DUNMAN SECONDARY SCHOOL

6092 CHEMISTRY

4E Preliminary Examination 2024

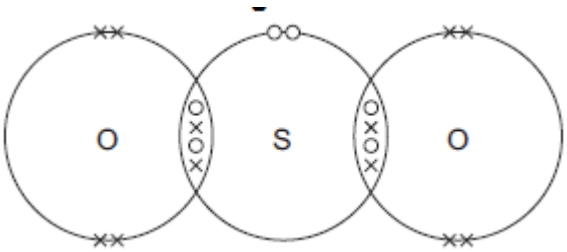
Marking Scheme

PAPER 1

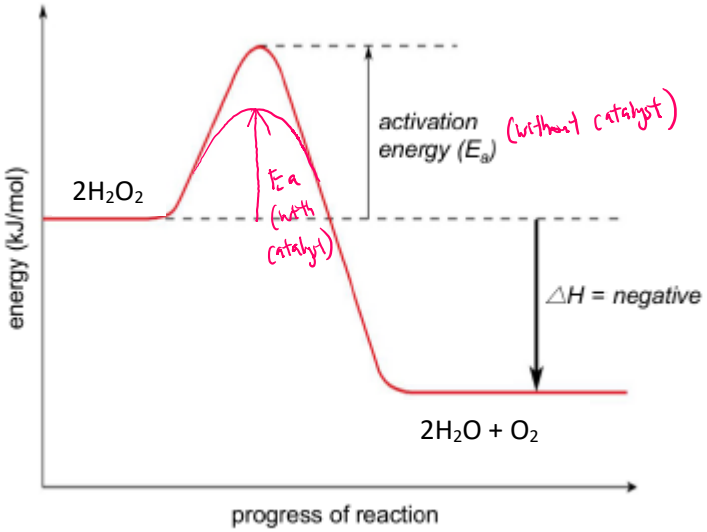
1	2	3	4	5	6	7	8	9	10
A	B	A	A	C	C	C	D	C	A
11	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
B	C	C	C	C	D	A	C	C	D
21	**22**	**23**	**24**	**25**	**26**	**27**	**28**	**29**	**30**
D	C	D	C	B	D	B	A	B	D
31	**32**	**33**	**34**	**35**	**36**	**37**	**38**	**39**	**40**
A	A	D	D	D	B	A	B	C	B

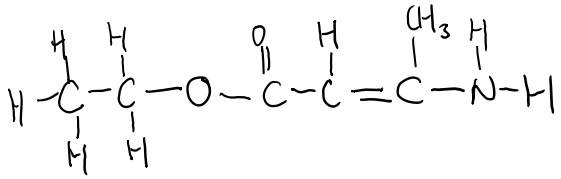
PAPER 2

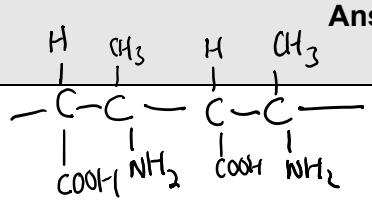
Section A

Qn	Answer	Mark (max)
1(a)	A, B, E	1
1(b)	C	1
1(c)	D	1
1(d)	E	1
1(e)	D and B	1
2(a)	Acidic oxide : SiO_2 / P_2O_5 / SO_2 Basic oxide : Na_2O / MgO Amphoteric oxide : Al_2O_3 [1] any 1-2 correct; [2] all correct	1
2(b)	 Correct sharing of electrons [1] Correct outermost electrons for each atom [1]	2

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark (max)</th></tr>
<tr><td>2(c)</td><td>• Silicon dioxide has a giant covalent structure.
• The extensive network of silicon and oxygen atoms
• are held by many strong covalent bonds,
• which require a lot of energy to overcome it, hence high melting point.
• Sulfur dioxide has a simple covalent structure.
• The molecules are held by weak intermolecular forces of attraction which require a little amount of energy to overcome it, hence low melting point.
6 points [3], 4-5 points [2], 2-3 points [1]</td><td>3</td></tr>
<tr><td>2(d)</td><td>movement : from slide past each other and exchanging position within liquid to move randomly at high speeds in all direction.
arrangement : from closely packed and disorderly arranged to far apart and disorderly arranged.</td><td>2</td></tr>
<tr><td>2(e)</td><td>• Dichlorine molecule exists as neutral molecules. They do not have mobile ions or electrons to carry charge.
• Hypochlorous acids have mobile ions which are free to move around to carry charged.</td><td>2</td></tr>
<tr><td>3</td><td>
<table>
<tr><th>formula of salt</th><th>Formulae of reagents used</th><th>method used</th></tr>
<tr><td>$MgCl_2$ (aq)</td><td>Mg / $MgCO_3$ / MgO
HCl (aq)</td><td>addition of excess solid to acid
filtration
evaporation and crystallisation</td></tr>
<tr><td>$(NH_4)_2SO_4$</td><td>NH_3 (aq)
H_2SO_4 (aq)</td><td>Titration between alkali and acid
Evaporation and crystallisation</td></tr>
<tr><td>$BaCO_3$ (s)</td><td>$Ba(NO_3)_2$ (aq)
Na_2CO_3 (aq) / K_2CO_3 (aq) / $(NH_4)_2CO_3$ (aq)</td><td>Mixing of the two salt solutions to form precipitate
Filtration to collect residue</td></tr>
</table>
</td><td>5</td></tr>
<tr><td></td><td></td><td></td></tr>
<tr><td></td><td></td><td></td></tr>
</table>

Qn	Answer	Mark (max)
4(a)	The <u>total energy absorbed to break</u> 1 mol of O-O bond and 2 mol of O-H bond in H_2O_2 is <u>less than</u> the <u>total energy released to form</u> 4 mol of O-H in H_2O and 1 mol of O=O in O_2. Since there is net release of energy to the surrounding, it is an exothermic reaction. [1] total energy absorbed to break bond is less than total energy released to form bond [1] correct number and type of bonds	2
4(b)(i)	catalyst	1
4(b)(ii)	 [1] for 2 correct [2] for 3-4 correct [3] for all correct - reactants and products - activation energy with catalyst - activation energy without catalyst - enthalpy change - shape of graph	3
5(a)	Insert a filter paper soaked in <u>acidified</u> potassium manganate(VII) [1] If **<u>purple</u> $KMnO_4$ <u>turns colourless</u>, SO_2 is still present**. OR If **<u>purple</u> $KMnO_4$ <u>remains purple</u>, SO_2 is not present** [1]	2
5(b)(i)	No. of moles of iodine = 12/ 1000 x 0.0250 = 0.000300 mol [1]	2

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark (max)</th></tr>
<tr><td></td><td>I_2 : SO_2
1 : 1
0.0003 : 0.0003
Volume of SO_2 produced = 0.000300 x 24 = 0.00720 dm^3 [1]</td><td></td></tr>
<tr><td>5(b)(ii)</td><td>SO_2 is oxidised as the oxidation state of sulfur increases from +4 in SO_2 to +6 in SO_4^{2-}. [1]
I_2 is reduced as the oxidation state of iodine decreases from 0 in I_2 to -1 in I^-. [1]</td><td>2</td></tr>
<tr><td>6(a)</td><td><table><tr><td>pollutant gas</td><td>how it is formed</td></tr><tr><td>carbon monoxide</td><td>Incomplete combustion of carbon-containing fuel</td></tr><tr><td>nitrogen monoxide</td><td>Nitrogen reacts with oxygen at high temperature in car engines</td></tr></table></td><td>2</td></tr>
<tr><td>6(b)</td><td>In lean burn engine, the amount of carbon monoxide formed is lower as more air mixed with petrol means more oxygen provided for complete combustion of fuel to occur.
In lean burn engine, the amount of nitrogen monoxide formed is lower as lower temperature lower the rate of reaction between nitrogen and oxygen molecules in the car engine.
[1] for describing the effect
[1] for each reason</td><td>3</td></tr>
<tr><td>6(c)</td><td>Carbon dioxide produced is a green house gas. [1] It causes global warming which melts polar ice caps, causing sea levels to rise and permanently flooding coastal areas. [1]</td><td>2</td></tr>
<tr><td>7(a)</td><td>Reddish brown aqueous bromine turns colourless. [1]
Bromination / addition of bromine [1]</td><td>2</td></tr>
<tr><td>7(b)(i)</td><td>Carboxyl group [1]</td><td>1</td></tr>
<tr><td>7(b)(ii)</td><td>  </td><td>1</td></tr>
<tr><td>7(c)(i)</td><td></td><td>1</td></tr>
</table>

Qn	Answer	Mark (max)
		
7(c)(ii)	Compound T has lower melting/boiling point than the polymer / Compound T has lower density than the polymer	1
7(d)	• Condensation polymerisation is formed from <u>monomers with two reactive functional groups</u> in each molecule i.e. diamines and dicarboxylic acids but addition polymerisation is formed from <u>unsaturated monomers</u> with carbon-carbon double bonds. • Condensation polymerisation involves <u>removal of a small molecule</u> such as H_2O but addition polymerisation <u>does not involve removal of a small molecule.</u> • Condensation polymerisation occurs at <u>high temperature and pressure in the presence of a catalyst</u> while addition polymerisation can <u>take place at room conditions</u>. (any 1 point)	2
7(e)	Physical method - Poly(ethene) are melted, cooled, pulled into long, thin strands, and cut into pellets. Chemical method - Poly(ethene) waste can undergo cracking to form short chains of alkanes and alkenes, that can be used as fuel and chemical feedstock	2
8(a)	In experiment 1, effervescence observed. Hydroxide ions are preferentially discharged as it is lower in the electrochemical series. $4OH^-(aq) \rightarrow O_2(g) + 2H_2O(l) + 4e$ In experiment 2, silver rod decreases in size. Silver is the reactive anode, it will oxidise and dissolve to form silver ions. $Ag(s) \rightarrow Ag^+(aq) + e$ [1] for ionic equation [1] observation [1] reason	3
8(b)(i)	In experiment 1, the <u>silver ions in solution are depleted by discharge</u> and there is no replenishment. In experiment 2, the <u>silver ions in solution are replenished from the dissolving of the silver rod anode</u>. [1]	1

Qn	Answer	Mark (max)
8(b)(ii)	Collect a small sample of electrolyte from each experiment and add 2 drops of sodium chloride into the samples separately. [1] White precipitate (insoluble silver chloride) would be observed from experiment 2 but not from experiment 1. [1]	2
8(c)	$Mg(s) \rightarrow Mg^{2+}(aq) + 2e$ [1] Magnesium is more reactive than iron, hence lose electrons more readily and corrode in place of iron. [1]	2
9(a)(i)	Isotopes have the same number of protons but different number of neutrons. In Fig. 9.1, there are <u>two ions</u> detected which have different m/z values of <u>6 and 7</u>. This indicates that these two ions have different number of neutrons.	2
9(a)(ii)	Average atomic mass of lithium = (3.75/100 x 6) + (96.25/100 x 7) = 6.9625 ≈6.96 (3 s.f.)	1
9(b)(i)	x = 72, y = 74	2
9(b)(ii)	Chlorine exists as diatomic molecules. There are 3 possible combinations: 2 atoms of chlorine-35, 1 atom of chlorine-35 and 1 atom of chlorine-37, 2 atoms of chlorine-37.	1
9(c)(i)	Agree with the student. [0] The largest m/z is 44, which belongs to the ion formed by the largest molecule. Since propane has a Mr of 44, the unknown hydrocarbon is propane.	1
9(c)(ii)	CH_2^+	1
9(c)(iii)	The highest m/z value would be 58. There would be more peaks.	2
9(d)	It is much harder / takes more energy to remove an electron from a positively charged ion.	1

Section B

Qn	Answer	Mark (max)
10(a)	$ZnSO_4$	1
10(b)	• **Comparing 1&2, when the concentration of acid is increases from 0.5 mol / dm^3 to 1.0 mol / dm^3,** • there **are more hydrogen ions per unit volume.**	

<table>
<tr><th>Qn</th><th>Answer</th><th>Mark (max)</th></tr>
<tr><td></td><td>

Frequency of collisions and effective collisions between the hydrogen ions and zinc increases, speed of reaction increases.
Hence, the time taken to collect 15 cm^3 of gas decreases.

Comparing 1&3, when the temperature is increased from 20˚C to 40˚C,
the particles gain kinetic energy / move faster.
There will be more particles having energy equal to or greater than the activation energy.
Frequency of collisions and effective collisions between the hydrogen ions and zinc increases, speed of reaction increases.
Hence, the time taken to collect 15 cm^3 of gas decreases.

</td><td></td></tr>
<tr><td>10(c)</td><td>
<table>
<tr><th>experiment</th><th>concentration in mol/dm^3</th><th>time taken to collect 15 cm^3 of gas / s</th><th>total volume of gas / cm^3</th></tr>
<tr><td>4</td><td>1.0</td><td>30
(More than 21)</td><td>150</td></tr>
</table>
Comparing experiment 4 to experiment 1, all conditions are the same except that a monobasic weak acid is used instead. Therefore, the volume of gas would be halved of experiment 2 and it can only be collected at a slower rate.
(OR In the reactions, zinc is in excess hence acids are limiting thus time taken and volume of gas are dependent on acids. Ethanoic acid is monobasic while sulfuric acid is dibasic acid hence will produce half total volume of gas as 1 mol of sulfuric acid. Since ethanoic acid is a weak acid with low concentration of hydrogen ions, unlike sulfuric acid which is strong, the rate of reaction for ethanoic acid will be much slower hence lower time of 30s is predicted.)

Summary:

Half volume of gas
Speed slower/ more time
Weak acid and Strong acid
Partial dissociation, low concentration of hydrogen ions, Complete dissociation high concentration of hydrogen ions
Speed slower/ more time
Monobasic , dibasic

</td><td>1

1</td></tr>
<tr><td>10(d)</td><td>Calcium is more reactive than zinc, so it will react faster with sulfuric acid. [1]</td><td>2</td></tr>
</table>

Qn	Answer	Mark (max)
	However, the reaction quickly stops because an **insoluble laye**r of calcium sulfate forms around the metal**, preventing further** reaction. [1]	
11(a)	Most reactive to least reactive: Magnesium, cobalt, nickel, copper	1
11(b)	Cobalt. It forms coloured compound which is pink cobalt(II) sulfate which is property of transition metal.	1 1
11(c)	silvery solid forms in green solution.	1
11(d)(i)	Yes. [0] A more reactive metal forms a more thermally stable compound, hence require higher temperature to reduce it.	1
11(d)(ii)	Observation : white zinc oxide remains white / yellow when hot. Black copper(II) oxide turns reddish-brown / pink. [1] Reasons : Hydrogen is less reactive than zinc hence unable to reduce zinc from its oxide. [1] Hydrogen is more reactive than copper hence can reduce copper from its oxide forming copper and steam. [1]	3
11(d)(iii)	Magnesium : electrolysis Zinc : reduction by carbon	1 1
11(d)(iv)	Gold is unreactive. / gold is below hydrogen in the reactivity series.	1