

4 Exp 6092 Chemistry Prelim 2019: Answer Scheme

Paper 1

Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans
1	D	6	B	11	B	16	D
2	C	7	A	12	D	17	B
3	D	8	D	13	B	18	C
4	C	9	C	14	C	19	D
5	B	10	D	15	A	20	C

Qn	Ans	Qn	Ans	Qn	Ans	Qn	Ans
21	A	26	C	31	D	36	B
22	D	27	D	32	B	37	D
23	B	28	C	33	D	38	C
24	D	29	D	34	A	39	C
25	C	30	A	35	D	40	A

Paper 2

Section A

A1 (a) (i) CF_3Cl

(ii) NaCl

(iii) Al_2O_3

(iv) Mg

(b) Mg loses two electrons and is oxidised to form Mg^{2+} [1] while Fe^{2+} gains two electrons and is reduced to Fe. [1] Since oxidation and reduction occurs at the same time, it is a redox reaction.

A2 (a)

chemical formula	oxidation state of chlorine
HClO_4	+7
HOCl	+1
HClO_3	+5
HClO_2	+3

(2 correct answers, 1 mark. No 0.5 mark)

- (b) (i) hypochlorous acid, chlorous acid, chloric acid, perchloric acid
OR HOCl , HClO_2 , HClO_3 , HClO_4
- (ii) The stronger the acid, the higher the number of oxygen atoms in each unit of the acid.
OR The stronger the acid, the higher the oxidation state of chlorine in the acid.

(c) No. of mol of NaOH = $0.1 \times 23.2/1000 = 0.00232$ mol [0.5]

By mol ratio, NaOH : acid

1 : 1

0.00232 mol : 0.00232 mol [0.5]

Relative formula mass of acid = $0.172 / 0.00232 = 74.138$ (to 5 s.f.)
= 74.1 (to 3 s.f.) [1]

Identity of acid = propanoic acid OR $\text{C}_2\text{H}_5\text{CO}_2\text{H}$ [1]

A3 (a) The higher the pressure, the larger the percentage of ammonia present at equilibrium. [1]

[1 mark - student quotes data from the graph, stating the percentage of ammonia at different pressures but at the same temperature.]

(b) 450°C , 250 atm, iron catalyst [1]

(c) (i) 200°C

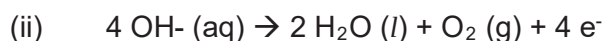
(ii) This temperature is lower than the actual temperature and thus the rate of the reaction to be slower, hence the process of manufacturing ammonia will not be cost-effective. [1]

(d) When ammonium nitrate fertilisers and slaked lime are added together, they react to release ammonia gas [1] which escapes from the soil, thus reducing the amount of nitrogen available in the soil that is needed for plant growth. [1]

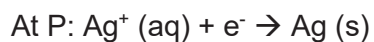
A4 (a) Graphite. [1] In graphite, each carbon atom is covalently bonded to three other carbon atoms and has one valence electron that is not used in bonding. [1] These electrons are delocalised and act as charge carriers to enable graphite to conduct electricity. [1]

(b) Silicon carbide. [1] In silicon carbide, each atom is covalently bonded to 4 other atoms to form a repeated network of tetrahedral structures. [1] It takes a large amount of energy to overcome the strong covalent bonds between the atoms, hence it is hard [1] and more suitable to be used as drill bits.

A5 (a) (i) Positive electrode [1]



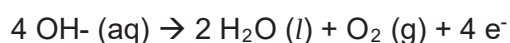
(iii) No. of mol of silver = $0.2025 / 108 = 0.001875 \text{ mol}$ [1]



By mol ratio, Ag : e^-

1 : 1

0.001875 mol : 0.001875 mol [0.5]



By mol ratio, O_2 : e^-

1 : 4

0.00046875 mol : 0.001875 mol [0.5]

Vol of oxygen gas produced = $0.00046875 \times 24 = 0.01125 \text{ dm}^3$

= 0.0113 dm^3 [1]

(b) If molten zinc chloride was used, grey metal deposits will be seen at P and a yellow-green gas will be obtained at Q. [1]

When molten zinc chloride is used, zinc ions are discharged at P to form molten zinc metal [1], chloride ions are discharged at Q to form chlorine gas. [1]

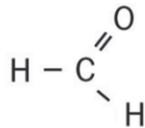
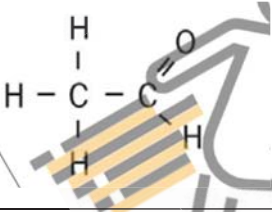
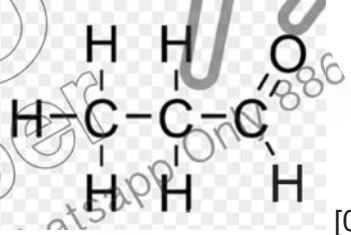
A6 (a)

trend	only true down a group	only true across a period	true for both	not true for both
The mass number increases.	✓			
The atomic radius decreases.		✓		
The melting point increases.				✓
The character of the oxides changes from basic to amphoteric to acidic.		✓		

(b) (i) Colourless potassium iodide solution turns brown. [1]

- (ii) The reaction occurs as chlorine is more reactive than iodine, hence chlorine is able to displace iodine from its solution. [1] Chlorine has a smaller atomic radii compared to iodine, and the distance between the positively charged nucleus and the valence electron shell is smaller. [1] Thus when chlorine reacts, its nucleus is able to attract the electrons more strongly [1], and thus chlorine is more reactive than iodine.

A7 (a) (i)

name	condensed formula	full structural formula
methanal	HCHO	
ethanal	CH ₃ CHO	
propanal	CH₃CH₂CHO OR C₂H₅CHO [0.5]	 [0.5]

- (ii) They have the same functional group – CHO, hence they belong to the same homologous series. [1]

OR They have the same general formula, C_{n-1}H_{2n-1}CHO, hence they belong to the same homologous series. [1]

- (b) The boiling points of the aldehydes increases down the series. [1] Going down the series, as the molecules increase in size, there will be stronger intermolecular forces of attraction between the molecules [1], thus more energy is needed to overcome these intermolecular forces [1] and hence the boiling point will increase.

A8 (a)

- (b) polyacrylamide [1]
- (c) Both of them have the same empirical formula / contain the amide functional group. [1]

Polyacrylamide has a higher melting and boiling point than acrylamide

OR polyacrylamide has a giant molecular structure while acrylamide has a simple molecular structure. [1]

(Accept any other logical difference and similarity)

- (d) 'Non-biodegradable' means that the polymer cannot be broken down by bacteria in the soil. [1]

Disposal of the polymer by burning releases toxic gases such as CO and thus contributes to air pollution.

OR Disposal of the polymer by burying results in the filling up of landfill sites and reduces the amount of land available for other uses such as agriculture and development. [1]

Section B

B9 (a) Carbon dioxide is a greenhouse gas that traps infrared radiation from the earth's surface and prevents it from escaping into space. [1] This thus causes the earth's temperature to rise, and causes heat waves. [1]

- (b) (i) Weak acids dissociate partially in water to form hydrogen ions. [1]



- (c) Limestone

- (d) (i) The higher temperature due to volcanoes around Iceland increases the speed of the reaction. [1]

- (ii) The calcite decomposes at high temperatures, hence 100% conversion may not be possible.

OR Carbonic acid is a weak acid, hence lesser amounts of soda water may have reacted and hence the yield is lower. [1]

- (e) Plants carry out photosynthesis by taking in carbon dioxide from the atmosphere and converting it into glucose, which is used by plants for energy. [1]

Carbon dioxide dissolves in the oceans, and is subsequently used by plants for photosynthesis or converted into calcium carbonate in the form of shells and skeletons of marine organisms. [1]

- (f) Catalytic converters contain rhodium and platinum catalysts [1] that convert harmful gases such as CO and NO into harmless gases such as N₂ and H₂O. [1]

It does not help to lower carbon emissions, as CO is converted into CO₂, and thus causes an increase in the amount of CO₂ present in the atmosphere. [1]

B10 (a) Let the bond energy for C-H bond be x

Energy absorbed for bond breaking = 4(+x) + 2 (+464)

Energy released for bond forming = -1080 + 3 (-436) = - 2388 kJ/mol

Enthalpy change = Energy absorbed for bond breaking + Energy released for bond forming

$$+200 = 4(+x) + 2 (+464) + (-2388) [1]$$

$$1660 = 4x$$

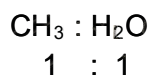
$$x = 415$$

Bond energy = 415 kJ/mol [1]

- (b) More energy is absorbed to break C-H and O-H bonds and less energy is released to form C≡O and H-H bonds. [1] Thus the reaction is endothermic. [1]
- (c) Reversible reactions are reactions where reactants are converted into products, and products are converted back into reactants at the same time. [1]
- (d) No. of mol of steam = 1600 / (16 + 1 + 1) = 88.889 mol [0.5]

$$\text{No. of mol of methane} = 1000 / (12 + 1 \times 4) = 62.5 \text{ mol [0.5]}$$

By mol ratio of the steam-methane reaction,



62.5 mol : 62.5 mol (reaction is possible as there is sufficient H₂O)

88.889 mol : 88.889 mol (reaction is not possible as there is insufficient methane)

Hence, as all methane is used up, methane is the limiting reagent. [0.5]

From the steam-methane reaction,

By mol ratio, CH₄ : H₂ : CO



$$62.5 \text{ mol} : 187.5 \text{ mol} : 62.5 \text{ mol [0.5]}$$

From the water-gas shift reaction,

By mol ratio, CO : H₂



$$62.5 \text{ mol} : 62.5 \text{ mol [0.5]}$$

Total amount of H_2 formed = $187.5 + 62.5 = 250$ mol

Mass of H_2 formed = $250 \times (1 + 1) = 500$ g [0.5]

EITHER

B11 (a) (i) Geranyl acetate is a covalent compound with a low boiling point. [1] Only a small amount of energy is needed to overcome the weak intermolecular forces between the molecules, [1] thus it evaporates readily and is suitable to be used as a top note for perfumes.

(ii)

(iii) ethanoic acid [1]

(iv)

	C	H	O
% by mass / %	73.47	10.20	16.33
Mass in 100 g / g	73.47	10.20	16.33
No. of mol / mol	$73.47 / 12$ $= 6.1225$	$10.20 / 1$ $= 10.20$	$16.33 / 16$ $= 1.0206$
Mol ratio	$6.1225 / 1.0206$ $= 5.9989$	$10.20 / 1.0206$ $= 9.9941$	$1.0206 / 1.0206$ $= 1$
	6	10	1

(Calculation of number of mol for all elements – [1])

Empirical formula = $C_6H_{10}O$ [1]

(b) Add the two compounds to 2 separate test tubes containing acidified potassium manganate(VII) and heat. [1]
If the test tube contains the middle note, purple acidified potassium manganate(VII) solution will turn from purple to colourless.

If the test tube contains the top note, purple acidified potassium manganate(VII) will remain. [1]

(c)

OR

B11 (a) Experiment A. Granules has a smaller particle size compared to lumps, thus it has more surface area exposed for collisions. [1] Hence the reaction that uses granules of lead(II) carbonate will have a higher frequency of effective collisions between reactant particles and thus have a faster rate of reaction. [1] Since the gradient of the graph for experiment A is steeper, it shows that experiment A has a faster rate of reaction, [1] and thus it used granules of lead(II) carbonate.

(b) The total volume of gas produced will be higher. Although the same mass of carbonates are used, the experiment using CaCO_3 will have a larger amount of carbonate present compared to PbCO_3 , as CaCO_3 has a smaller molar mass. [1] Thus, more CO_2 will be produced in the reaction that uses CaCO_3 [1].

(c) (i) Graph drawn should have the highest loss in mass initially, but quickly remains constant. Volume of gas produced should be small. – [1]

(ii) The rate of reaction is fast initially as sulfuric acid is a dibasic acid and hence the reaction has a twice the number of H^+ per unit volume / twice the concentration of H^+ compared to experiment A [1], thus frequency of effective collisions between reactant particles is higher. [1]
The volume of gas produced quickly remains constant as PbCO_3 reacts with sulfuric acid to form insoluble PbSO_4 [1] which forms a protective layer around the carbonate and prevents further reaction from taking place. [1]

