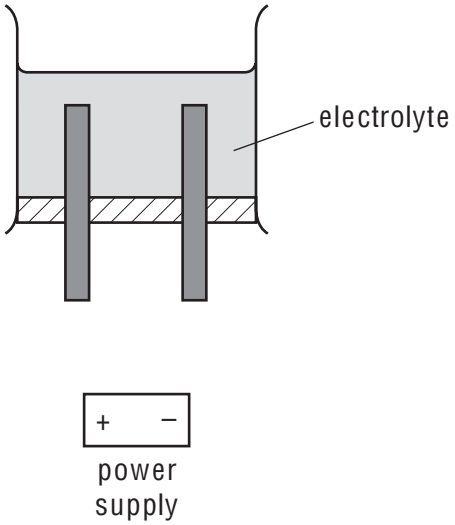
.....

[2]

[Total: 9]

7 **(a)** The electrolysis of dilute sulfuric acid produces gases at both electrodes.

(i) The incomplete apparatus is shown.



Complete the diagram by:

- labelling the anode and cathode
- adding connecting wires
- showing how the gases are collected.

[3]

(ii) Name the products formed at each electrode.

positive electrode .....

negative electrode .....

[2]

(b) Carbon dioxide is produced when sulfuric acid reacts with sodium carbonate.

Name the **two** other products which are formed.

..... and .....

[2]

(c) Describe the test for carbon dioxide.

test .....

observations .....

[2]

(d) Carbon dioxide is a greenhouse gas.

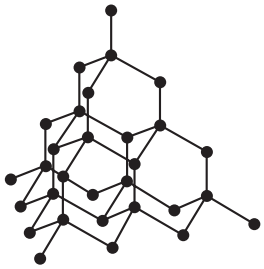
State **one** effect of greenhouse gases on the environment.

..... [1]

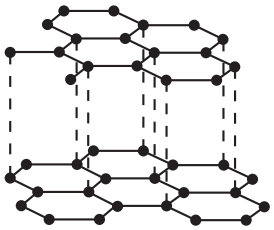
[Total: 10]

8 **(a)** The structures of four substances **C**, **D**, **E** and **F**, are shown.

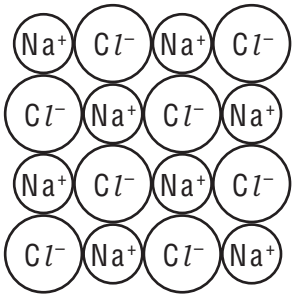
C



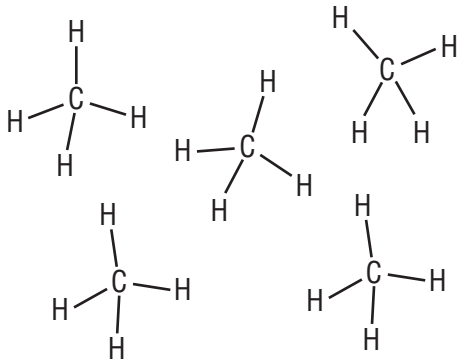
D



E



F



(i) Which **one** of these substances, **C**, **D**, **E** or **F**, is a gas at room temperature?

..... [1]

(ii) What type of bonding is present in substance **E**?

..... [1]

(iii) Which **one** of these substances, **C**, **D**, **E** or **F**, is soluble in water?

..... [1]

(iv) Which **one** of these substances, **C**, **D**, **E** or **F**, conducts electricity when solid?

..... [1]

(b) The halogens have molecules containing two atoms.

What is the name for molecules containing only two atoms?

..... [1]

(c) The reaction of iodine with hydrogen is shown.

$$I_2 + H_2 \rightleftharpoons 2HI$$

What is the meaning of the symbol $\rightleftharpoons$?

..... [1]

(d) Iodine is formed when chlorine reacts with aqueous potassium iodide.

(i) Complete the chemical equation for this reaction.

..... + 2KI $\rightarrow$ I_2 + ...KCl [2]

(ii) When aqueous iodine is mixed with aqueous potassium chloride, there is no reaction.

Suggest, in terms of chemical reactivity, why there is no reaction.

..... [1]

[Total: 9]

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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		Key: atomic number / atomic symbol / name / relative atomic mass									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 –		

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.).

PMT