Nanyang JC J2 Prelim Exam 2024 H1 Chemistry 8873/01 Paper 1 MCQ Answers and Comments

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

1 B	3 C				
$n(ethanol) = 20 \div 46.0 = 0.4347 mol$ $n(propanoic acid) = 30 \div 74.0 = 0.4054 mol$	$Zn \rightarrow Zn^{2+} + 2e^{-}$				
∴ propanoic acid is the limiting reagent	Mole ratio of Zn : VO_2^+ : e ⁻ \Rightarrow 1 : 2 : 2				
m(ethyl propanoate) = 0.4054×102.0 = 41.35g	$\Rightarrow \frac{1}{2} : 1 : 1$				
yield of ester = $(22 \div 41.35) \times 100\% = 53\%$	∴ 1 mol of \	∴ 1 mol of VO ₂ ⁺ gained 1 mol of e ⁻			
2 C	Since ON of V in $VO_2^+ = +5$, final ON of V in Y is +4				
$AI_xC_y + H_2O \rightarrow gas$	$V^{5+} + e^- \rightarrow V$	/ ⁴⁺			
gas + O ₂ \rightarrow CO ₂ + H ₂ O	Ion Y is VO ²⁺ (ON of V is +4)				
$n(CO_2) = 0.072 \div 24 = 0.003 mol$	4 C				
n(C) in every mol of gas = $n(C)$ in every mol of compound A = 0.003 mol	+ X →	+ p+			
Option A: n(Al ₂ C ₃) = 0.144÷90.0 = 0.0016 mol	The numbe & neutrons)	r of subatomic pa should be balan	articles (proton ced.		
n(C) in Al ₂ C ₃ = $3 \times 0.0016 = 0.00480$ mol		no. of	no. of		
Option B:		protoris	neutions		
n(Al ₃ C ₄) = 0.144÷129.0 = 0.00112 mol	³² D and nt		(32 – 15) + 0		

n(C) in Al₃C₄ = 4 × 0.00112 = 0.00447 mol

Option C: $n(AI_4C_3) = 0.144 \div 144.0 = 0.0010 \text{ mol}$ n(C) in Al₄C₃ = 3 × 0.0010 = **0.00300 mol**

Option D: $n(AI_5C_3) = 0.144 \div 171.0 = 0.000842 \text{ mol}$ n(C) in Al₅C₃ = 3 × 0.000842 = 0.00253 mol

	no. of protons	no. of neutrons
³² ₁₅ P and p+	15 + 1 = 16	(32 – 15) + 0 = 17
³² ₁₆ S	16	32 – 16 = 16
Х	0	1

5 D 7 Α AI: 1s² 2s² 2p⁶ 3s² 3p¹ CCl₄ and C₆H₁₄ are non-polar molecules that forms only id-id interactions. Option A is incorrect as electrons are For A, CH₂Cl₂ and (CH₃)₂CO are polar present in five different energy levels. molecules that can form pd-pd interactions. Option B is incorrect as there are 7 electrons in p orbitals and 6 electrons in s For B and C, stronger pd-pd interactions orbitals. are broken and weaker id-id interactions are formed between non-polar molecule Option C is incorrect as the occupied orbital mixed with a polar molecule hence heat is of lowest energy (1s) is spherical. taken in. С Similarly for D, strong hydrogen bonds 6 between CH₃CH₂OH molecules are broken 1: bond angle wrt O decreases from 109° in and only weak id-id interactions are formed ice (0lp, 4bp - 2 covalent bonds and 2 Hin the mixture. bonds: see below) to 105° in water (2bp, 2lp) Hence, A is the best answer where comparable pd-pd interaction is formed between two polar molecules. 8 Α Since m.p. of **Y** is very low and it also has Hydrogen bonds poor electrical conductivity, it should have a simple molecular structure \Rightarrow based on options, Y is SiCl₄ Since m.p. of X is very high and it also has 2: bond angle wrt S increases from <120° in good electrical conductivity, it could have a SO₂ (2bp, 1lp) to 120° in SO₃ (3bp, 0lp) giant metallic structure or giant molecular structure (graphite). It could also be giant 3: bond angle wrt C increases from 109° in ionic structure if the electrical conductivity is RCH(OH)R' (4bp, 0lp) to 120° in ketone in molten or aqueous state. \Rightarrow based on RCOR' (3bp, 0lp) options, X is C(graphite) Since m.p. of of **W** is very high and it also has slight electrical conductivity, it should be silicon (metalloid). Diamond is unable to conduct electricity as 4: bond angle wrt Al decreases from 120° in all 4 valence electrons are used to form AICI₃ (3bp, 0lp) to 109° Al₂Cl₆ (4bp, 0lp) covalent bonds and none are delocalised to be able to act as charge carriers. CI Cl

9 D

$$|\mathsf{LE}| \alpha | \frac{q_+q_-}{r_++r_-}|$$

 q_+q_- for CaCl = (+1)(-1); q_+q_- for CaCl₂ and MgCl₂ = (+2)(-2).

Since lattice energy depends more on product of ionic charges (q_+q_-) than on the sum of ionic radius $(r^+ + r^-)$; hence magnitude of lattice energy of CaCl₂ and MgCl₂ is greater than that of CaCl.

Between CaCl₂ and MgCl₂: r^+ Mg²⁺ < r^+ Ca²⁺. Therefore, $r^+ + r^-$ for MgCl₂ < CaCl₂. Hence, magnitude of lattice energy of MgCl₂ is greater than that of CaCl₂.

10 B

 $\Delta H_{\rm f}$ (CO₂): It is energy change when one mole of CO₂(g) is formed from its constituent elements, carbon and oxygen in their standard states under standard conditions. C(s) + $\frac{1}{2}$ O₂(g) \rightarrow CO₂(g)

Option **B** is correct as the standard enthalpy change of combustion of carbon is the energy change when one mole of carbon is completely burnt in excess oxygen under standard conditions. The chemical equation is the same as ΔH_f (CO₂). C(s) + $\frac{1}{2}O_2(g) \rightarrow CO_2(g)$

Option **A** is incorrect as it only considers the bonds formed without considering bonds broken in carbon and oxygen. (See formula below).

 $\Delta H_{\rm r} = \sum {\rm BE}({\rm bonds \ broken}) - \sum {\rm BE}({\rm bonds \ formed})$

Option **C** is incorrect as the standard state of carbon is graphite, not diamond. Graphite is the elemental form with the lowest energy.

Option **D** is incorrect as the standard enthalpy change is measured under standard conditions of 298 K and 1 bar.

mol	1/2 H2SO4	NaOH	$1/_2Na_2SO_4$	H ₂ O
initial	0.1	0.1	0	0
change	-0.05	-0.1	+0.1	+0.1
final	0.05	0	0.1	0.1
final	_0.05 0.05	0.1	0.1	+0.1 0.1

NaOH is the limiting reagent. Hence, the number of moles of H_2O formed = 0.1 mol

 $\begin{array}{l} \mathsf{q} = \mathsf{mc} \Delta \mathsf{T} \\ \mathsf{=} (50.0 + 100)(1)(4.18)(29.0 - 20.0) \\ \mathsf{=} 5643 \ \mathsf{J} \end{array}$

$$\Delta H = -\frac{q}{n(H_2O)} = -\frac{5643 \times 10^{-3}}{0.1}$$

= -56.4 kJ mol⁻¹

12 D

If the temperature of the gas is increased, average kinetic energy of the particles increases. The maximum of the curve becomes <u>lower</u> and moved to the <u>right</u>.

The fraction of molecules that react in the presence of a catalyst is shown by +

13 D

Rate of a chemical reaction can be measured by change in concentration of reactants and products.

Decomposition of NH₄Cl(g)

 $NH_4Cl(g) \rightleftharpoons NH_3(g) + HCl(g) \Delta H = +314 \text{ kJ mol}^{-1}$



progress of reaction

 E_A refers to the activation energy required for the reaction to overcome before the reaction can take place.

Reactant, NH₄Cl will have lower energy level than products, NH₃ + HCl since $\Delta H =$ +314 kJ mol⁻¹

15 D

A is wrong as catalyst only increases the rate of reaction and not the yield of the reaction.

B is wrong as the reaction is exothermic. An increase in temperature will favour the backward endothermic reaction instead to reduce the added heat. Hence, decreasing the yield of reaction.

C is wrong as the higher pressure will favour the reaction that produced a lesser amount of gaseous particles which is the forward reaction. Hence the position of equilibrium will shift to the right to reduce the total amount of gaseous particles.

D is correct as the addition of a catalyst and/or a high temperature will increase the rate of reaction.

	2NO(g)	+	Cl ₂ (g)	Ý	2NOCI(g)
Initial	2.32		Х		0
Change	-1.77		-0.885		+1.77
Final	0.55		X – 0.885		1.77

$$\begin{split} & \mathcal{K}_c = [\text{NOCI}]^2 / [\text{NO}]^2 [\text{CI}_2] \\ & 2807 = (1.77/1)^2 / (0.55/1)^2 ((X-0.885)/1) \\ & X - 0.885 = 0.003689 \\ & X = 0.08886 = 0.889 \end{split}$$

17 B

A lower temperature at T_2 will favour the forward exothermic reaction to compensate for the lost of heat. Hence, I_2 will decrease more. Hence, the equilibrium amount of I_2 should be lower than 0.23.

At T_2 , the rate of reaction will also be slower. Hence, the gradient of the graph should be gentler.

18 C

Bronsted Lowry acid: donates hydrogen ions

Lewis acid: accepts a lone pair of electrons Arrhenius acid: produces hydrogen ions in aqueous solution

19 A

Option 1 is correct. [H]⁺ dissociated from acid 1 = $10^{-4} = 0.000100 \text{ mol dm}^{-3}$ [H]⁺ << [acid 1], acid 1 is partially dissociated. [H]⁺ dissociated from acid 2 = $10^{-1} = 0.100 \text{ mol dm}^{-3}$ [H]⁺ = [acid 2], acid 2 is completely dissociated. Thus, acid 1 dissociates to a smaller extent than acid 2, OR

Since initial [acid] is the same and acid 1 has a higher pH i.e. lower [H⁺], acid 1 must have dissociated to a smaller extent. <u>Option 2 is correct.</u> [H⁺] in base $1 = 10^{-11}$ mol dm⁻³

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[H ⁺] in base $2 = 10^{-13}$ mol dm ⁻³ Thus, base 2 contains a lower [H ⁺] in solution than base 1 OR	$2HX \rightarrow 2H_2 + 2X_2$ $\Delta H = sum BE(bonds broken) - sum BE(bonds formed)$		
or more basic with higher $[OH^-]$. Since $[H^+][OH^-] = K_w$, it will have lower $[H^+]$.	For HCI: 2(431) – 436 – 244 = +182 kJ mol ⁻¹		
Option 3 is correct.solutionpHpOH[OH ⁻] / mol dm ⁻³ base 11130.00100	For HBr: 2(366) – 436 – 193 = +103 kJ mol ⁻¹		
base 2 13 1 0.100 Base 1 is a weak base while base 2 is a	For HI: 2(299) – 436 – 151 = +11 kJ mol ⁻¹		
strong base.	The above calculation proves that statement 3 is correct.		
1 would require same volume of base 1 and base 2 as a weak acid or weak base would eventually be fully dissociated to produce the same amount of H ⁺ or OH ⁻ as a strong acid or strong base as neutralisation is carried out.	Statement 4 is incorrect The boiling points of hydrogen chloride is lower than that of hydrogen bromide because id-id forces of attraction between HCI molecules are weaker due to smaller and less polarisable HCI electron cloud. The H–CI bond is indeed stronger but this is		
This is because the constant removal of H^+ or OH^- from the system during neutralisation to form H ₂ O would drive the	not the reason for explaining why bpt of HCl is lower than that of HBr.		
dissociation of a weak acid / weak base to completion.	22 A Since X and Y are in the same group and		
20 B Buffer solution containing the weak acid,	the first ionisation energy of X is greater than the first ionisation energy of Y, X must be above Y in the group. Option B and C are therefore eliminated.		
HCO ₃ ⁻ and its conjugate base, CO ₃ ²⁻ . When small amounts of H ⁺ is added, $CO_3^{2-} + H^+ \rightarrow HCO_3^-$	From Qn: X, Y and Z are found in Grp 13, 14 and 15 & Y and Z in Period 3.		
When small amounts of OH ⁻ is added, HCO ₃ ⁻ + OH ⁻ \rightarrow H ₂ O + CO ₃ ²⁻	Option A is correct: If Y is AI, Z could be Si or P. Firstly, melting point of P ₄ is lower than that of AI. Secondly, PCI ₅ is a white		
21 A	solid. Thus, X is B, Y is AI and Z is P.		
Statement 1 is correct Chlorine reacts with hydrogen to form HCI which is a colourless gas	Both PCI ₅ and AlCI ₃ are white solids that react with water to produce solutions with a pH of less than 4.		
Statement 2 is incorrect Potassium iodine produces a purple gas after oxidising reducing bromine. Statement 3 is correct Use the following formula to calculate the enthalpy change of decomposition of HX	Option D is incorrect. If Y is P, Z could be Al or Si. Firstly, melting point of Al and Si is higher than that of P ₄ . Secondly, AlCl ₃ is a yellow-white solid.		

23 D

Cpd	In H ₂ O Nature		When NaOH is added
Na ₂ O	Dissolves	Basic	Dissolves in the
	to produce		aqueous medium to
MaO	NaOH	Decia	produce NaOH
MgO	soluble in water hence white solid will remain	Basic	aqueous medium
Al ₂ O ₃	Insoluble in water	Amphoteric	Reacts with NaOH and hence dissolves
SiO ₂	Insoluble in water	Acidic	Insoluble in dilute NaOH and can only react with concentrated NaOH
NaCl	Soluble in water	Neutral	Soluble in the aqueous medium
MgCl ₂	Hydrolysis s water to proo solution	lightly in duce acidic	White ppt of Mg(OH) ₂ insoluble in excess NaOH (QA cation test).
Al ₂ Cl ₆	Hydrolyses of water to proo	completely in duce acidic	White ppt of Al(OH) ₃ soluble in excess NaOH
SiCl₄	Undergoes h produce inso	nydrolysis to pluble SiO ₂	Undergoes hydrolysis to produce insoluble SiO ₂
			Insoluble in dilute NaOH and can only react with concentrated NaOH

24 B

Potassium or rubidium undergoes oxidation when reacting with water, which undergoes reduction. Hence potassium or rubidium is reducing agent while water is oxidising agent.

Reducing strength / reactivity of Group 1 elements increases down the group. So, rubidium reacts more vigorously with water than potassium.

25 A

- Like sodium, calcium metal reduces -OH group to -O $^{-}$
- A 2CH₃COOH + Ca \rightarrow (CH₃COO⁻)₂Ca + H₂
- B 2CH₃CH₂CH₂COOH + Ca \rightarrow (CH₃CH₂CH₂COO⁻)₂Ca + H₂
- C HOOCCH₂CH₂COOH + 2Ca \rightarrow (-OOCCH₂CH₂COO-)Ca + H₂
- D HOOCCH(CH₃)COOH + 2Ca

\rightarrow (-OOCCH(CH₃)COO-)Ca + H₂

26 C

If CI is the halogen present in compound D (same ease of substitution), to get greater amount of NaX in a given time, compound D should contain more than one possible CI that can substituted.

If there can only be one halogen present in compound D, the halogen has to be either Br or I. This is because the C-Br and C-I bonds are weaker than C-Cl bond. Hence, the rate of substitution for compound D will be faster than CH₃CH₂Cl.

27 D

Compound E has one oxygen and is unreactive towards mild oxidising agent \Rightarrow compound E contains tertiary alcohol or ketone functional group

Since ketone cannot undergo dehydration, compound E contains tertiary alcohol

Option D is the only alkene that can be obtained from dehydrating a tertiary alcohol

28 C

 $M_{\rm r}$ of repeating unit: 72.0 -



no. of monomers = 144 000 / 72.0 = 2000

29 A

Option 1 is incorrect as Bakelite cannot be recycled. It is a thermosetting polymer as

the polymer chains are cross-linked together via covalent bonds.

Option 2 is correct.



Option 3 is incorrect as the reactant in step 2 should be methanal, an aldehyde.

30 B

Option A is incorrect as it is a nanomaterial.

Option B is correct as each carbon atom is bonded to three other carbon atoms and there are 3 bond pairs and 0 lone pair around each carbon atom, giving a trigonal planar shape (120°).

Option C is incorrect as the valency of each carbon atom in the lattice is 4 as it forms 3 sigma and 1 pi bonds.

Option D is incorrect as it consists of a single layer of carbon atoms.