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CHEMISTRY

PAPER 3

Friday **29 MAY 2020** 12:00 NOON–1:30 P.M.

Additional materials:
Graph paper

MINISTRY OF EDUCATION NATIONAL EXAMINATIONS
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BAHAMAS GENERAL CERTIFICATE OF SECONDARY EDUCATION

INSTRUCTIONS AND INFORMATION TO CANDIDATES

Do not open this booklet until you are told to do so.

Write your school number, candidate number, surname and initials at the top of this page as well as at the top of all lined paper submitted.

Answer **ALL** questions in **Section A** in the spaces provided on this question booklet and any **TWO** questions from **Section B** on the lined paper provided at the back of this question booklet.

Equations and diagrams should be given wherever they are helpful.

Essential working must be shown.

The intended marks for each question or part question are given in brackets [].

Relative atomic masses are given in the Periodic Table printed on page 2.

ADDITIONAL INFORMATION

s.t.p. ($t = 0^{\circ}\text{C}$, $p = 1 \text{ atm.}$)

The volume of one mole of gas at room temperature and pressure (r.t.p.) is $24\,000 \text{ cm}^3$.

For Examiner's Use	
Section A	
1	
2	
3	
4	
Section B	
5	
6	
7	
TOTAL	

This question paper consists of 15 printed pages, 4 lined pages and 1 blank page.

The Periodic Table of the Elements

Group																		
I	II											III	IV	V	VI	VII	0	
												1 H Hydrogen 1						4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10	
23 Na Sodium 11	24 Mg Magnesium 12											27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18	
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36	
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	99 Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54	
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86	
87 Fr Francium	88 Ra Radium	89 Ac Actinium																

a

X

b

a = relative atomic mass
X = atomic symbol
b = proton (atomic) number

* 58-71 Lanthanoid series										† 90-103 Actinoid series									
140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71	101 Md Mendelevium 101	102 No Nobelium 102	103 Lr Lawrencium 103				

* 58-71 Lanthanoid series
† 90-103 Actinoid series

a

X

b

a = relative atomic mass

X = atomic symbol

b = proton (atomic) number

Key

SECTION A

Answer **all** questions

1. (a) An experiment was conducted where solid zinc metal was added to copper(II) sulfate solution in a beaker.
- (i) Write a balanced chemical equation for the reaction. Include state symbols.
_____ [2]
- (ii) List **two** observations that show the reaction is complete.
observation 1 _____
observation 2 _____ [2]
- (iii) State how the reactivity of zinc compares with copper.
_____ [1]
- (iv) Bauxite is an ore of aluminium. Bauxite contains Al_2O_3 .
Calculate the percentage by mass of aluminium in Al_2O_3 .
_____ [2]
- (v) The method of extraction of a metal depends upon its position in the reactivity series.
Name the method by which aluminium is extracted from bauxite.
_____ [1]
- (vi) Name a metal, other than aluminium, that is extracted by a similar method from its ore.
_____ [1]
- (vii) Buildings can be made using aluminium because it is malleable.
State one **other** property of aluminium that makes it suitable for buildings.
_____ [1]

TOTAL MARKS [10]

[Turn over]



2. This question is about metals found in the Periodic Table.

(a) Complete the table

element	formula of oxide	type of oxide	ions present
sodium			
magnesium		basic	Mg^{2+} and O^{2-}
zinc	ZnO		

[3]

(b) Zinc is an important transition element.

(i) Give **two** properties of transition elements that are different from Group I elements.

[2]

(ii) A solution of zinc ions produces a precipitate with aqueous sodium hydroxide.
State the colour of the precipitate.

[1]



- (iii) Chromium has four isotopes. Its composition is given in the table.

Isotope with mass	51.94	52.94	49.95	53.94
Relative abundance %	83.79%	9.50%	4.35%	2.36%

Calculate the average atomic mass of chromium (round your answer to 3 decimal places).

[2]

- (iv) Describe the bonding in zinc.

[2]

TOTAL MARKS [10]

[Turn over



3. (a) A 0.0115 g sample of sodium is added to water in a large beaker. The temperature of water increased.

The table shows the results.

m, mass of water/g	50
initial temperature/°C	25
final temperature/°C	48
ΔT temperature change/°C	

- (i) Complete the table by calculating the temperature change. [1]

- (ii) The heat given out during the reaction is calculated using this equation.

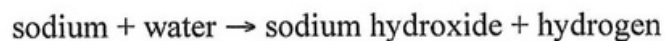
$$\text{heat given out} = m \times 4.2 \times \Delta T$$

_____ J [1]

- (iii) Determine the heat given out when 1 mole of sodium reacts with water.

_____ J/mol [1]

The equation for the reaction is:

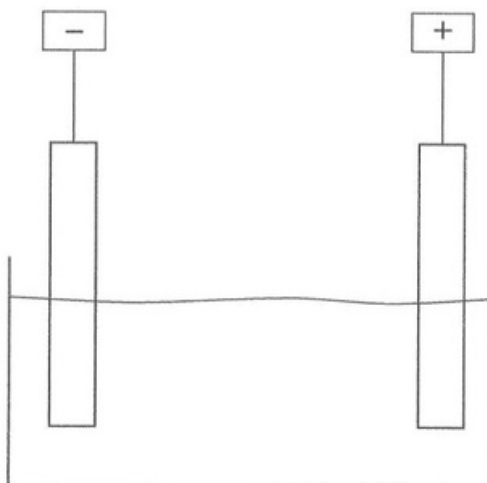


- (iv) Draw an energy level diagram for the reaction.

Label the reactants and products.



- (b) The diagram shows equipment used in the electrolysis of brine, sodium chloride.



- (i) The electrodes used are inert.

Why are inert electrodes used?

_____ [1]

- (ii) Write the half-equation for the reaction at the:

negative electrode _____

positive electrode. _____

[2]

- (iii) State why sodium is not deposited during the electrolysis of sodium chloride.

_____ [1]

- (iv) During electrolysis, the sodium chloride solution turns into another solution.

Name this solution.

_____ [1]

TOTAL MARKS [10]

4. (a) Hydrogen chloride is a gas at room temperature.

- (i) Draw a dot and cross diagram for one molecule of hydrogen chloride, showing the outer shell electrons only.

[2]

- (ii) Hydrogen chloride is soluble in water.

The solution produced turns Universal Indicator from green to red.

Explain why the Universal Indicator changes colour in a solution of hydrogen chloride in water.

[1]

(b) A student dissolved solid potassium hydroxide in water.

The solution was made up to 1000 cm^3 . 35 cm^3 of the solution neutralised 42 cm^3 of 1.21 mol dm^{-3} hydrochloric acid.

- (i) Write a balanced chemical equation for the neutralisation reaction.

[1]

- (ii) Calculate the number of moles of HCl in 42 cm^3 of the hydrochloric acid.

[1]

- (iii) Determine the number of moles of KOH in 35 cm^3 of the potassium hydroxide solution.

[1]



- (iv) Calculate the concentration of potassium hydroxide solution in mol dm^{-3} .

_____ mol dm^{-3} [1]

- (v) Calculate the mass of potassium hydroxide solid that was dissolved in 1000 cm^3 solution.

_____ g [2]

- (vi) Suggest a piece of apparatus the student could use to accurately measure the 42 cm^3 of hydrochloric acid.

_____ [1]

TOTAL MARKS [10]

SECTION B

You should answer **two** questions from **Section B**

5. A student added 0.035 moles of magnesium ribbon to 25 cm³ of dilute sulfuric acid. The magnesium metal added was in **excess**. The volume of hydrogen gas produced during this experiment was recorded every minute. (gas produced at room temperature and pressure)

The results of the experiment are given in the table.

Time/minutes	0	1	2	3	4	5	6	7	8
Volume of hydrogen gas/cm ³	0	12	22	30	36	41	45	48	48

- (a) (i) Plot the results on graph paper and draw a smooth curve. [4]
- (ii) Use your graph to determine the volume of hydrogen gas produced in 90 seconds. [1]
- (b) The equation for the reaction is shown.



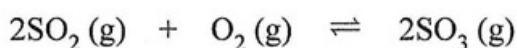
- (i) State why the magnesium metal was added in excess. [1]
- (ii) Use the equation to calculate the accurate mass of magnesium required to produce the final volume of hydrogen gas in the reaction at room temperature and pressure. [2]
- (iii) Calculate the mass of magnesium remaining in the solution at the end of the reaction. [2]
- (iv) Sulfuric acid, H₂SO₄, is a dibasic acid.

How many moles of hydrogen ions, H⁺ (aq), are present in 25cm³ of H₂SO₄. [1]



- (c) (i) On your graph in (a)(i), sketch the graph of results obtained if the experiment is repeated at a higher temperature [1]
- (ii) Explain, in terms of collision theory, the effect of increasing temperature on the rate of reaction. [3]
- (iii) State the effect adding a catalyst will have on the volume of hydrogen produced. [1]
- (d) Sulfuric acid, H_2SO_4 , is manufactured by the Contact process.

One of the reactions in the Contact process is shown.

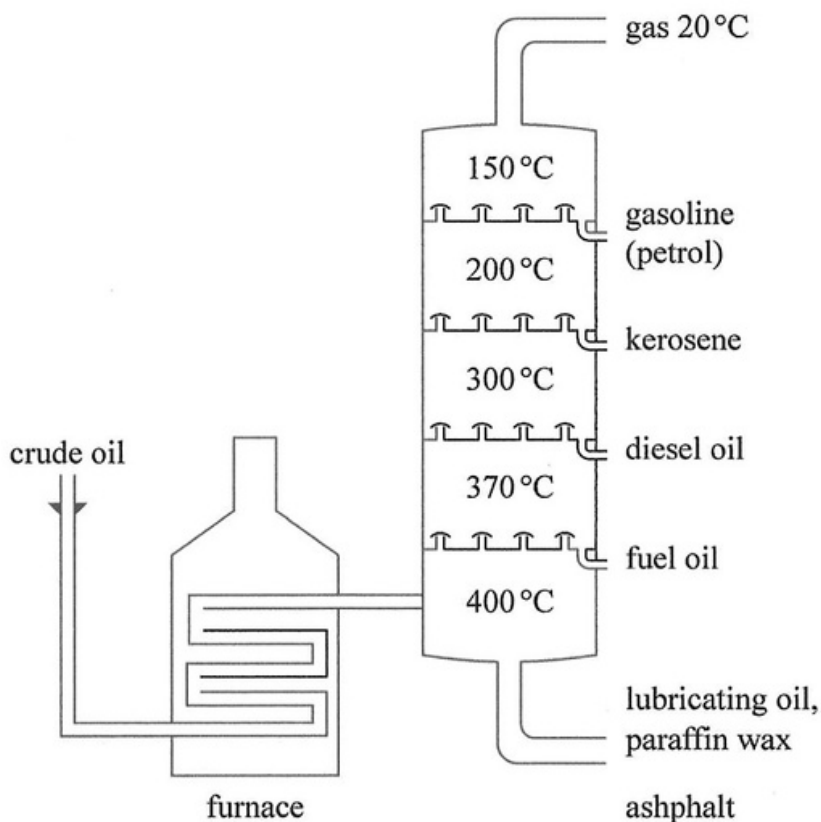


State and explain in terms of Le Chatelier's Principle, the effect on the equilibrium concentration of sulfur trioxide, SO_3 , if:

- (i) pressure is increased [1]
- (ii) sulfur trioxide, SO_3 is removed. [1]
- (e) Increasing the temperature causes the position of equilibrium to shift to the left.
- Explain why the position of equilibrium shifts left. [1]
- (f) Give **one** industrial use of sulfuric acid, H_2SO_4 . [1]

TOTAL MARKS [20]

6. Petroleum is a mixture of hydrocarbons. Study the diagram below and use your knowledge of organic chemistry to answer the following questions.



- (a) (i) State the method of separation that is shown in the diagram. [1]
- (ii) Show on the diagram where the following groups of hydrocarbons are found:
- Group A hydrocarbons with 1 to 4 carbon atoms
 - Group B hydrocarbons with 15 to 25 carbon atoms. [2]
- (iii) Draw the structural formula for a saturated hydrocarbon that contains 4 carbon atoms. [1]
- Show all of the atoms and all of the bonds.
- (iv) Draw and name an isomer of your answer in (a) (iii). [2]
- (v) Decane, $C_{10}H_{22}$, is one of the hydrocarbons produced in a (i). [1]
- Name the method by which decane can be broken down into shorter chain hydrocarbons that are more useful.

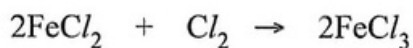


- (vi) Draw the structural formula of a saturated and unsaturated hydrocarbon formed when decane is broken down in the process in (v). [2]
- (vii) State a test and results that can be used to distinguish between a saturated and unsaturated hydrocarbon. [2]
- (viii) Write a word equation to show the reaction of propene and chlorine gas. [1]
- (ix) Name the type of chemical reaction occurring in (viii). [1]
- (b) (i) An organic compound was found to be composed of: 40% carbon, 7% hydrogen and the remaining substance was oxygen.
Calculate the empirical formula for this compound. [3]
- (ii) The relative molecular mass of the compound is 60.
Give the molecular formula of the compound. [1]
- (c) (i) Ethanol is an alcohol.
Write a chemical equation for the formation of ethanol from glucose. [2]
- (ii) Ethanol can form ethanoic acid.
What type of reaction is this? [1]

TOTAL MARKS [20]



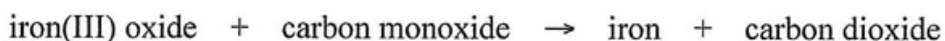
7. (a) The equation shows the formation of FeCl_3 .



State which substance is oxidised and which substance is reduced. Give a reason in terms of electrons, for each answer. [2]

- (b) Iron is extracted from its ore haematite. The ore is mixed with limestone and coke to extract the metal in a Blast furnace.

The equation for the process is shown.



- (i) Name the reducing agent in the reaction. [1]
- (ii) Write a balanced chemical equation for the reaction. [2]
- (iii) Calculate the mass of iron produced in kg, from 5 kg of iron(III) oxide. [3]
- (c) Two unknown solutions, X and Y, are tested. The tests and results are shown.

Solution X:

When added to potassium iodide solution, iodine is produced.

Red cloth is bleached.

Solution Y:

When added to excess copper(II) sulfate, a deep blue solution is formed.

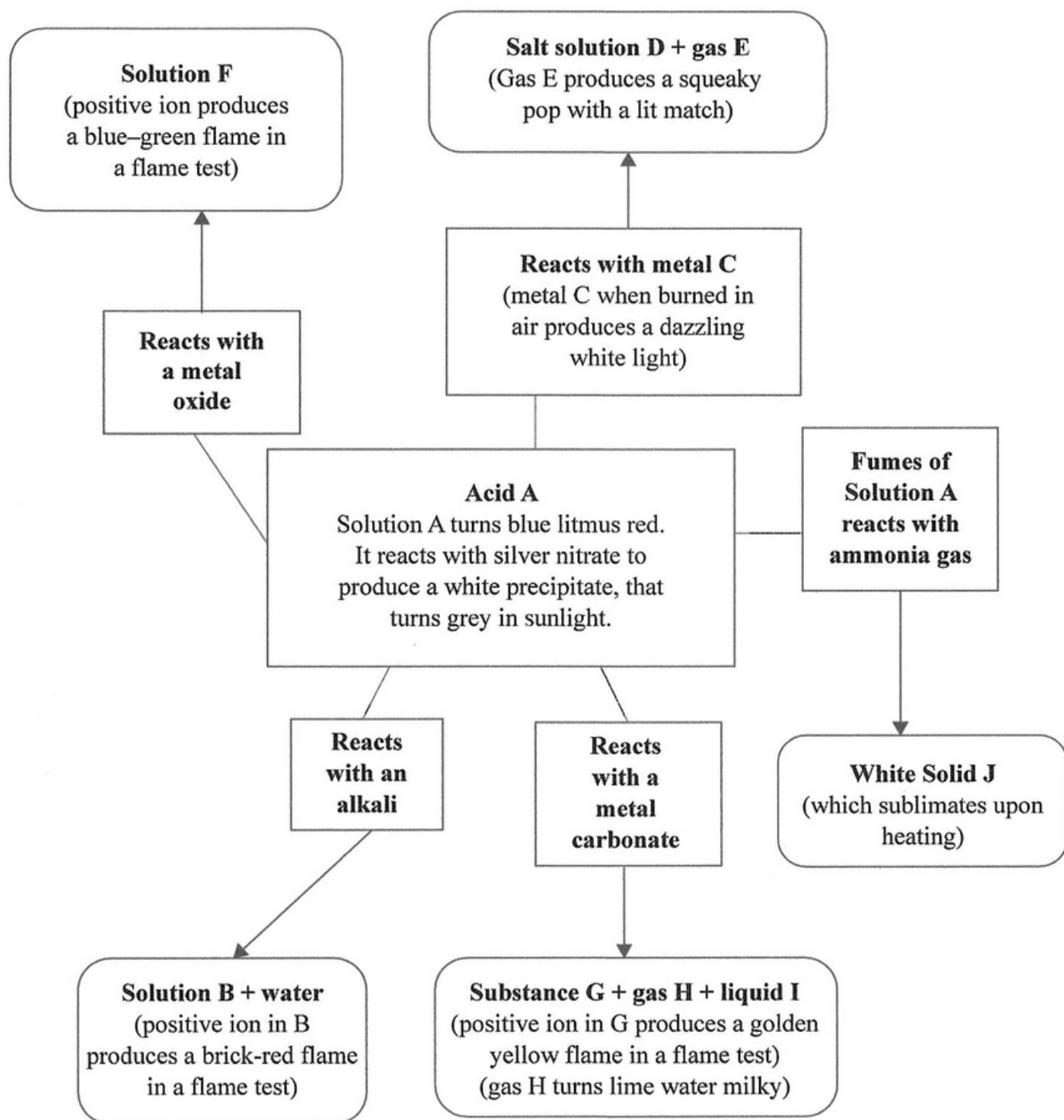
When warmed with sodium hydroxide, produces an alkaline gas that turns moist red litmus paper to blue.

Identify solutions X and Y. [2]



- (d) The flow diagram shows information on 10 substances, A to J. Solution A turns blue litmus red. It reacts with silver nitrate and dilute nitric acid to produce a white precipitate, that turns grey in sunlight.

Identify substances A–J



[10]

TOTAL MARKS [20]

[Turn over

Question
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