Rewarding Learning

Centre Number

Candidate Number

General Certificate of Secondary Education
2019

GCSE Chemistry

Unit 2

Foundation Tier

GCM21

[GCM21]

WEDNESDAY 12 JUNE, MORNING

TIME

1 hour 15 minutes.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Do not write outside the boxed area on each page or on blank pages.
Complete in black ink only. **Do not write with a gel pen.**
Answer **all six** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 80.
Figures in brackets printed down the right-hand side of pages indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Question **3(d)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

1 Iron is extracted from its ore in the Blast Furnace. The extraction involves redox reactions.

(a) (i) Name the ore from which iron is extracted in the Blast Furnace.

_____ [1]

(ii) Apart from iron ore, name one other substance added to the Blast Furnace.

_____ [1]

(b) (i) Name the reducing agent in the Blast Furnace and write balanced symbol equations to show the formation of this compound.

Name _____

Equations

_____

_____ [6]

(ii) Balance the symbol equation below for the production of iron in the Blast Furnace.

$$Fe_2O_3 + CO \rightarrow Fe + CO_2$$

[1]

(iii) Explain, in terms of oxygen content, why the reaction in **(b)(ii)** is a redox reaction.

[5]

[Turn over

2 Ammonia is manufactured in the Haber Process. An iron catalyst is used in this process to increase the rate of the reaction.

The balanced symbol equation for the reversible reaction in the Haber Process is:

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(a) (i) Explain how a catalyst increases the rate of a chemical reaction.

_____

_____

_____ [2]

(ii) State two conditions which can be altered to change the direction of a reversible reaction.

1. _____

2. _____ [2]

(b) A dynamic equilibrium is achieved in the reaction between nitrogen and hydrogen in the Haber Process.

Complete the following table by placing a tick (✔) in the correct column.

Statement	True	False
Dynamic equilibrium occurs in a closed system.		
Dynamic equilibrium occurs when the rates of the forward and reverse reactions are equal.		
Dynamic equilibrium occurs when the rate of the forward reaction is greater than the rate of the reverse reaction.		
At equilibrium the amount of reactants is always equal to the amount of products.		
At equilibrium the amounts of reactants and products remain constant.		

[5]

[Turn over

(c) In the Haber Process the forward reaction is exothermic.

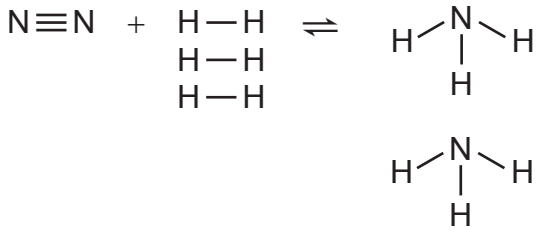
$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

(i) Explain, in terms of bonds, why this reaction is exothermic.

[3]

(ii) The covalent bonds which are present in the reactants and products are shown below the equation. Use these bonds and the bond energies given in the table to calculate the energy change for the forward reaction.

$$N_2 + 3H_2 \rightleftharpoons 2NH_3$$



Bond	Bond Energy/kJ
N≡N	916
H—H	436
N—H	386

Energy change = _____ kJ [4]

(iii) Using your answer to **(c)(ii)** suggest a value for the energy change of the reverse reaction.

_____ [1]

[Turn over

3 Alkenes are hydrocarbons which may be produced by cracking.

(a) **(i)** State the meaning of the term hydrocarbon.

_____

_____ [1]

(ii) Write the general formula of the alkenes.

_____ [1]

(b) Write a balanced symbol equation for the complete combustion of C_4H_8 forming carbon dioxide and water.

_____ [3]

(c) Propene may be produced from the cracking of the hydrocarbon C_7H_{16}. One other product is formed in this reaction.

(i) Write a balanced symbol equation for the cracking of C_7H_{16}.

_____ [2]

(ii) Name the other product formed in this reaction.

_____ [1]

(iii) Suggest why high temperatures are required for cracking reactions.

_____

_____ [1]

(d) Identify the functional group present in alkenes and describe a chemical test for this functional group.

Write a balanced symbol equation for the chemical reaction which occurs when ethene is tested in this way.

In this question you will be assessed on your written communication skills including the use of specialist terms.

[6]

[Turn over

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4 Calcium nitrate and calcium chloride are compounds often used in commercial treatments for garden plants.

(a) Calcium nitrate may be formed from the reaction of nitric acid with calcium hydroxide solution. An experiment was carried out during which nitric acid was slowly added from a burette to 25.0 cm^3 of calcium hydroxide solution in a conical flask.

(i) An indicator was added to the conical flask to show when the reaction was complete. Name a suitable indicator which could have been used in this experiment.

_____ [1]

(ii) Name a piece of apparatus which was used to accurately measure 25.0 cm^3 of calcium hydroxide solution.

_____ [1]

(iii) The balanced symbol equation for the reaction is:

$$Ca(OH)_2 + 2HNO_3 \rightarrow Ca(NO_3)_2 + 2H_2O$$

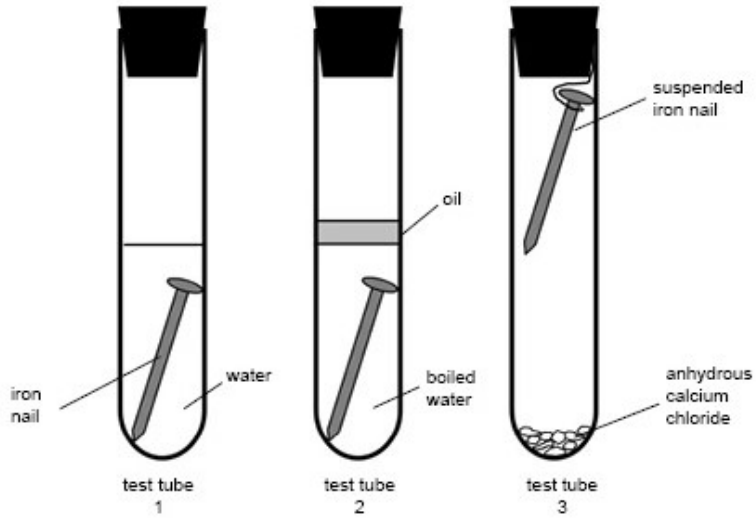
Calculate the atom economy when calcium nitrate is made using this reaction.

Show your working out.

Atom economy = _____ % [3]

[Turn over

(b) Anhydrous calcium chloride is used in an experiment to investigate rusting as shown below. An iron nail is placed in three different test tubes (1, 2, and 3) under different conditions. The test tubes were left for one week.



(i) In which test tube(s) would rusting have occurred after one week?

_____ [1]

(ii) What is the purpose of the oil in test tube 2?

_____

_____ [1]

(iii) What is the purpose of the anhydrous calcium chloride in test tube 3?

_____

_____ [1]

(iv) Describe the appearance of rust.

_____ [2]

(v) What is the chemical name for rust?

_____ [1]

(vi) State one method of preventing the formation of rust.

_____ [1]

[Turn over

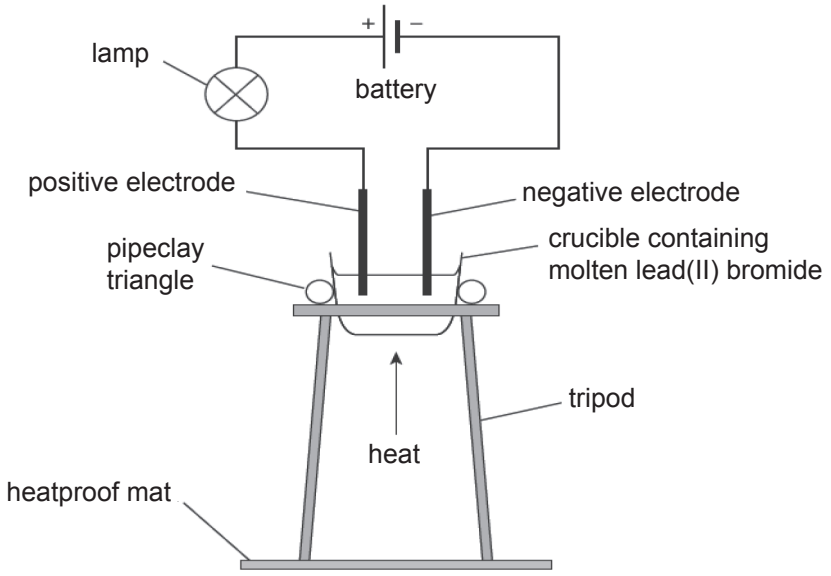
5 Molten lead(II) bromide undergoes electrolysis.

(a) What is meant by the term electrolysis?

_____

_____ [1]

(b) The apparatus below is used to carry out the electrolysis of molten lead(II) bromide.



(i) Name the material used to make the electrodes in this electrolysis.

_____ [1]

(ii) State two reasons why this material is used to make the electrodes.

1. _____

_____

2. _____

_____ [2]

(iii) Suggest why this electrolysis experiment needs to be carried out in a fume cupboard.

_____

_____ [1]

(iv) What name is given to the positive electrode?

_____ [1]

(c) Complete the table to give details of the electrolysis of molten lead(II) bromide.

	Negative electrode	**Positive electrode**
Observations at the electrode	silvery grey liquid formed	
Name of electrolysis product		

[4]

[Turn over

6 Oxygen and nitrogen are the most abundant gases found in the atmosphere.

(a) (i) State the colour of oxygen gas.

_____ [1]

(ii) State one use for oxygen gas.

_____ [1]

(b) Oxygen gas reacts with both metals and non-metals to form oxides. Complete the following table giving information about the reaction of oxygen gas with the elements magnesium and sulfur.

	Magnesium	**Sulfur**
Observations during reaction with oxygen	white flame	
Appearance of product after reaction with oxygen		colourless gas
Nature of oxide formed (acidic or basic)		

[5]

(c) (i) State the percentage composition of nitrogen gas in the atmosphere.

_____ [1]

(ii) Explain why nitrogen gas is unreactive.

_____

_____ [2]

(iii) Apart from nitrogen and oxygen, name two other gases which are present in the atmosphere.

1. _____

2. _____ [2]

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For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
Total Marks	

Examiner Number

SYMBOLS OF SELECTED IONS

Positive ions

Name	Symbol
Ammonium	NH_4^+
Chromium(III)	Cr^{3+}
Copper(II)	Cu^{2+}
Iron(II)	Fe^{2+}
Iron(III)	Fe^{3+}
Lead(II)	Pb^{2+}
Silver	Ag^+
Zinc	Zn^{2+}

Negative ions

Name	Symbol
Butanoate	$C_3H_7COO^-$
Carbonate	CO_3^{2-}
Dichromate	$Cr_2O_7^{2-}$
Ethanoate	CH_3COO^-
Hydrogencarbonate	HCO_3^-
Hydroxide	OH^-
Methanoate	$HCOO^-$
Nitrate	NO_3^-
Propanoate	$C_2H_5COO^-$
Sulfate	SO_4^{2-}
Sulfite	SO_3^{2-}

SOLUBILITY IN COLD WATER OF COMMON SALTS, HYDROXIDES AND OXIDES

Soluble
All sodium, potassium and ammonium salts
All nitrates
Most chlorides, bromides and iodides EXCEPT silver and lead chlorides, bromides and iodides
Most sulfates EXCEPT lead and barium sulfates Calcium sulfate is slightly soluble

Insoluble
Most carbonates EXCEPT sodium, potassium and ammonium carbonates
Most hydroxides EXCEPT sodium, potassium and ammonium hydroxides
Most oxides EXCEPT sodium, potassium and calcium oxides which react with water

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New Specification

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Data Leaflet

Including the Periodic Table of the Elements

For the use of candidates taking
Science: Chemistry,
Science: Double Award
or Science: Single Award

Copies must be free from notes or additions of any kind. No other type of data booklet or information sheet is authorised for use in the examinations

gcse examinations

chemistry

For first teaching from September 2017

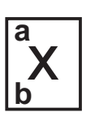
THE PERIODIC TABLE OF ELEMENTS

Group

1	2											3	4	5	6	7	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** Sulfur 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	98 **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
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac†** Actinium 89	261 **Rf** Rutherfordium 104	262 **Db** Dubnium 105	266 **Sg** Seaborgium 106	264 **Bh** Bohrium 107	277 **Hs** Hassium 108	268 **Mt** Meitnerium 109	271 **Ds** Darmstadtium 110	272 **Rg** Roentgenium 111	285 **Cn** Copernicium 112						

* 58 – 71 Lanthanum series
† 90 – 103 Actinium series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	145 **Pm** Promethium 61	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
232 **Th** Thorium 90	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	242 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	245 **Bk** Berkelium 97	251 **Cf** Californium 98	254 **Es** Einsteinium 99	253 **Fm** Fermium 100	256 **Md** Mendelevium 101	254 **No** Nobelium 102	257 **Lr** Lawrencium 103



a = relative atomic mass (approx)
x = atomic symbol
b = atomic number