

Name: _____

School: _____



Rugby School

Sixth Form Entrance Examination

**Mark Scheme
November 2020**

Chemistry

Time allowed: 1 hour

This paper is divided into two sections, both of which must be attempted.
You **must** write your name on the front of this booklet.

Section A: multiple choice (30 marks)

Section B: short answer questions (30 marks)

A Data Sheet and a Periodic Table are provided (inside front cover and first page)

Equipment Required: Pen, pencil, ruler and calculator

For examiner's use only:

Section A	/30
Section B	/30
Total	/ 60

Group	3	4	5	6	7	0
1						
2						

7

4	He	Helium	2
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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	63.5	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		
86	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	106	Rh Rhodium 45	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	179	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	Pb Lead 82	207	Bi Bismuth 83	210	Po Polonium 84	210	At Astatine 85	222	Rn Radon 86				
223	Fr Francium 87	226	Ra Radium 88	227	Ac Actinium 89											271	Th Thorium 90	285	Pa Protactinium 91	289	U Uranium 92	293	Np Neptunium 93	297	Pu Plutonium 94	301	Am Americium 95	305	Cm Curium 96	309	Bk Berkelium 97	313	Cf Californium 98	317	Es Einsteinium 99	321	Fm Fermium 100

Key

Relative atomic mass	Symbol	Name	Atomic number
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Chemistry Data Sheet

1. Reactivity Series of Metals

Potassium	most reactive
Sodium	
Calcium	
Magnesium	
Aluminium	
<i>Carbon</i>	
Zinc	
Iron	
Tin	
Lead	
<i>Hydrogen</i>	
Copper	
Silver	
Gold	
Platinum	least reactive

(elements in italics, though non-metals, have been included for comparison)

2. Formulae of Some Common Ions

Positive ions		Negative ions	
Name	Formula	Name	Formula
Hydrogen	H ⁺	Chloride	Cl ⁻
Sodium	Na ⁺	Bromide	Br ⁻
Silver	Ag ⁺	Fluoride	F ⁻
Potassium	K ⁺	Iodide	I ⁻
Lithium	Li ⁺	Hydroxide	OH ⁻
Ammonium	NH ₄ ⁺	Nitrate	NO ₃ ⁻
Barium	Ba ²⁺	Oxide	O ²⁻
Calcium	Ca ²⁺	Sulfide	S ²⁻
Copper(II)	Cu ²⁺	Sulfate	SO ₄ ²⁻
Magnesium	Mg ²⁺	Carbonate	CO ₃ ²⁻
Zinc	Zn ²⁺		
Lead	Pb ²⁺		
Iron(II)	Fe ²⁺		
Iron(III)	Fe ³⁺		
Aluminium	Al ³⁺		

Marking Grid for Section A

Question	Answer
1	B
2	A
3	D
4	C
5	A
6	D
7	D
8	D
9	A
10	C
11	D
12	D
13	C
14	A
15	C

16	C
17	A
18	D
19	C
20	B
21	D
22	A
23	D
24	B
25	D
26	D
27	C
28	B
29	B
30	C
Total for Section A	/30

Section A

You should complete this section using the answer grid provided.

- 1 Below are some statements regarding the smokeless fuels *Burnbrite* and *Hiheat*. Which of these statements **cannot** be checked scientifically?
- A *Burnbrite* produces less ash than *Hiheat*
B *Hiheat* is a better solid fuel than *Burnbrite*
C 1 kg of *Burnbrite* produces more heat when it is burned than 1 kg of *Hiheat*
D *Burnbrite* produces more sulfur dioxide than *Hiheat*
- 2 When a geologist tested a sample of copper ore with dilute hydrochloric acid, a gas was given off. This suggests the ore could contain...
- A CuCO_3**
B CuCl_2
C CuSO_4
D Cu(OH)_2
- 3 A metal atom X has the electron arrangement 2,8,3 and a non-metal atom Y has the electron arrangement 2,8,6. What is the correct formula for the compound formed between elements X and Y?
- A X_2Y
B XY
C XY_2
D X_2Y_3
- 4 Hydrochloric acid reacts with iron (II) sulfide to produce hydrogen sulfide gas. Under which of the following sets of conditions would the reaction start at the **slowest** rate?

	Concentration of acid (mol/dm ³)	Temperature (°C)	State of iron (II) sulfide
A	1.0	15	Powdered
B	0.1	30	Powdered
C	0.1	15	Lumps
D	2.0	30	Lumps

5 What group number of the periodic table are the Alkaline Earth Metals in?

- ☒ A 2
- ☐ B 0
- ☐ C 1
- ☐ D 7

6 Which of the following is the correct formula for niobium (V) oxide

- A Nb_5O
- B NbO_5
- C Nb_5O_2
- ☒ D Nb_2O_5

7 Many chemical reactions produce energy because...

- A the reactants must be heated for the reaction to begin
- B bonds have broken during the reaction
- C the products have weaker bonds than the reactants
- ☒ D the energy content of the products is less than that of the reactants

8 Magnesium is more reactive than zinc. This means that...

- A zinc will displace magnesium from a solution of magnesium sulfate
- B zinc will corrode in preference to magnesium
- C magnesium displaces chlorine from potassium chloride (aq), but zinc will not
- ☒ D magnesium forms ions more readily than zinc

9 Which one of the following contains the greatest percentage by mass of potassium?

(relative atomic masses: H = 1, C = 12, O = 16, K = 39)

- ☒ A KOH
- B KHCO_3
- C K_2CO_3
- D $\text{K}_2\text{C}_2\text{O}_4$

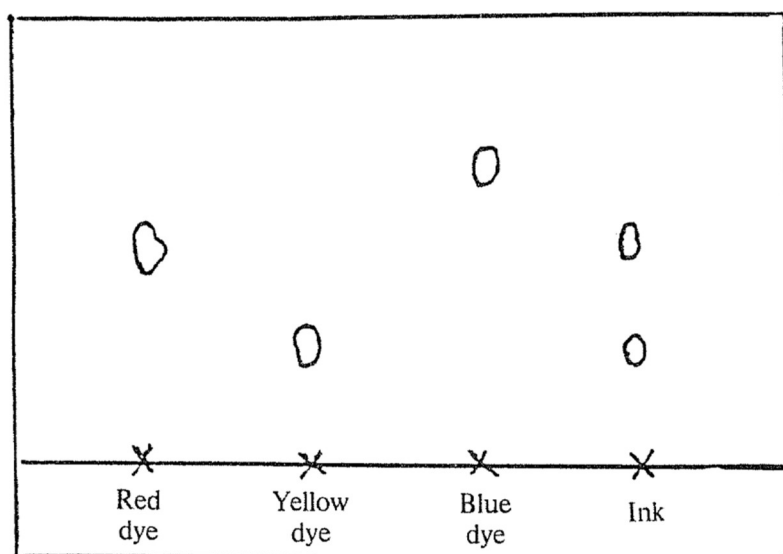
- 10 This question refers to the two particles **X** and **Y**. The table shows some data for X and Y.

	Particle X	Particle Y
Number of protons	26	26
Number of neutrons	30	31
Number of electrons	24	23

Particles **X** and **Y** are...

- A atoms of the same element
 - B atoms of different elements
 - C ions of the same element**
 - D ions of different elements
- 11 Sodium chloride is...
- A an element
 - B a molecule
 - C a compound of two non-metals
 - D a compound of a metal and a non-metal**
- 12 Which of the following gases is not considered to be a cause of air pollution?
- A sulfur dioxide
 - B nitrogen dioxide
 - C carbon monoxide
 - D carbon dioxide**

- 13 The diagram of a chromatogram shows the dyes present in an ink. Spots of red, yellow and blue dyes were used as well as the ink.



The ink contained...

- A blue and yellow dyes.
 - B red dye only.
 - C red and yellow dyes.**
 - D yellow, red and blue dyes.
- 14 Indigestion is caused by the presence of an excess of acid in the stomach. Which of the following substances could an indigestion tablet contain to neutralise this acid?
- A magnesium hydroxide**
 - B sugar
 - C sodium chloride
 - D lemon juice
- 15 Which of the following is a single compound?
- A air
 - B seawater
 - C limestone**
 - D chocolate

- 16 The table below shows the melting points of the elements in Group 1. The melting point of rubidium is missing.

Element	Li	Na	K	Rb	Cs
Melting Point (°C)	180	98	64		29

The most likely melting point of rubidium is...

- A 31 °C
B 55 °C
C 39 °C
D 115 °C
- 17 Newly laid bricks sometimes become coated with an alkaline white deposit. The best way to remove this deposit is to wash it with a mixture of detergent and a chemical that will react with the white deposit.

Which one of the following could be used with the detergent in the mixture?

- A vinegar**
B limewater
C sodium hydroxide solution
D ethanol
- 18 Methanoic acid (a weak acid) is present in many kettle/steam iron descalers. What pH would you expect a solution of methanoic acid to have?

- A 1
B 13
C 7
D 5
- 19 Pollution of the environment is reduced by...
- A burning coal in power stations
B adding fertilisers to the soil
C replacing metal items with plastic items
D using a catalytic converter on a car exhaust

20 Which change of state occurs when dry ice (solid carbon dioxide) is heated and converted into a gas for stage effects?

- A condensation
- ☒ B **sublimation**
- C evaporation
- D solidification

21 Which of the following compounds contains the largest number of atoms?

- | | | |
|------------------------------------|---|---|
| A | aluminium oxide | Al_2O_3 |
| B | ammonium sulfate | $(\text{NH}_4)_2\text{SO}_4$ |
| C | calcium nitrate | $\text{Ca}(\text{NO}_3)_2$ |
| ☒ D | hydrated copper(II) sulfate crystals | $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ |

22 The metal most commonly used for a drink can is...

- ☒ A **aluminium**
- B iron
- C tin
- D copper

23 Carbon dioxide is a gas which...

- A is insoluble in water
- B makes up 0.93% of earth's atmosphere
- C burns in air
- ☒ D **is more dense than air**

- 24 2.0 g of magnesium metal were reacted with an excess of dilute sulphuric acid. The volume of gas given off was measured at one minute intervals. The results of this experiment are shown in the table below:

Time (min)	0	1	2	3	4	5	6	7	8	9	10
Volume (cm ³)	0	16	25	35	40	44	47	49	50	50	50

The time needed for 1.0 g of magnesium to react was

- A 1 minutes
B 2 minutes
C 4 minutes
D 8 minutes
- 25 A sample of sodium chloride has become contaminated with dust. What sequence of operations is the best way to obtain pure sodium chloride?
- A solution, crystallisation, filtration
B decantation, solution, precipitation
C solution, filtration, crystallisation
D solution, filtration, evaporation

Questions 26 – 30, choose from the list A to D

- A Water (H₂O)
B Hydrogen chloride (HCl)
C Sodium chloride (NaCl)
D Diamond (C)
- 26 The substance that has a giant covalent structure
D Diamond (C)
- 27 The substance that consists of ions in a giant structure
C Sodium chloride (NaCl)
- 28 The substance which boils at -85 °C
B Hydrogen chloride (HCl)
- 29 The substance that forms dense white fumes with ammonia gas
B Hydrogen chloride (HCl)
- 30 The substance that contains no covalent bonds
C Sodium chloride (NaCl)

Total marks (30)

[END OF SECTION A]

Section B

1 Complete the following table for the atoms shown

Element	Symbol	Atomic Number	Mass Number	Protons	Neutrons	Electrons
Sodium	Na	11	23	11	12	11
Aluminium	Al	13	27	13	14	13
Fluorine	F	9	19	9	10	9
Potassium	K	19	39	19	20	19

(2)

2 Copy and complete the following table for the ions shown

Ion	Symbol	Atomic Number	Mass Number	Protons	Neutrons	Electrons
Lithium	Li ⁺	3	7	3	4	2
Oxide	O ²⁻	8	16	8	8	10
Magnesium	Mg ²⁺	12	24	12	12	10
Phosphide	P ⁻³	15	31	15	16	18

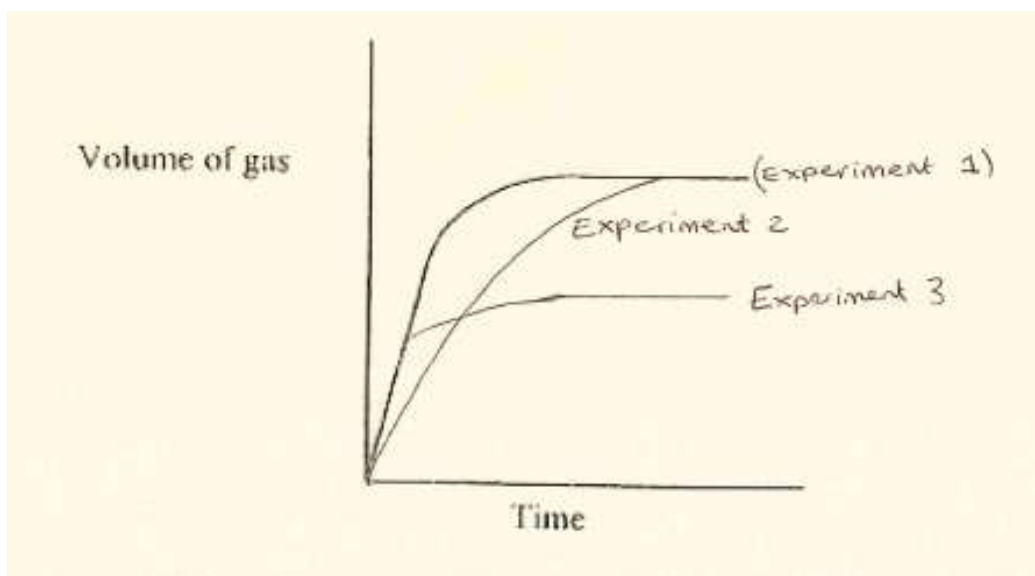
(2)

- 3 A company which produces sweets was introducing a new product called “Moon Dust”. This sweet was in the form of a powder, which fizzed in water. The fizziness was investigated before it was put on the market.

Three different experiments were carried out.

Experiment	Mass of powder added to 1 litre of water	Temperature (°C)
1	40	25
2	40	37
3	20	25

For each experiment, a graph was plotted of the volume of gas produced against time. The graph for experiment 1 is shown below.



On the graph above, sketch the plots for experiments 2 and 3 on to it. Label each curve clearly.

1 mark for each correct line drawn (for Experiment 2 and 3)

(2)

- 4 In 1926 the plastic *Polysynth* was invented and immediately used in household furniture. The material was found to generate poisonous fumes when burnt. The fire services kept the following statistics.

Year	<i>Polysynth</i> used in household furniture (tons)	Household fire deaths
1910	0	10
1920	0	10
1930	1000	12
1940	4000	18
1950	7000	24
1960	10000	30
1970	10000	30
1980	0	10

- a) Use the graph paper below to plot a bar chart of household deaths against year.

The grid below is 32 squares wide and 30 squares high. Spare graph paper is provided on the back page.

Correct x axis and title = 1 mark

Correct y axis and title = 1 mark

Correct plotted bar chart points = 1 mark

- b) Describe the relationship between the quantity of plastic used and the number of household fire deaths from fumes?

As the quantity of plastic used **increases**, the number of household fire death increases.

Mention of **positive correlation**/ state one variable increases the other

(1)

- c) What evidence is there in the statistics that not all fire deaths were due to *Polysynth*?

In **1910**, **1920** and **1980**, there were **still deaths** despite no plastic being used.

(1)

- 5** The corrosion of iron was investigated by giving six identical iron nails different treatments. A seventh nail was left untreated. All seven nails were then left exposed to the atmosphere for several days.

The results of the experiment are given below.

Nail	Treatment	Cost of treatment	Initial mass of nail (g)	Final mass of nail (g)
A	waxed	low	5.0	5.3
B	oiled	low	5.0	4.1
C	chromium plated	high	5.0	5.0
D	painted	low	5.0	5.4
E	galvanised	high	5.0	5.1
F	salted	low	5.0	6.7
G	untreated	nil	5.0	6.1

- a) What happens to the mass of a nail when it corrodes?
Increases (1)
- b) Which nail was weighed incorrectly after exposure to the atmosphere?
B (1)
- c) Which nail was best protected against corrosion?
C (1)
- d) Which nail received a treatment which made corrosion much worse?
F (1)

- 6 a) Complete the following table. Use the words *solid*, *liquid* or *gas*.

Element	Melting point (°C)	Boiling point (°C)	Physical State at 25 °C
Iron	1535	2750	Solid
Fluorine	-220	-188	Gas
Mercury	-39	357	Liquid
Iodine	114	184	Solid
Nitrogen	-210	-196	Gas
Sodium	98	883	Solid
Bromine	-7	59	Liquid
Xenon	-112	-107	Gas

8 correct = 2 marks

7 correct = 1 mark

6 correct = 0 marks

(2)

- b) What is the name given to the elements in group 1?
Alkali metals

(1)

- c) What is the name given to the elements in group 7?
Halogens

(1)

- d) Explain why elements in the same group exhibit similar chemical properties.
Same number of outer electrons

(1)

7 Complete the following table. Use the words *metallic*, *ionic* or *covalent*.

Substance	Melting point (°C)	Boiling point (°C)	Type of bonding
Nitrogen	-210	-196	Covalent
Sodium	98	883	Metallic
Sulfur dioxide	-73	-10	Covalent
Water	0	100	Covalent
Ethane	-183	-88	Covalent
Magnesium chloride	712	1418	Ionic

(3)

All 6 correct = 3 marks

5 correct = 2 marks

3 correct = 1 mark

2 correct = 0 marks

8 Using the table below to answer the following questions.

Ionic Compound	Colour
Potassium chromate	Yellow
Sodium chloride	White
Nickel (II) sulfate	Green
Sodium chromate	Yellow
Copper (II) chloride	Blue
Potassium chloride	White
Potassium permanganate	Purple
Nickel (II) chloride	Green

a) Deduce the colour of the nickel (II) ion?

Green

(1)

b) Deduce the colour of the permanganate ion?

Purple

(1)

c) Deduce the colour of the copper (II) ion?

Blue

(1)

d) Deduce the colour of the chromate ion?

Yellow

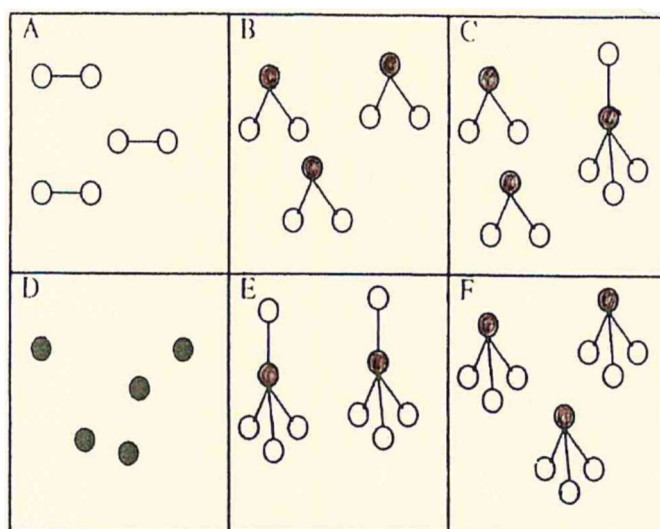
(1)

e) What colour would you expect copper (II) chromate to be?

Green (accept green in answer) or blue/yellow

(1)

9 Use the diagrams below to answer parts 'a)' and 'b)'.



a) Identify the two elements

A and D

b) Identify the mixture

C

(2)

Total marks (30)

[END OF SECTION B]

[END OF PAPER]

Spare graph paper for question 4 a)

