2009 H1 CHEMISTRY PRELIMS PAPER 1 MCQ Answer Key

1.	В	6.	В	11.	С	16.	В	21.	С	26.	D
2.	С	7.	D	12.	С	17.	Α	22.	С	27.	С
3.	Α	8.	С	13.	D	18.	В	23.	В	28.	В
4.	В	9.	С	14.	D	19.	D	24.	Α	29.	Α
5.	Α	10.	Α	15.	В	20	В	25.	С	30	С

2009 H1 CHEMISTRY PRELIMS PAPER 2 MARKS SCHEME SECTION A:

(a) (i) It is the ratio of the average mass of 1 atom of the element to 1. [1] $\frac{1}{12}$ the mass of an atom of carbon-12.

> (ii) From the data booklet, Ar of Ga = 69.7 $69.7 = 69 \times 0.64 + x \times (1 - 0.64)$ [½] 0.36x = 69.7 - 44.16x = 70.9[1/2] x = 71

Relative isotopic mass of the other Ga isotope = 71

(b) (i)
$$5 C_2 O_4^{2^-} + 2MnO_4^{-} + 16H^+ \rightarrow 10CO_2(g) + 2Mn^{2^+} + 14H_2O$$
 [1]
(ii) No. of moles of MnO_4^{-} used = $\frac{25.60}{1000} \times 0.02$

$$= 5.12 \times 10^{-4} \text{ mol}$$
No of moles of C₂O₄²⁻ in 25.0 cm³ = $5.12 \times 10^{-4} \times \frac{5}{2}$
= $1.28 \times 10^{-3} \text{ mol}$ [½]
No of moles of C₂O₄²⁻ in 250 cm³ = no. of moles of H₂C₂O₄ [1/2]

lo of moles of
$$C_2O_4^{2^-}$$
 in 250 cm³ = no. of moles of $H_2C_2O_4$ [½]

Mass of
$$H_2C_2O_4$$
 in 250 cm³ = 0.0128 × 90 [1/2]

Percentage purity =
$$\frac{1.152}{1.27} \times 100$$
 [½]
=90.7%

(b) (i)
$$WO_2 \text{ or } WO_3$$
 [1/2]

Covalent bonding

(ii) pH = 2

(c)

3.

(a) C1: sp^2 C2: sp^3

(b)	Carbon	Shape	Bond angle	7
	C1	Trigonal planar	120°	[1]
	C2	tetrahedral	109°	[1]

4. (a) (i) Standard enthalpy change of formation of 2-methylpropene is [1] the enthalpy change when 1 mole of 2-methylpropene is formed from carbon and hydrogen elements under standard conditions.

(ii)	4 C (s)	+ 4 H ₂ (g) \rightarrow	$(CH_3)_2CH=CH_2$ (g)	[1]
· /	()	= (0)		

(b)	ΔH_{f}° (2-methylpropene)	[1]
	= $4 \times \Delta H_c^{\circ}$ (C) + $4 \times \Delta H_c^{\circ}$ (H ₂) - ΔH_c° (2-methylpropene)	
	= 4(-393) + 4(-286) – (-2520) = - 196 kJ mol ⁻¹	[1]
	[1/2] for ans [1/2] for units	

5.	(a)	Show 2 half-lives on graph	[½]
		half-life = 10 s	[½]
		half-lives are constant hence 1 st order	[1]

- (b) (i): Max vol = 60 cm³; [$\frac{1}{2}$] half-life = 20s [$\frac{1}{2}$] (ii):
 - Same half life as original curve = 10 s; $[\frac{1}{2}]$

[1	/2	

[1]

(a)

$$\kappa_{c} = \frac{[Z]^{2}}{[X][Y]}$$

$$\frac{0.04^{2}}{(Z)^{2}} = 0.4$$
[1]

$$= \frac{0.04^2}{(0.08)(0.05)} = 0.4$$
 [1/2] for correct substitution; [1/2] for ans

$$= \overline{(0.08)(0.05)}^{=0.4}$$
 [1/2] for correct substitution; [1/2] for ans

$$K_{\rm C} = 0.4$$

(b)
$$0.05 \text{ mol dm}^{-3}$$
 of **Y** was added into the system. [1]

- show all 3 concentrations halved [½] (c)
 - no change in equilibrium position

[½]



7. (a) A buffer solution is a solution whose <u>pH does not change significantly</u> [2] when a small amount of acid or base is added to it.

Or A buffer solution <u>resists changes in pH</u> on <u>addition of a small</u> <u>amount of acid or alkali</u>.

either phrases - both underlined terms must be present else [0]

7. (b) (i) $HPO_4^{2-} + H^+ \rightarrow H_2PO_4^{--}$

The additional H^+ ions are removed by the large concentration of HPO_4^{2-} in the buffer. Therefore the pH of the solution remains almost unchanged.

(ii) $H_2PO_4^- + OH^- \rightarrow HPO_4^{2-} + H_2O$ [1] The additional OH⁻ ions are removed by the large concentration of $H_2PO_4^-$ in the buffer. Thus, H⁺ changes very slightly and the pH <u>remains almost unchanged</u>. If only equations were written, -[1]





[1] per structure

8. (b) The rate of reaction would increase[1]

C-C/ is a stronger bond as compared to C-Br bond and (requires [1/2]

[1]

more energy before a reaction could take place / has a larger[½]activation energy)[1]. Therefore the rate of reaction would besignificantly faster for C-Br then C-C/.

[1]

(c) butan-2-ol < butanoic acid [1]

Carboxylic acids act as acids by donating their protons and forming carboxylate ions according to the following equilibrium equation:

$$\begin{array}{c} O \\ \parallel \\ R - C - O - H \end{array}^{+} H_2 O \xrightarrow{\bullet} R^{-} C - O^{-} H_3 O^{+} \\ \end{array}$$
[1]

Hence carboxylic acids are stronger acids than alcohols.

8. (d) Step 1 – HCI (aq) or H2SO4 (aq) and heat
Step 2 – aq. I2, excess NaOH / KOH and heat
Step 3 – LiAIH4 in dry ether
Each reagent and condition [½]

SECTION B:

9. (a) (i)
$$N_2H_4(l) + O_2(g) \rightarrow N_2(g) + 2H_2O(g)$$
 [1]
(ii) Energy required for bond –breaking

$$= BE(N-N) + 4x BE(N-H) + BE(O=O)$$

= 160 + 4(390) + 496 [1]

Energy released from bond-forming =
$$BE(N=N) + 4x BE(O-H)$$
 [1]
= 994 + 4(460)
= 2834 kJ

Enthalpy change of formation of hydrazine = 2216 - 2834



Marking points:

- ✓ Label both axes
- ✓ Enthalpy change of formation shown.
- ✓ Label Activation energy
- ✓ Reactants and products label as N₂H₄ and oxygen, water and steam respectively.

Each point = [1/2] mark

[2]

9. (a) (iv) Since the process is only 80% efficient,

Total amount of energy needed =
$$\frac{100}{80} \times 10^{6}$$

=1.25 × 10⁶ J [1]

No of moles of hydrazine needed =
$$\frac{1.25 \times 10^6}{618 \times 10^3}$$

= 2.02 mol [1]

Relative molecular mass of hydrazine = 32

Mass of hydrazine needed = 2.02 × 32

9. (b) (i)
$$CH_3CH(OH)COOH \leftarrow CH_3CH(OH)COO^- + H^+$$
 [1/2]

$$K_{a} \text{ of lactic acid} = \frac{[CH_{3}CH(OH)COO^{-}][H^{+}]}{[CH_{3}CH(OH)COOH]}$$
[1/2]

(ii)
$$CH_3CH(OH)COOH + NaOH \rightarrow CH_3CH(OH)COONa + H_2O$$
 [1]

No. of moles of NaOH used =
$$\frac{24.30}{1000} \times 0.025$$

$$= 6.075 \times 10^{-4} \text{ mol}$$
 [1/2]

[1]

[½]

No. of moles of lactic acid = 6.075×10^{-4} mol

Concentration of lactic acid =
$$\frac{6.075 \times 10^{-3}}{10 \times 10^{-3}}$$

= 0.0608 mol dm⁻³ [1/2]

(iii) Phenolphthalein

9. (c) (i)

 [½]

 Reagent: Acidified KMnO₄

 [1]

Condition: Heat

Observation: $C_6H_5CH_2CH_3$ will decolourise purple KMnO₄ while $C_6H_{11}CH_2CH_3$ will not.



them:

Aliphatic aldehyde will give a red-brown precipitate of Cu_2O but [1/2] no ppt seen for the aromatic aldehyde. [1/2]

Reagent: (i) Dilute HCl/ H_2SO_4 ; (ii) acidified $K_2Cr_2O_7$ [1]Condition: (i)Heat; (ii) heat[1]Observation:[1] $CH_3CH_2COOCH(CH_3)_2 \rightarrow CH_3CH_2COOH + HOCH(CH_3)_2$ $CH_3OCOCH(CH_3)_2 \rightarrow CH_3OH + HOOCCH(CH_3)_2$ The alcohols ini bold will undergo oxidation to further distinguish

CH₃OH will turn orange dichromate green while HOCH(CH₃)₂ [1] will not be oxidised.

*Equations for the hydrolysis of esters are not required, but students should at least show the alcohols formed which undergoes oxidation in the second step.

10.	(a)	(i)	Comparing expts 1 and 2,	
			when [NO] triples, rate increases by 9 times.	[½]
			2 nd order w.r.t. [NO]	[1/2]

(ii)

Comparing expts 2 and 3,

10. (b)

	$\frac{0.130}{0.116} = \frac{(0.03)^2 (0.02)^n}{(0.02)^2 (0.04)^n} \rightarrow n = 1 $ [1/2] for working	[½]
	1 st order w.r.t. [H ₂] [1/2]	[½]
(ii)	rate = k $[NO]^2 [H_2]$	[1]
(iii)	$k = 7.25 \times 10^{-4} \text{ mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$	[1]
	[1/2] for ans [1/2] for units	
(iv)	rate = 1.57 × 10 ⁻⁹ mol dm ⁻³ s ⁻¹	[1]
	[1/2] for ans [1/2] for units	
(v)	Catalyst provides an alternative pathway with lower activation	
	energy [1].	[1]
	Particles with energy more than or equal to the lower activation	
	energy increases.	[½]
	Effective collision increases.	[½]
	Rate increases.	[1]
(i)	$N_2(g) + 3 H_2(g)$ 2 $NH_3(g)$	[1]
(ii)	$\mathbf{K}_{\mathbf{C}} = \frac{[NH_3]^2}{[N_2][H_2]^3}$	[1]
	$= \frac{(0.142)^2}{(1.40)(1.78)^3} = 0.00255 \text{ mol}^{-2} \text{ dm}^6$	[1]
	[1/2] for ans [1/2] for units	

(iii)	Haber process is an exothermic reaction [1].	[1]
	When temperature increases, eqm shifts to the left [1] to	[1]
	decrease the temp	
	by favouring the endothermic reaction.	[½]
	Yield of ammonia decreases.	[1/2]

 10. (c)
 Step I : hot acidified KMnO₄
 [1]

 Step II : H₂ and Ni
 [1]

 A: CH₃COCH₂COOH
 [1]

10. (d)
 (i)

$$CH_3CH(OH)COO^- Na^+$$
 [1]

 (ii)
 CHI_3
 [1]



(a) (ii) NaC/ dissolves readily in water and due to the low charge density of Na⁺, it will not <u>hydrolyse in water</u> and thus form a <u>neutral solution of pH 7</u>.

NaC/(s) + aq \rightarrow Na⁺(aq) + C/⁻(aq) [½] – each underline word; [1] – for equations

In the presence of water, A/CI_3 undergoes <u>hydrolysis</u> to form an <u>acidic solution of pH \approx 3 (accept less than 7)</u>.

 $\begin{array}{rcl} A/CI_{3}\left(s\right) \ + \ aq & \rightarrow & \left[A/(H_{2}O)_{6}\right]^{3+}\left(aq\right) + 3C/^{-}\left(aq\right) \\ \left[A/(H_{2}O)_{6}\right]^{3+}\left(aq\right) \ + & H_{2}O(I) & \overbrace{}^{-----} & \left[A/(H_{2}O)_{5}(OH)\right]^{2+}\left(aq\right) + & H_{3}O^{+}\left(aq\right) \\ (accept irreversible equation as well) \end{array}$

 $[\frac{1}{2}]$ – each underline word; [1] – for equations In the presence of water, phosphorous trichloride <u>hydrolyse</u> in water to form a <u>strongly acidic solution of pH \approx 2 (accept range pH < 4).</u>

PCl ₃ (<i>I</i>)	+	3H ₂ O (<i>I</i>)	\rightarrow	H₃PO₃ (aq)	+	3HC <i>I</i> (aq)	[6]
[½] – ead	ch ι	underline w	ord; [1] – for equati	on		

11. (a) (iii) Both phosphorous trichloride and aluminium chloride are simple covalent molecules[½].

Phosphorous trichloride is a <u>polar molecule</u>, with permanent dipole <u>permanent dipole interactions</u> as the predominant interaction. [½] It
 [½] is able to <u>form strong permanent dipole interactions with</u>
 <u>chloromethane[½]</u> and thus it is soluble in chloromethane.

[1/2]

Aluminium trichloride is a <u>non-polar molecule with induced dipole-</u> <u>induced dipole interactions</u> only [½]. It would <u>form weak induced</u> <u>dipole-induced dipole interactions</u> with chloromethane [½], which [½] would <u>not compensate for the energy needed to overcome</u> the original permanent dipole-permanent dipole interaction between chloromethane molecules[½]. Thus it is insoluble in chloromethane.

14 /6)	Information	Deduction
(d)	Information	Deduction
	Compound A has molecular	absence of benzene functional
	formula of $C_9H_{15}O_2CI$.	group
	1 mole of compound A	electrophilic addition
	decolourises 1 mole of aqueous	presence of one alkene
	bromine.	functional group
	It forms 2 products, compounds	oxidation of alkene group
	B and C , upon reaction with	hydrolysis
	acidified potassium	presence of ester functional
	manganate(VII) in a ratio of 2 : 1.	group
	Compound B , with empirical	• from previous ratio – molecular
	formula CH ₂ O,	formula C ₂ H ₄ O ₂
	Compound B reacts with excess	 Colorless gas is CO₂.
	sodium carbonate to form a	• $CO_2 + Ca(OH)_2 \rightarrow$
	colorless gas, which forms a	$CaCO_3$ (white ppt) + H_2O
	white precipitate with limewater.	Presence of carboxylic acid
	Compound C , with molecular	Presence of 2 –OH functional
	formula $C_5H_9O_3CI$, reacts with	groups
	phosphorous trichloride to form	odd number of O indicates
	compound D , with molecular	presence of tertiary alcohol [1]
	formula $C_5H_7OCI_3$.	as C came from an oxidation
		reaction
	Compound C can also be formed	electrophilic addition (award only

via the reaction of aqueous	if previous clue was not
chlorine solution with	awarded)
(CH ₃) ₂ C=CHCOOH.	

Each point award [1/2] except for point on tertiary alcohol.

Deductions – $[6\frac{1}{2}]$

Compound	Structure	
A	$\begin{array}{c} O & CH_3 Cl H \\ H & CH_3 & C & C \\ CH_3 & C & C & C \\ CH_3 & H & C \\ CH_3 & H & H \end{array}$	
В	CH₃COOH	
C	$\begin{array}{c} CH_3 Cl & OH \\ I & I & I \\ HO \\ HO \\ CH_3 \\ H \\ O \end{array}$	
D	$CH_{3} Cl Cl$ $Cl Cl Cl$ $Cl Cl Cl Cl$ $Cl Cl CH_{3} CL Cl$ $Cl CH_{3} CL Cl$	Structures – [1] each *Total – [10½] <u>cap at</u> [7]