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CHEMISTRY

0620/43

Paper 4 Theory (Extended)

October/November 2017

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

A copy of the Periodic Table is printed on page 12.

You may lose marks if you do not show your working or if you do not use appropriate units.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [] at the end of each question or part question.

The syllabus is approved for use in England, Wales and Northern Ireland as a Cambridge International Level 1/Level 2 Certificate.

This document consists of **12** printed pages.





1 Substances can be classified as elements, compounds or mixtures.

State whether each of the following is an element, a compound or a mixture.

(a) brass [1]

(b) gold [1]

(c) butane [1]

(d) air [1]

[Total: 4]

2 (a) (i) Define the term *molecule*.

.....
 [2]

(ii) Define the term *element*.

.....
 [1]

(b) The table shows the composition of four atoms or ions, **A**, **B**, **C** and **D**.

| | number of protons | number of neutrons | number of electrons |
|----------|-------------------|--------------------|---------------------|
| A | 10 | 10 | 10 |
| B | 10 | 12 | 10 |
| C | 12 | 10 | 10 |
| D | 13 | 14 | 10 |

(i) What is the atomic number of **A**?

..... [1]

(ii) What is the nucleon number of **B**?

..... [1]

(iii) Which of **A**, **B**, **C** and **D** are isotopes of each other?

..... [1]

(iv) Which of **A**, **B**, **C** and **D** are atoms?

..... [1]

(v) Which of **A**, **B**, **C** and **D** are positive ions?

..... [1]

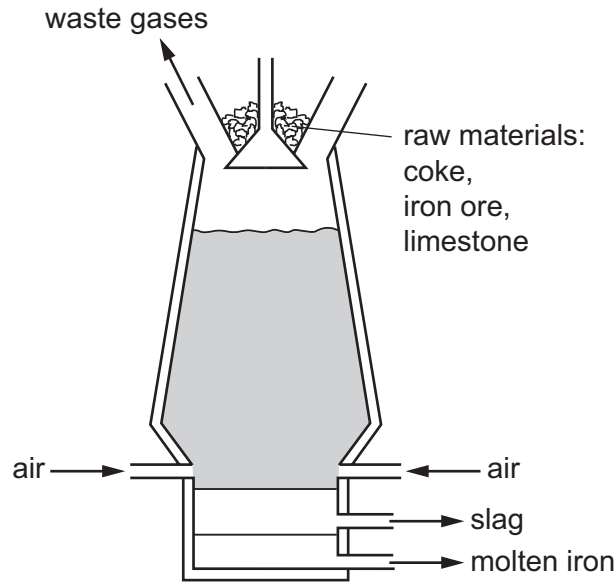
(c) Complete the table.

| | number of protons | number of electrons |
|-----------------|-------------------|---------------------|
| Na | | |
| S ²⁻ | | |
| Cl ₂ | | |

[3]

[Total: 11]

3 Iron is extracted from its ore using coke in a blast furnace.



(a) Name the ore of iron which is mainly iron(III) oxide.

..... [1]

(b) Describe the reactions occurring in the blast furnace.

In your answer, include

- **two** reasons for using coke in the blast furnace,
- a chemical equation for the reduction of iron(III) oxide,
- an explanation for using limestone in the blast furnace.

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.....
..... [6]

(c) (i) Describe the bonding in iron. Include a diagram in your answer.

.....
 [3]

(ii) Use your diagram in (c)(i) to explain why iron is malleable.

.....
 [2]

(iii) Iron containing a small amount of carbon is known as steel.

Explain why steel is less malleable than iron.

.....
 [2]

(d) (i) When iron is added to dilute sulfuric acid, an aqueous solution of iron(II) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [1]

(ii) When iron(III) oxide is added to dilute sulfuric acid, an aqueous solution of iron(III) sulfate is formed as one of the products.

Write a chemical equation for the reaction.

..... [3]

(e) Aqueous sodium hydroxide, aqueous potassium iodide and aqueous acidified potassium manganate(VII) are added to aqueous solutions of iron(II) sulfate and iron(III) sulfate.

- Iron(II) ions, Fe^{2+} , are reducing agents in aqueous solution.
- Iron(III) ions, Fe^{3+} , are oxidising agents in aqueous solution.

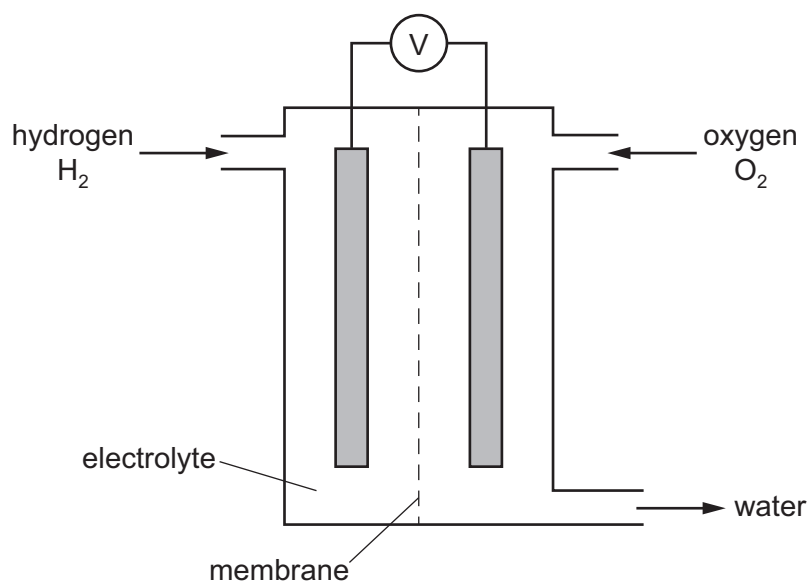
Complete the table.

| reagent | observations with aqueous iron(II) sulfate | observations with aqueous iron(III) sulfate |
|--|--|---|
| aqueous sodium hydroxide | green precipitate | |
| aqueous potassium iodide | | |
| aqueous acidified potassium manganate(VII) | | no change |

[4]

[Total: 22]

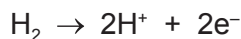
4 Hydrogen and oxygen react together in a hydrogen fuel cell. A hydrogen fuel cell is shown in the diagram.



(a) Name the process by which oxygen is obtained from air.

..... [1]

- (b) (i) In a hydrogen fuel cell, the hydrogen molecules are converted into hydrogen ions, H^+ , according to the ionic half-equation shown.



What type of reaction does this ionic half-equation represent?

..... [1]

- (ii) What **type** of substance reacts by donating hydrogen ions, H^+ ?

..... [1]

- (c) Write a chemical equation for the overall reaction that occurs in a hydrogen fuel cell.

..... [1]

- (d) Hydrogen fuel cells are being developed as alternatives to petrol engines in cars.

- (i) Give **one** advantage of hydrogen fuel cells compared to petrol engines.

..... [1]

- (ii) Give **one** disadvantage of hydrogen fuel cells compared to petrol engines.

..... [1]

- (e) Some fuel cells use ethanol, C_2H_5OH , instead of hydrogen. Carbon dioxide and water are products of the reaction in an ethanol fuel cell.

- (i) Write a chemical equation for the overall reaction occurring in an ethanol fuel cell.

..... [2]

- (ii) State an environmental problem caused by the release of carbon dioxide into the atmosphere.

..... [1]

- (iii) Name the process by which ethanol can be manufactured from a renewable resource.

..... [1]

- (f) Name the process occurring when electrical energy is used to break down an ionic compound.

..... [1]

[Total: 11]

- 5 (a) (i) Name the products formed when sodium nitrate is heated.

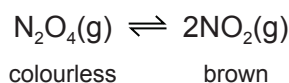
..... [2]

- (ii) When copper(II) nitrate, $\text{Cu}(\text{NO}_3)_2$, undergoes thermal decomposition, three products are formed. One of the products is nitrogen dioxide, NO_2 .

Write a chemical equation for the thermal decomposition of copper(II) nitrate.

..... [2]

- (b) The chemical equation shows the equilibrium between dinitrogen tetroxide (N_2O_4 , a colourless gas) and nitrogen dioxide (NO_2 , a brown gas).



A mixture of dinitrogen tetroxide and nitrogen dioxide is allowed to reach equilibrium in a closed gas syringe.

- (i) In chemistry, what is meant by the term *equilibrium*?

.....

 [2]

- (ii) If the equilibrium mixture is heated at constant pressure, a darker brown colour is seen inside the gas syringe.

What does this information indicate about the decomposition of dinitrogen tetroxide? Explain your answer in terms of the position of the equilibrium.

.....

 [2]

- (iii) Suggest what you would see if the pressure on the equilibrium mixture were increased at constant temperature. Explain your answer in terms of the position of the equilibrium.

.....

 [2]

[Total: 10]

6 (a) Alkanes and alkenes are two homologous series of hydrocarbons.

(i) What is meant by the term *hydrocarbon*?

..... [1]

(ii) What is the general formula of the homologous series of

alkanes,

alkenes?

[2]

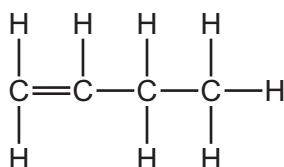
(iii) Other than having a general formula, state **two** characteristics of a homologous series.

1

2

[2]

(iv) The structure of an alkene molecule with the molecular formula C_4H_8 is shown.



Draw the structure of a different alkene molecule with the molecular formula C_4H_8 . Show all of the atoms and all of the bonds.

[1]

(v) What term describes molecules with the same molecular formula but different structural formulae?

..... [1]

- (b) 25 cm³ of a gaseous hydrocarbon, C_xH_y, were burnt in 150 cm³ of oxygen. This was an excess of oxygen.

After cooling, the volume of the gases remaining was 100 cm³. This consisted of 75 cm³ of carbon dioxide and 25 cm³ of unreacted oxygen. The water that was produced in the reaction was liquid.

All volumes were measured at the same temperature and pressure.

- (i) What is meant by an excess of oxygen?

..... [1]

- (ii) What was the volume of oxygen that reacted with the hydrocarbon?

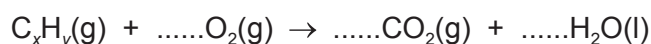
..... cm³ [1]

- (iii) Complete the table to show the smallest whole number ratio of volumes.

| | volume of hydrocarbon reacted | : | volume of oxygen reacted | : | volume of carbon dioxide produced |
|---|-------------------------------|---|--------------------------|---|-----------------------------------|
| smallest whole number ratio of volumes | | : | | : | |

[1]

- (iv) Use your answer to (b)(iii) to balance the chemical equation. Deduce the formula of the hydrocarbon.



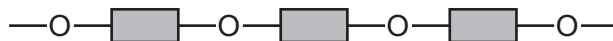
formula of the hydrocarbon = [2]

[Total: 12]

- 7 (a) Carbon and silicon are elements in Group IV of the Periodic Table. Carbon dioxide from the air moves into green plants and is converted into carbohydrates.
- (i) Name the process by which carbon dioxide molecules move through the air into green plants.
 [1]
- (ii) Explain why silicon(IV) oxide **cannot** move through the air in the same way that carbon dioxide can.
 [1]
- (iii) Name the process by which carbon dioxide is converted into glucose, $C_6H_{12}O_6$, in green plants. Give **two** conditions required for this process to occur. Write a chemical equation for the reaction which occurs.
- name of process
- condition 1
- condition 2
- chemical equation [5]

(b) Starch is a natural polymer made from glucose.

- (i) What type of polymerisation occurs when glucose is converted into starch?
 [1]
- (ii) What type of reaction occurs when starch is converted into glucose?
 [1]
- (iii) Starch can be represented as shown.



Complete the diagram below to represent the structure of the glucose monomer.



[1]

[Total: 10]

The Periodic Table of Elements

| | | Group | | | | | | | | | | | | | | | |
|----------------------------|-----------------------------|--|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-------------------------------|------------------------------|------------------------------|---------------------------|--------------------------|
| I | II | III | IV | V | VI | VII | VIII | | | | | | | | | | |
| 3 Li lithium 7 | 4 Be beryllium 9 | 1 H hydrogen 1 | 5 B boron 11 | 6 C carbon 12 | 7 N nitrogen 14 | 8 O oxygen 16 | 9 F fluorine 19 | 10 Ne neon 20 | 2 | | | | | | | | |
| 11 Na sodium 23 | 12 Mg magnesium 24 | Key atomic number atomic symbol name relative atomic mass | | | | | | | | 18 Ar argon 40 | | | | | | | |
| 19 K potassium 39 | 20 Ca calcium 40 | | | | | | | | | 13 Al aluminium 27 | 14 Si silicon 28 | 15 P phosphorus 31 | 16 S sulfur 32 | 17 Cl chlorine 35.5 | 36 Kr krypton 84 | | |
| 37 Rb rubidium 85 | 38 Sr strontium 88 | 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 | 54 Xe xenon 131 |
| 55 Cs caesium 133 | 56 Ba barium 137 | 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 | 86 Rn radon — |
| 87 Fr francium — | 88 Ra radium — | 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 — | — |
| | | 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 dm³ at room temperature and pressure (r.t.p.).