3E Pure Chem SR P1 MS 2023

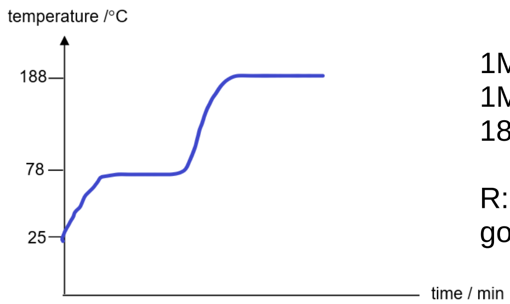
Q1	B
Q2	D
Q3	B
Q4	A
Q5	B
Q6	B
Q7	A
Q8	D
Q9	D
Q10	C
Q11	C
Q12	A
Q13	A
Q14	A
Q15	A
Q16	A
Q17	C
Q18	C
Q19	D
Q20	A

3E SR Chemistry Paper 2 2023
Mark scheme

<table>
<tr><td>1</td><td></td><td></td></tr>
<tr><td>(a)</td><td>The mistake is in methane.

The lower the relative molecular mass of the gas, the faster the rate of diffusion.
In the data, methane has a lower molecular mass than CO/ nitrogen. It should diffuse faster in less than 32 s, but the data showed that it diffused in 35 s.

R: quicker time</td><td>[1]

[1]</td></tr>
<tr><td>(b)</td><td>Ammonia is soluble in water.</td><td>[1]</td></tr>
<tr><td>(c)</td><td>The molecules are closely packed in a disorderly/irregular manner;
and will slide across one another.</td><td>[1]
[1]</td></tr>
<tr><td></td><td></td><td>Total: 5</td></tr>
<tr><td>2</td><td></td><td></td></tr>
<tr><td>(a)</td><td>(i) Ethanol</td><td>[1]</td></tr>
<tr><td></td><td>(ii)
• To ensure that the condenser is fully filled with water
• for more efficient cooling of the vapour into liquid
• for the vapour to fully condense into liquid before leaving the condenser.</td><td>[1]</td></tr>
<tr><td></td><td>(iii) To measure the temperature of the vapour entering the condenser / boiling point of T (so that its identity can be determined)</td><td>[1]</td></tr>
<tr><td></td><td>(iv)


1M - shape of graph
1M – labelling of temperature at 78 and 188 °C

R: if unit is indicated on y-axis or graph goes beyond 188 °C</td><td>[2]</td></tr>
<tr><td></td><td>(v) No. Water and oil are immisible.</td><td>[1]</td></tr>
<tr><td></td><td>(b) They have a simple molecular structure (A: simple molecules); with weak intermolecular forces of attraction.
Hence, little/ small amount of energy is required to overcome these forces of attraction.

R: ‘break’/ if wrong type of bonds are used</td><td>[1]

[1]</td></tr>
<tr><td></td><td></td><td>Total: 8</td></tr>
<tr><td>3</td><td></td><td></td></tr>
<tr><td>(a)</td><td><table>
<tr><th>element</th><th>atomic number</th><th>number of protons</th><th>number of neutrons</th><th>mass number</th><th>electronic configuration</th></tr>
<tr><td>W</td><td>16</td><td>16</td><td>16</td><td>32</td><td>2, 8, 6</td></tr>
<tr><td>X</td><td>7</td><td>7</td><td>7</td><td>14</td><td>2, 5</td></tr>
<tr><td>Y</td><td>2</td><td>2</td><td>2</td><td>4</td><td>2</td></tr>
<tr><td>Z</td><td>11</td><td>11</td><td>12</td><td>23</td><td>2,8,1</td></tr>
</table></td><td>[2]

3 right = 2M
2 right = 1M
1 right = 0M</td></tr>
</table>

(b)	Element Z. The atom of Z has only <u>one valence electron.</u> Accept: It <u>loses one valence electron</u> to form a <u>complete valence electron shell</u>. Accept: It <u>loses electron</u> to form a <u>cation</u>.	[1] [1]
(c)	W has an electronic configuration of <u>2</u>,8,6 gains <u>2 electrons</u> to form an ion of W^{2-} with a stable electronic configuration of <u>2, 8, 8</u>.	[1]
		Total:5
4		
(a)	(i) $Zn\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + H_2\ (g)$ 1M for balanced chemical eqn THEN 1M for state symbols	[2]
	(ii) $Zn + 2H^+ \rightarrow Zn^{2+} + H_2$	[1]
(b)	Hydrogen gas is <u>less dense than air</u> , therefore <u>it will not sink/ escape</u> into the gas jar.	[1]
(c)	Dry agent / dry the gas A: absorb moisture	[1]
(d)	Observation: Less <u>effervescence</u>/<u>bubbles</u> observed Explanation: Ethanoic acid is a <u>weak acid</u> which <u>ionise partially</u>; Has lower H+ concentration/ <u>lesser H+ ions</u>(present per unit time/volume) compared to hydrochloric acid. No explanation marks if observation is wrong.	[1] [1] [1]
		Total:9
5		
(a)	Substance M is a good electrical conductor. Each carbon atom is covalently <u>bonded</u> to <u>three other carbon</u> atoms, thus having <u>one valence electron</u> <u>not involve</u>d in bonding Presence of these <u>delocalised /free-moving electrons</u> allows graphite to conduct electricity. R: If ‘ions’ are used.	 [1] [1]
(b)	(i) Drill bits/cutting tools	[1]
	(ii) Substance N is very strong. Substance N has a <u>giant molecular structure</u> made up of carbon <u>atoms covalently bonded</u> in <u>(i) a rigid/tetrahedral</u> in a (ii) <u>continuous/extensive/network</u> structure. OR Substance N has a <u>giant molecular structure</u> with <u>each carbon atom is covalently bonded to four other atoms</u>, which, in turn <u>are bonded to four more carbon atoms</u>. [1]; **NB: It is not enough to write that N has a giant molecular structure because graphite also has a giant molecular structure.** These <u>covalent bonds are strong.</u> and it will <u>require a high amount of energy to break these bonds</u>. [1] making structure N very strong.	 [1] [1]
(c)	Simple molecular structure	[1]
		Total:6

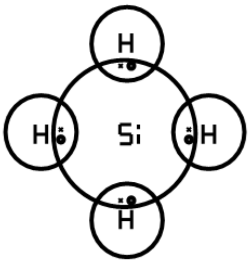
6		
(a)	sulfuric acid; and copper(II) oxide / copper(II) carbonate R – chemical formulae / copper / missing oxidation state NB: lack of oxidation state will only be penalized once in whole paper	[1]
(b)	(i) CuO / $CuCO_3$ no longer dissolves (and remains a solid in solution) OR No more effervescence is observed (only if student proposed copper(II) carbonate as the solid reactant R: copper compound no longer reacts A: use of indicators/litmus papers with indication of expected results	[1]
	(ii) measurement of mass of CuO / $CuCO_3$/ copper compound	[1]
	(iii) to increase the rate / speed of reaction/ allows more copper compound to dissolve	[1]
	(iv) <u>filter the</u> mixture and collect the <u>filtrate/solution</u> (A: if written in the next steps) <u>heat</u> the filtrate until it is <u>saturated</u> <u>cool</u> the saturated filtrate to <u>allow crystals to form</u> filter to obtain the crystals <u>wash / rinse</u> with (cold) distilled water; and <u>dry the crystals</u> between pieces of filter paper (before weighing) Any 2 points for 1M (penalise 1 M overall if students did not start from subsequent step)	[3]
(c)	saturated filtrate could be further cooled by placing it in a beaker of ice	[1]
		Total: 8
7		
(a)	Aluminium is corrosion-resistant / does not corrode easily. Accept: Aluminium is a reactive metal that reacts readily with oxygen in air to form a protective aluminium oxide layer	[1]
(b)	bauxite contains a variable percentage of aluminium Accept: bauxite does not have a fixed proportion / percentage of aluminium	[1]
(c)	Acting as an acid / acidic THEN Reacts with <u>s</u>odium hydroxide (or an alkali)/ to form a salt and water.	[1] [1]
(d)	Any two from: • Conserve resources/aluminium/ores • Less waste (rock)/less landfill needed R: wastes 50% of the ore • no purification/separation of aluminium oxide • less carbon dioxide produced • Less/no mining or less associated environmental problems (e.g. noise/loss of land/habitat etc) R: Pollution without elaoration/explanation • Reduces <u>energy/electricity</u> used as aluminium extraction/production <u>has high heat/temperature requirements/require electrolysis</u> R: saves 14 kwH of electricity (not from Fig. 7.1)	[2]

(e)	1 kg = 1000 g of aluminium → 14 kWh of electricity saved No of mole of Al in 1000 g = (1000/27) = 37.037 Electricity saved for 1 mol. of aluminium = 14/37.037 = 0.378 kWh ECF accepted – max 1M	 [1] [1]
(f)	Introducing other metals causes the aluminium mixture to be stronger/harder. The different-sized atoms of other metals disrupts the orderly arrangement of Al atoms. This causes the layer of Al atoms to be harder to slide over one another (or more force is required for the later of Al atoms to slide over one another).	[1] [1]
		Total: 10

<table>
<tr><td>8</td><td></td><td></td></tr>
<tr><td>(a)</td><td>High melting/boiling point;
Good electrical conductor in <u>aqueous/molten states</u>
Soluble in water/ insoluble in organic solvent</td><td>[1]</td></tr>
<tr><td>(b)</td><td>(i) Rel atomic mass = 0.79 x 24 + 0.1 x 25 + 0.11 x 26 = <u>24.32</u></td><td>[1]</td></tr>
<tr><td></td><td>(ii) After 21 hours, mass of 28Mg remaining = 1 g
After 42 hours, mass of 28Mg remaining = 0.5 g
After 63 hours, mass of 28Mg remaining = 0.25 g
After 84 hours, mass of 28Mg remaining = <u>0.125</u> g</td><td>[1]</td></tr>
<tr><td></td><td>(iii) They have the same number of <u>valence</u> electrons.</td><td>[1]</td></tr>
<tr><td>(c)</td><td>
<table>
<tr><td>Element</td><td>Magnesium Mg</td><td>Oxygen O</td></tr>
<tr><td>Mass (g)</td><td>1.2 [1]</td><td>0.8</td></tr>
<tr><td>Relative atomic mass</td><td>24</td><td>16</td></tr>
<tr><td>No. of moles</td><td>0.05</td><td>0.05 [1]</td></tr>
<tr><td>Mole ratio</td><td>1</td><td>1</td></tr>
</table>

Hence, the empirical formula of magnesium oxide is MgO.

• correct calculation of mass for Mg [1]
• correct number of moles for both Mg and O [1]
• empirical formula of MgO [1]

NB: Award max of 2M if empirical formula is not explicitly written.</td><td>[3]</td></tr>
<tr><td>(d)</td><td>$Mg_2Si + 2H_2O \rightarrow SiH_4 + 2MgO$</td><td>[1]</td></tr>
<tr><td>(e)</td><td>

[1] for correct type of bonding
[1] for correct ratio of atoms of each element with correct no. of electrons</td><td>[2]</td></tr>
<tr><td></td><td></td><td>Total: 10</td></tr>
</table>

<table>
<tr><td>9</td><td></td><td></td></tr>
<tr><td>(a)</td><td>(i)

<table>
<tr><td>Element</td><td>Cr</td><td>Fe</td><td>O</td></tr>
<tr><td>Mass (g)</td><td>46.4</td><td>25.0</td><td>28.6[1]</td></tr>
<tr><td>Relative atomic mass</td><td>52</td><td>56</td><td>16</td></tr>
<tr><td>No. of moles[1]</td><td>0.8923</td><td>0.4464</td><td>1.7875</td></tr>
<tr><td>Mole ratio</td><td>2</td><td>1</td><td>4</td></tr>
</table>

correct calculation of mass for O [1]
correct number of moles of Cr, Fe and O [1]
empirical formula of Cr_2FeO_4 [1]

Hence, the empirical formula of X is Cr_2FeO_4.

NB: Award max of 2M if empirical formula is not explicitly written.</td><td>[3]</td></tr>
<tr><td></td><td>(ii)
Since the ore contains 46.4% chromium, the theoretical mass of chromium:
= 46.4/100 X 10 000 g
= <u>4 640 g</u> [1]

% purity of Cr = 3 000/4640 x 100%
= <u>64.7%</u> (3 sig. fig)

No ECF accepted</td><td>[1]

[1]</td></tr>
<tr><td>(b)</td><td>(i) yellow</td><td>[1]</td></tr>
<tr><td></td><td>(ii) barium chromate(VI)
NB: lack of oxidation state will only be penalized once in whole paper (pls check qns 6(a))</td><td>[1]</td></tr>
<tr><td></td><td>(iii) concentration of K_2CrO_4 or volume of K_2CrO_4</td><td>[1]</td></tr>
<tr><td></td><td>(iv) 1.5 <u>cm</u> [unit required]
Reason : K_2CrO_4/potassium dichromate(V) which is a limiting reactant is <u>used up</u>, no more precipitation reaction occurring.</td><td>[1]
[1]</td></tr>
<tr><td></td><td></td><td>Total: 10</td></tr>
</table>