Name: _____ School: _____

Rugby School

Sixth Form Entrance Examination

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

THE PERIODIC TABLE

Period	1	2											3	4	5	6	7	0
	Group																	
1	1 H Hydrogen 1																	4 He Helium 2
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
3	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
4	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
5	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	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
6	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 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	210 Po Polonium 84	210 At Astatine 85	222 Rn Radon 86
7	223 Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89															

Key

Relative atomic mass
Symbol
Name
Atomic number

Chemistry Data Sheet

1. Reactivity Series of Metals

Potassium	most reactive
Sodium	
Calcium	
Magnesium	
Aluminium	
Carbon	
Zinc	
Iron	
Tin	
Lead	
Hydrogen	
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+}		

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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 (^oC)	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 $K_2C_2O_4$

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

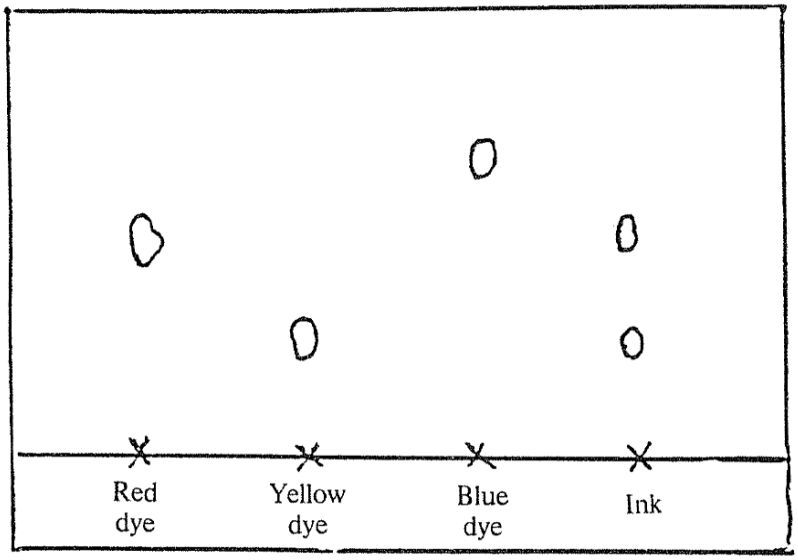
11 Sodium chloride is…

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 (^{o}C)	180	98	64		29

The most likely melting point of rubidium is…

A 31 ^{o}C
B 55 ^{o}C
C 39 ^{o}C
D 115 ^{o}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	$(NH_4)_2SO_4$
C	calcium nitrate	$Ca(NO_3)_2$
D	hydrated copper(II) sulfate crystals	$CuSO_4.5H_2O$

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 (H_2O)
B Hydrogen chloride (HCl)
C Sodium chloride (NaCl)
D Diamond (C)

26 The substance that has a giant covalent structure

27 The substance that consists of ions in a giant structure

28 The substance which boils at -85 ^0C

29 The substance that forms dense white fumes with ammonia gas

30 The substance that contains no covalent bonds

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			23			
		13	27			
				9	10	
	K		39			

(2)

2 Copy and complete the following table for the ions shown

Ion	Symbol	Atomic Number	Mass Number	Protons	Neutrons	Electrons
				3	4	2
	O^{2-}		16			
Magnesium		12				
		15	31			18

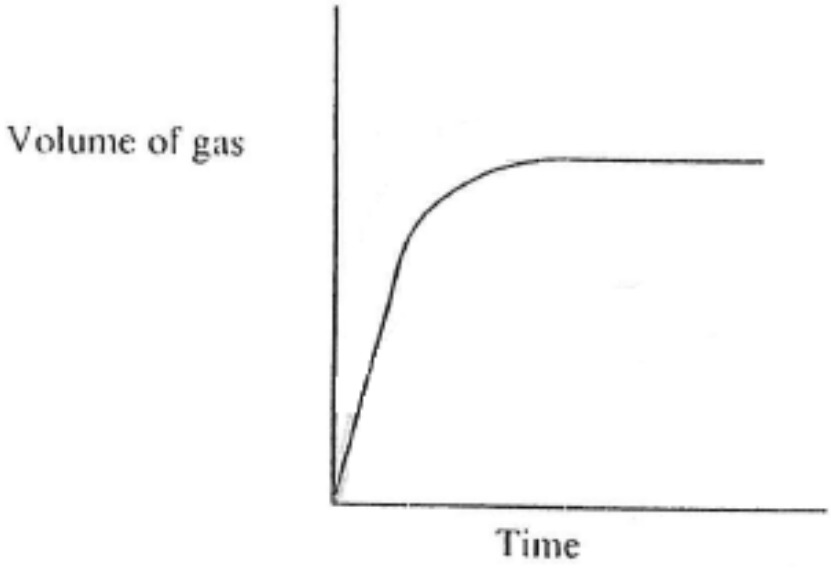
(2)

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.

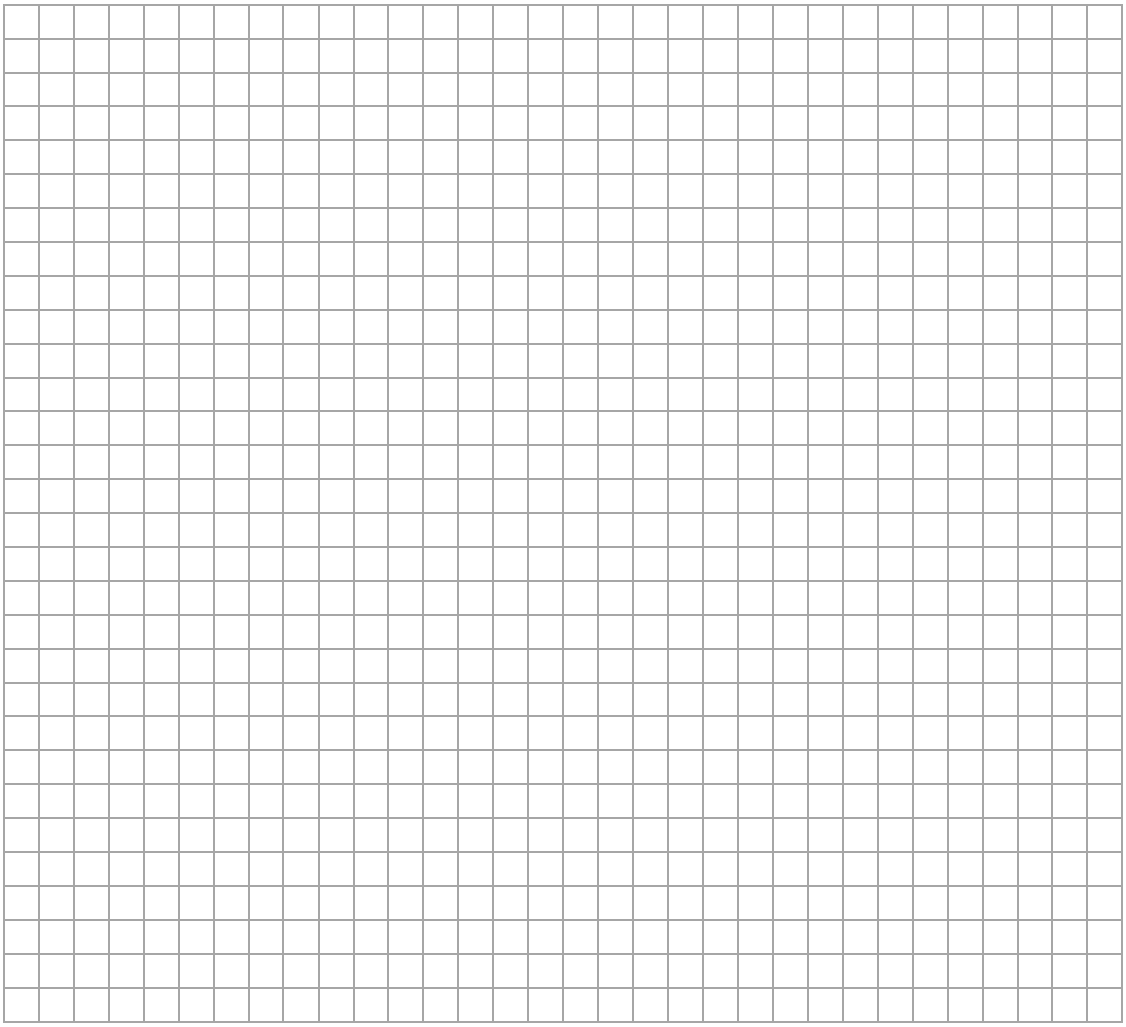
(2)

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	***Polysynth* 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.



(3)

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

(1)

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

(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?

(1)

b) Which nail was weighed incorrectly after exposure to the atmosphere?

(1)

c) Which nail was best protected against corrosion?

(1)

d) Which nail received a treatment which made corrosion much worse?

(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 ^{0}C
Iron	1535	2750	
Fluorine	-220	-188	
Mercury	-39	357	
Iodine	114	184	
Nitrogen	-210	-196	
Sodium	98	883	
Bromine	-7	59	
Xenon	-112	-107	

(2)

c) What is the name given to the elements in group 1?

(1)

d) What is the name given to the elements in group 7?

(1)

e) Explain why elements in the same group exhibit similar chemical properties.

(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	
Sodium	98	883	
Sulfur dioxide	-73	-10	
Water	0	100	
Ethane	-183	-88	
Magnesium chloride	712	1418	

(3)

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?

(1)

b) Deduce the colour of the permanganate ion?

(1)

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

(1)

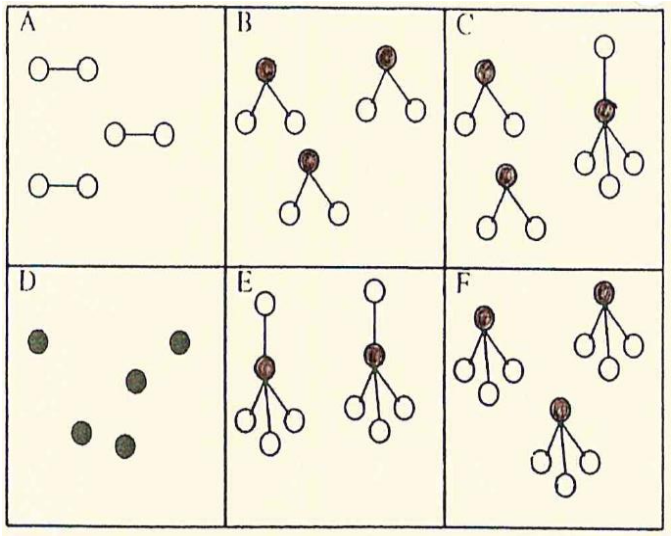
d) Deduce the colour of the chromate ion?

(1)

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

(1)

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



a) Identify the two elements

b) Identify the mixture

(2)

Total marks (30)

[END OF SECTION B]

[END OF PAPER]

Spare graph paper for question **4 a)**