



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0620/43

May/June 2022

1 hour 15 minutes

No additional materials are needed.

- 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.

- 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. Any blank pages are indicated.

1 A list of substances is shown.

aluminium oxide	carbon dioxide	carbon monoxide	chlorine	copper
glucose	iron(III) oxide	limestone	nitrogen	oxygen

Answer the questions using the substances in the list.

Each substance may be used once, more than once or not at all.

State which substance is:

(a) a product of respiration

..... [1]

(b) the main constituent of hematite

..... [1]

(c) an element which has a sulfate that is used to test for water

..... [1]

(d) a colourless toxic gas

..... [1]

(e) a reactant in fermentation

..... [1]

(f) a reducing agent in the extraction of iron

..... [1]

(g) a conductor of electricity when solid

..... [1]

(h) a gas that is approximately 21% of clean, dry air.

..... [1]

[Total: 8]

- 2 (a) $^{32}_{16}\text{S}$ and $^{33}_{16}\text{S}$ are isotopes of sulfur.

Use your knowledge of protons, neutrons and electrons to answer the following questions.

- (i) Describe how these isotopes of sulfur are the same and how they are different.

same

 different
 [3]

- (ii) Explain why each of these isotopes have an overall charge of zero.

.....
 [1]

- (iii) Explain why both isotopes have the same chemical properties.

.....
 [1]

- (b) Sulfide ions, S^{2-} , have the electronic structure 2,8,8.

- (i) Explain why sulfide ions have a charge of 2–.

.....
 [1]

- (ii) Give the formula of:

- an anion which has the same electronic structure as S^{2-}

.....

- a cation which has the same electronic structure as S^{2-} .

.....

[2]

[Total: 8]

3 This question is about nitrogen and compounds of nitrogen.

(a) Nitrogen molecules have the formula N_2 .

Some properties of nitrogen are shown:

- melting point of -210°C
- boiling point of -196°C
- non-conductor of electricity when solid
- insoluble in water.

(i) Name the type of bonding between the atoms in an N_2 molecule.

..... [1]

(ii) Explain, in terms of attractive forces between particles, why nitrogen has a low melting point.

.....
 [1]

(iii) Explain why nitrogen does **not** conduct electricity.

.....
 [1]

(b) Nitrogen reacts with hydrogen to form ammonia, NH_3 , in the Haber process.

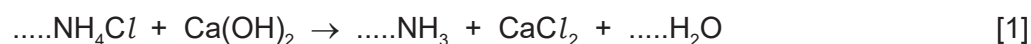
State the essential conditions in the Haber process. Write an equation for the chemical reaction.

.....

 [4]

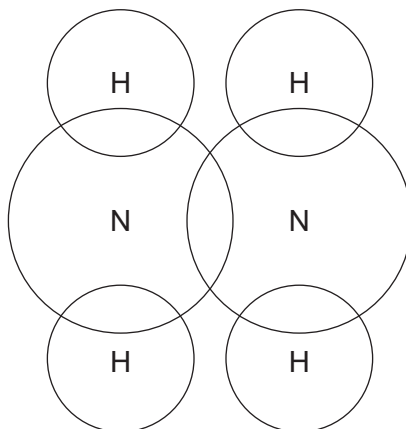
(c) Ammonia is made in the laboratory by heating ammonium chloride with calcium hydroxide.

Balance the chemical equation for the reaction.



- (d) Hydrazine, N_2H_4 , is another compound that contains nitrogen and hydrogen.

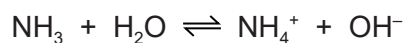
Complete the dot-and-cross diagram to show the electron arrangement in a molecule of hydrazine. Show outer electrons only.



[2]

- (e) Ammonia and hydrazine are weak bases.

The chemical equation for the reaction between one molecule of ammonia and one molecule of water is shown.



- (i) State the meaning of the term *base*.

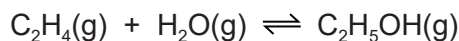
..... [1]

- (ii) Write a chemical equation for the reaction between one molecule of hydrazine, N_2H_4 , and one molecule of water.

..... [1]

[Total: 12]

- 4 Ethanol is made industrially by the reaction of ethene with steam. The reaction occurs at a temperature of 300 °C and a pressure of 60 atmospheres.



A catalyst is used in this reaction.

The forward reaction is exothermic.

- (a) State what is meant by the term *catalyst*.

.....
 [2]

- (b) Complete the table using only the words *increases*, *decreases* or *no change*.

	effect on the rate of the forward reaction	effect on the equilibrium yield of C ₂ H ₅ OH(g)
increasing the temperature		
decreasing the pressure		

[4]

- (c) Ethanol is a member of the alcohol homologous series.

Members of the same homologous series have the same general formula.

- (i) State the general formula of alcohols.

..... [1]

- (ii) State two **general** characteristics, other than the same general formula, of all homologous series.

1

2

[2]

- (iii) One alcohol containing three carbon atoms is propan-1-ol.

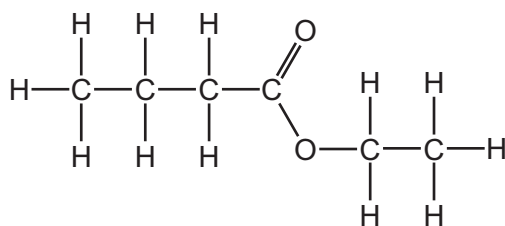
Draw the structure of one **other** alcohol containing three carbon atoms. Show all of the atoms and all of the bonds.

Name the alcohol you have drawn.

name [2]

- (d) When alcohols react with carboxylic acids, esters are produced.

- (i) The structure of ester **X** is shown.



Name ester **X**.

..... [1]

- (ii) Give the name of the alcohol and the carboxylic acid that react together to produce ester **X**.

alcohol

carboxylic acid [2]

- (e) Ester **Y** has the following composition by mass:

C, 58.82%; H, 9.80%; O, 31.37%.

Calculate the empirical formula of ester **Y**.

empirical formula = [3]

- (f) Ester **Z** has the empirical formula $\text{C}_3\text{H}_6\text{O}$ and a relative molecular mass of 116.

Calculate the molecular formula of ester **Z**.

molecular formula = [1]

[Total: 18]

5 This question is about copper and its compounds.

(a) Describe the bonding in a metallic element such as copper.

You may include a diagram as part of your answer.

.....

.....

..... [3]

(b) A metal spoon is electroplated with copper.

State what is used as:

the positive electrode (anode)

the negative electrode (cathode)

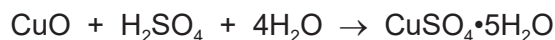
the electrolyte.

[3]

(c) The formula for crystals of hydrated copper(II) sulfate is $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$.

Hydrated copper(II) sulfate is made by reacting copper(II) oxide with dilute sulfuric acid.

The overall equation is shown.



The crystals are made using the following steps:

step 1 50.0 cm³ of 0.200 mol/dm³ dilute sulfuric acid is heated in a beaker. Powdered copper(II) oxide is added until the copper(II) oxide is in excess. Aqueous copper(II) sulfate is formed.

step 2 The excess copper(II) oxide is separated from the aqueous copper(II) sulfate.

step 3 The aqueous copper(II) sulfate is heated until a saturated solution is formed.

step 4 The saturated solution is allowed to cool and crystallise.

step 5 The crystals are removed and dried.

Calculate the maximum mass of copper(II) sulfate crystals, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$, that can form using the following steps.

- Calculate the number of moles of H_2SO_4 in 50.0 cm³ of 0.200 mol/dm³ H_2SO_4 .

..... mol

- Deduce the number of moles of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ that can form.

..... mol

- The M_r of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ is 250.

Calculate the maximum mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ that can form.

..... g
[3]

- (d) State **one** observation that indicates the copper(II) oxide is in excess in **step 1**.

..... [1]

- (e) **Step 1** is repeated without heating the dilute sulfuric acid.

All other conditions are kept the same.

The rate of reaction decreases.

Give a reason why the rate of reaction decreases. Explain your answer in terms of particles.

.....

.....

.....

.....

..... [3]

- (f) Name a substance, other than copper(II) oxide, that can be added to dilute sulfuric acid to produce copper(II) sulfate in **step 1**.

..... [1]

- (g) Name the process used to separate excess copper(II) oxide from aqueous copper(II) sulfate in **step 2**.

..... [1]

- (h) Suggest what is meant by the term *saturated solution* in **step 3**.

.....

.....

..... [2]

- (i) The phrase 'heating to dryness' means heating until no more water is given off.

Explain why aqueous copper(II) sulfate is **not** heated to dryness in **step 3**.

.....

..... [1]

[Total: 18]

6 The Periodic Table can be used to classify elements.

(a) The Group I metals react with cold water. Transition elements do not react with cold water.

(i) Describe two **other** differences in the **chemical** properties between Group I metals and transition elements.

1

2 [2]

(ii) Describe the observations when potassium is added to cold water. Write a balanced equation for the reaction. Include state symbols.

observations

.....

.....

.....

equation [5]

(b) Transition elements are stronger than Group I metals.

Describe two **other** differences in the **physical** properties of Group I metals and transition elements.

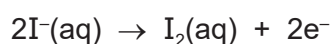
1

2 [2]

(c) Some Group VII elements react with aqueous solutions containing halide ions.

When aqueous bromine is added to aqueous potassium iodide a reaction occurs.

The ionic half-equations for the reaction are shown.



(i) Describe the colour change of the solution.

original colour of potassium iodide solution

final colour of reaction mixture [2]

- (ii) State the name of the general term given to the type of reaction in which electrons are transferred from one species to another.

..... [1]

- (iii) Identify the oxidising agent in this reaction. Give a reason for your answer.

oxidising agent

reason [2]

- (d) Use the key to complete the table to show the results of adding aqueous halogens to aqueous solutions of halides. One has been completed for you.

		halides		
		KCl(aq)	KBr(aq)	KI(aq)
halogens	Cl ₂ (aq)			
	Br ₂ (aq)			✓
	I ₂ (aq)			

key
✓ = reaction
X = no reaction

[2]

[Total: 16]

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The Periodic Table of Elements

Group																	
I	II	Key										III	IV	V	VI	VII	VIII
		1Hhydrogen1															
		atomic number atomic symbol name relative atomic mass															
3Li lithium 7	4Be beryllium 9											5B boron 11	6C carbon 12	7N nitrogen 14	8O oxygen 16	9F fluorine 19	2He helium 4
11Na sodium 23	12Mg magnesium 24											13Al aluminium 27	14Si silicon 28	15P phosphorus 31	16S sulfur 32	17Cl chlorine 35.5	18Ar argon 40
19K potassium 39	20Ca calcium 40	21Sc scandium 45	22Ti titanium 48	23V vanadium 51	24Cr chromium 52	25Mn manganese 55	26Fe iron 56	27Co cobalt 59	28Ni nickel 59	29Cu copper 64	30Zn zinc 65	31Ga gallium 70	32Ge germanium 73	33As arsenic 75	34Se selenium 79	35Br bromine 80	36Kr krypton 84
37Rb rubidium 85	38Sr strontium 88	39Y yttrium 89	40Zr zirconium 91	41Nb niobium 93	42Mo molybdenum 96	43Tc technetium —	44Ru ruthenium 101	45Rh rhodium 103	46Pd palladium 106	47Ag silver 108	48Cd cadmium 112	49In indium 115	50Sn tin 119	51Sb antimony 122	52Te tellurium 128	53I iodine 127	54Xe xenon 131
55Cs caesium 133	56Ba barium 137	57–71 lanthanoids		72Hf hafnium 178	73Ta tantalum 181	74W tungsten 184	75Re rhenium 186	76Os osmium 190	77Ir iridium 192	78Pt platinum 195	79Au gold 197	80Hg mercury 201	81Tl thallium 204	82Pb lead 207	83Bi bismuth 209	84Po polonium —	85At astatine —
87Fr francium —	88Ra radium —	89–103 actinoids		104Rf rutherfordium —	105Db dubnium —	106Sg seaborgium —	107Bh bohrium —	108Hs hassium —	109Mt meitnerium —	110Ds darmstadtium —	111Rg roentgenium —	112Cn copernicium —	113Nh nihonium —	114Fl flerovium —	115Lv livermorium —	116Ts tennessine —	117Uue unseptennium —

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.).