Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME

SOLVED BY SMART EXAM RESOURCES

CENTRE NUMBER

CANDIDATE NUMBER

0107964504

CHEMISTRY **0620/42**

Paper 4 Theory (Extended) **May/June 2018**

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 **11** printed pages and **1** blank page.

1 Give the name of the process that is used:

(a) to obtain water from aqueous sodium chloride

distillation ..... [1]

(b) to produce lead from molten lead(II) bromide

electrolysis ..... [1]

(c) to separate an insoluble solid from a liquid

filtration ..... [1]

(d) to separate the components of petroleum

fractional distillation [OR] fractionation ..... [1]

(e) to separate a mixture of coloured dyes.

chromatography ..... [1]

[Total: 5]

2 This question is about the elements in Period 3 of the Periodic Table.

Na	Mg	Al	Si	P	S	Cl	Ar

For each of the following, identify a Period 3 element which matches the description. Each element may be used once, more than once or not at all.

State which Period 3 element:

(a) forms an oxide with a macromolecular structure

silicon [OR] Si ..... [1]

(b) is extracted from the ore bauxite

aluminium [OR] Al ..... [1]

(c) is soft, metallic and stored in oil

sodium [OR] Na ..... [1]

(d) is a green gas at room temperature and pressure

chlorine [OR] Cl_2 [OR] Cl ..... [1]

(e) provides an inert atmosphere in lamps

argon [OR] Ar ..... [1]

(f) forms **two** different oxides during the Contact process

sulfur [OR] S ..... [1]

(g) is non-metallic and an important component of fertilisers.

phosphorus [OR] P ..... [1]

[Total: 7]

3 Complete the following table.

particle	number of protons	number of electrons	number of neutrons	number of nucleons
$^{23}_{11}Na$	11	11	12	23
$^{37}_{17}Cl^-$	17	18	20	37
$^{56}_{26}Fe^{2+}$	26	24	30	56

[6]

[Total: 6]

[Turn over

4 Potassium reacts with bromine at room temperature to form potassium bromide.

(a) Write a chemical equation for this reaction. Include state symbols.

$2K(s) + Br_2(l) \rightarrow 2KBr(s)$

..... [3]

(b) Potassium bromide exists as an ionic lattice.
Potassium bromide does **not** conduct electricity when solid but does conduct electricity when molten.

(i) What is meant by the term *ionic lattice*?

The word ionic lattice means made up of alternating positively and negatively charged ions

[2]

(ii) Explain why potassium bromide does **not** conduct electricity when solid but does conduct electricity when molten.

In solid potassium bomide the ions don't move and when it is in its molten form , the ions are mobile

[2]

(c) Concentrated aqueous potassium bromide is an electrolyte.

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

An electrolyte is a substance that conducts electricity when it is decomposed [or] It is a substance that undergoes electrolysis when present in the molten or liquid or as a solution or in an aqueous form

..... [2]

(ii) Describe the electrolysis of concentrated aqueous potassium bromide.

Include:
- an ionic half-equation for the reaction at the cathode
- the name of the product at the anode
- the name of the potassium compound formed.

$2H^+ + 2e^- \rightarrow H_2$

Andoe: Bromine is formed at the anode
Cathode: Hydrogen gas is formed at the anode
The compound that is formed is potassium hydroxide

[4]

(iii) When molten potassium bromide is electrolysed, the product at the cathode is different.

Name the product at the cathode when molten potassium bromide is electrolysed.

potassium

..... [1]

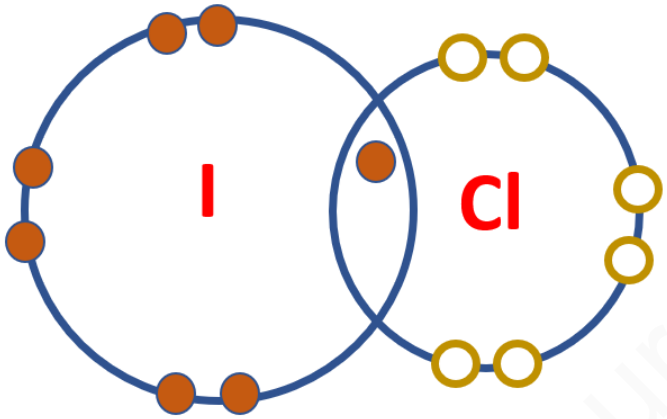
(d) Iodine reacts with chlorine to form iodine monochloride, ICl, as the only product.

(i) Write a chemical equation for this reaction.

$I_2 + Cl_2 \rightarrow 2ICl$

..... [2]

(ii) Draw a dot-and-cross diagram to show the electron arrangement in a molecule of iodine monochloride. Show outer shell electrons only.



[2]

(e) Potassium bromide has a melting point of 734 °C.
Iodine monochloride has a melting point of 27 °C.

In terms of attractive forces, explain why there is a large difference between these melting points.

Potassium bromide: ionic bonds exist in potassium bromide.
Iodine monochloride: Intermolecular forces such as van der Waals / London forces / dispersion forces / dipole- dipole exist
The bonds in KBr are stronger .Hence there is a large difference between these melting points

[3]

(f) When chlorine gas is passed through aqueous potassium bromide, a redox reaction occurs. The ionic equation is shown.

$$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$$

(i) Write an ionic half-equation showing what happens to the chlorine molecules, Cl_2, in this reaction.

$Cl_2 + 2e^- \rightarrow 2Cl$

..... [1]

(ii) Explain why the bromide ions, Br^-, act as reducing agents in this reaction.

The bromide ions lose electrons [or] The bromide ions are oxidised

..... [1]

[Total: 23]

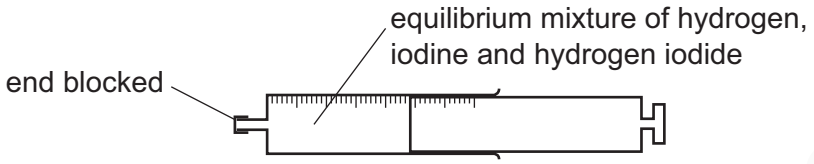
[Turn over

5 Hydrogen and iodine react together in a reversible reaction. Hydrogen iodide is formed.

$$\underset{\text{colourless gas}}{H_2(g)} + \underset{\text{purple gas}}{I_2(g)} \rightleftharpoons \underset{\text{colourless gas}}{2HI(g)}$$

The forward reaction is exothermic.

A gas syringe containing an equilibrium mixture of hydrogen, iodine and hydrogen iodide gases was sealed and heated to 250 °C. The equilibrium mixture was a pale purple colour.



(a) What is meant by the term *equilibrium*?

The rate of forward reaction equals the rate of the reverse reaction and the concentrations of reactants and products are constant

[2]

(b) The plunger of the gas syringe was pressed in while the end of the gas syringe was blocked. This increased the pressure. The position of the equilibrium did **not** change. The colour of the gaseous mixture turned darker purple.

(i) Give a reason why the position of the equilibrium did **not** change.

Same number of gas moles are present on both sides of the equilibrium [1]

(ii) Suggest why the gaseous mixture turned darker purple, even though the position of the equilibrium did **not** change.

Increased pressure forces the particles or molecules closer together[or] same number of particles or molecules in a smaller volume [1]

(c) The temperature of the gas syringe was increased to 300 °C.

(i) What happened to the **position** of the equilibrium when the temperature of the gas syringe was increased from 250 °C to 300 °C?

The equilibrium shifts towards the reactants [1]

(ii) What happened to the **rate** of the forward reaction and the **rate** of the backward reaction when the temperature of the gas syringe was increased from 250 °C to 300 °C?

rate of the forward reaction increase [or] faster

rate of the backward reaction increase [or] faster

[2]

[Total: 7]

6 **(a)** All sodium salts are soluble in water. All nitrates are soluble in water. Barium carbonate is insoluble in water.

Describe how you would make a pure, dry sample of barium carbonate by precipitation.
Include:

- the names of the starting materials
- full practical details
- a chemical equation.

Step:1-Mix sodium carbonate AND barium nitrate [or] barium chloride in solution
Step:2-Filter [or] centrifuge the barium carbonate
Step:3-Wash the residue AND dry

$Ba(NO_3)_2 + Na_2CO_3 \rightarrow BaCO_3 + 2NaNO_3$ / $Ba^{2+} + CO_3^{2-} \rightarrow BaCO_3$
OR
$BaCl_2 + Na2CO_3 \rightarrow BaCO_3 + 2NaCl$

[5]

(b) Nitrates decompose when heated.

(i) Write a chemical equation for the decomposition of sodium nitrate when it is heated.

$2NaNO_3 \rightarrow 2NaNO_2 + O_2$

..... [2]

(ii) The unbalanced chemical equation for the decomposition of hydrated copper(II) nitrate crystals is shown.

Balance the chemical equation for this reaction.

$2Cu(NO_3)_2.3H_2O(s) \rightarrow$ 2 ....$CuO(s)$ + 4 ....$NO_2(g)$ + $O_2(g)$ + 6 ....$H_2O(g)$

[2]

(iii) When the hydrated copper(II) nitrate crystals are heated, steam is produced. When the steam condenses on a cool surface, it turns into a colourless liquid.

Anhydrous cobalt(II) chloride is used to show that the colourless liquid contains water.

How does the colour of the anhydrous cobalt(II) chloride change?

from blue pink ..... to pink .....

[2]

(iv) How would the student test to determine if the water produced in **(b)(iii)** is pure?

Boiling point sharp[or] melting point sharp [or] freezing point sharp[or boiling point 100 (°)C [or]freezing point or melting point 0°C ..... [1]

[Total: 12]

7 Many organic compounds, such as alcohols, carboxylic acids and esters, contain the elements carbon, hydrogen and oxygen only.

(a) Compound **R** has the following composition by mass: C, 60.00%; H, 13.33%; O, 26.67%.

Calculate the empirical formula of compound **R**.

Elements	C	H	O
Mass	60	13.33	26.67
M_r	12	1	16
Moles =Mass/M_r	60/12=5	13.33/1=13.33	26.67/16=1.67
Lowest mole ratio	5/1.67=2.99	7.98	1.67/1.67
Whole number ratio	3	8	O

Hence empirical formula = $C_3H_8O_2$ C_3H_8O

empirical formula = ... [2]

(b) Compound **S** has the empirical formula C_2H_4O and a relative molecular mass of 88.

Calculate the molecular formula of compound **S**.

Empirical formula mass=3(12)+8(1)+2(16)=76
Hence: 88/76=1.16
Hence We multiply the subscripts in C_2H_4O by 1.16 to get $C_4H_8O_2$

[Because: 1.16x 2=3.48=4
1.16 x 4=4.64=5
1.16x 1=1.16=2]

$C_4H_5O_2$

molecular formula = ... [2]

(c) Compounds **T** and **V** both have the molecular formula $C_3H_6O_2$.

- Compound **T** produces bubbles of carbon dioxide gas when it is added to aqueous sodium carbonate.
- Compound **V** is an ester.

(i) What is the name given to compounds with the same molecular formula but different structures?

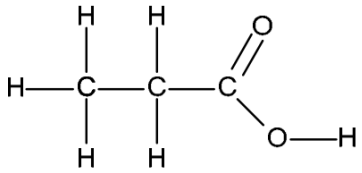
Structural isomers

..... [1]

(ii) Draw the structures of compounds **T** and **V**. Show all of the atoms and all of the bonds.

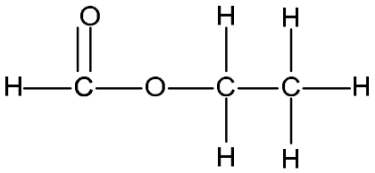
compound **T**

T

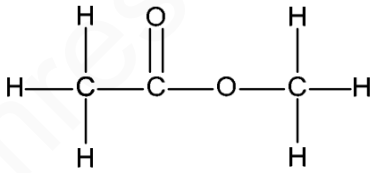


compound **V**

V



OR



[2]

(iii) All compounds with the molecular formula $C_3H_6O_2$ can undergo complete combustion in an excess of oxygen.

Complete the chemical equation for this reaction.

$C_3H_6O_2$ + ... → ..... + ...

$C_3H_6O_2 + 3\frac{1}{2}\ O_2 \rightarrow 3CO_2 + 3H_2O$

[2]

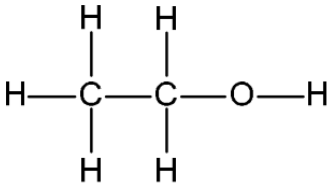
(d) Compound **W** has the molecular formula C_2H_6O. Compound **W** reacts when heated with ethanoic acid and a catalyst to produce a sweet-smelling liquid.

(i) Give the name of the homologous series to which compound **W** belongs.

Alcohol

..... [1]

(ii) Draw the structure of compound **W**. Show all of the atoms and all of the bonds.



[1]

(e) Alkanes and alkenes are hydrocarbons.

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

Hydrocarbons contain carbon and hydrogen atoms only

..... [2]

(ii) State the general formula of:

alkanes C_nH2_{n+2}

alkenes C_nH_{2n}

[2]

(f) Ethanol can be produced from long-chain alkanes as shown.

long-chain alkane $\xrightarrow{\text{step 1}}$ ethene $\xrightarrow{\text{step 2}}$ ethanol

Describe the **two-stage** manufacture of ethanol from the long-chain alkane octane, C_8H_{18}.
Include:

- the names of the types of chemical reactions that occur
- reaction equations
- reaction conditions.

step 1 Cracking of octane

Equation: . $C_8H_{18} \rightarrow C_2H_4 + C_6H_{14}$

Temperature: 450°C to 800°C

Catalyst: zeolites / aluminosilicates / silica / SiO_2 / aluminium oxide / Al_2O_3 / alumina / china / broken pot / chromium oxide / Cr_2O_3

Pressure: up to 70 atmospheres

step 2 Hydration [or] Addition

Hydration:Conditions: Phosphoric acid / H_3PO_4 / 300°C / 60 atmospheres

..... [5]

[Total: 20]

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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.).