Victoria Junior College 2022 H2 Chemistry Prelim Exam 9729/1 Suggested Answers

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

<u>1 B</u>

alamant		electronic	no. of	
	element	configuration	unpaired e⁻	
~	Al	1s ² 2s ² 2p ⁶ 3s ² 3p ¹	1	
A	0	1s ² 2s ² 2p ⁴	2	
Р	В	1s ² 2s ² 2p ¹	1	
D	Н	1s ¹	1	
2	Cu	[Ar]3d ¹⁰ 4s ¹	1	
C	Ι	[Kr]4d ¹⁰ 5s ² 5p ⁵	1	
D	Fe	[Ar]3d ⁶ 4s ²	4	
U	Cl	1s ² 2s ² 2p ⁶ 3s ² 3p ⁵	1	

2

Large dip in second I.E. from M to N \rightarrow second electron removed from an outer shell in N \rightarrow M is in Group 1 (Na) while N is in Group 2 (Mg).

Option A: True

D

L is a noble gas (Ne). It has a fully filled valence electron shell and does not form an oxide.

Option B: True

Q is silicon (Si) which has the highest melting point across period 3. Si has a giant molecular structure. Large amount of energy is required to break the strong covalent bonds.

Option C: True

The atomic radius of J (O) is larger than that of K (F). Both O and F are in the same period (similar shielding effect), but F has a greater number of protons (higher nuclear charge), hence higher effective nuclear charge, and valence electrons are pulled closer to the nucleus. So F has a smaller atomic radius than O.

Option D: False

The oxide of N (MgO) has a higher melting point than the oxide of R (P_4O_{10}).

3	В				
	molecule	no. of	no. of	shano	bond
	molecule	bp	lp	Shape	angle
•	SO ₂	2	1	bent	118°
A	OF ₂	2	2	bent	105°
в	OCS	2	0	linear	180°
В	HCN	2	0	linear	180°

C	CCl ₄	4	0	tetrahe dral	109.5°
C	XeF ₄	4	2	square planar	90°
C	CS ₂	2	0	linear	180°
U	H ₂ S	2	2	bent	105°

4

Statement 1: Correct

Α

In all the three allotropes, each carbon atom is covalently bonded to 3 other carbon atoms. The remaining electron is delocalised and mobile. The p orbitals of the carbon atoms overlap to form a continuous π electron cloud allowing delocalisation of electrons and conduction of electricity.

Statement 2: Incorrect

Unlike graphite, graphene and carbon nanotube do not have layers held together by weak intermolecular forces of attraction. Hence they are not slippery to be used as lubricants.

Statement 3: Incorrect

Note that both carbon allotropes are non-polar. Energy released from the formation of dipole-induced dipole interactions between carbon allotropes and water is insufficient to overcome the strong C-C covalent bonds in the carbon nanotube and graphene as well as the hydrogen bonds between water molecules.

5 A

Since G_A has a higher M_r than G_B , and mass of the two gases is the same, amount of G_A is lower than amount of G_B . For an ideal gas, pV = nRT.

Option A: Correct

At constant p, $V = \frac{nR}{p}T$. Plotting V against T gives a straight line graph passing through the origin with constant gradient $\frac{nR}{r}$.

Option B: Incorrect

At constant T, pV = nRT = constant. Plotting pV against V gives a horizontal line.

Option C: Incorrect

At constant T, pV = nRT = constant. Plotting p against pV gives a vertical line.

Option D: Incorrect

At constant V, $p = \frac{nR}{V}T$.

Plotting Vp against T gives a straight line graph passing through the origin with constant gradient $\frac{nR}{v}$.

6 D

Option A: Correct

Be in $BeCl_2$ is electron deficient, hence it can accept lone pair of electrons to achieve stable octet configuration.

Option B: Correct

Ba has a lower melting point than Sr. Less energy is required to overcome the weaker metallic bonds between the larger Ba²⁺ ions and electrons than the stronger metallic bonds between the smaller Sr²⁺ ions and electrons.

Option C: Correct

Ba has more electron shells than Ca. Its valence electrons are further away from the nucleus, hence less attracted to the nucleus, and so need less energy to be removed.

Option D: Incorrect

The charge density and hence polarising power of Mg²⁺ is higher than that of Ca²⁺ since Mg²⁺ is smaller than Ca2+. Hence there is a greater distortion of the anionic charge cloud and so MgCO₃ is less stable to heat and decomposes at a lower temperature than CaCO₃.

7

С **Option A: Incorrect**

N₂H₄ is the Bronsted-Lowry base in Reaction 1 as it accepts a proton to form N₂H₅+.

Option B: Incorrect

 $N_2H_5^+$ and N_2H_4 , as well as NH_3 and NH_4^+ , are conjugate acid-base pairs.

Option C: Correct

Since the POE lies to the right for both reactions, HCIO is a stronger acid than N₂H₅⁺ from Reaction 1 as it prefers to donate a proton. Likewise for Reaction 2 where N₂H₅⁺ is a stronger acid than NH4⁺.

Option D: Incorrect

Α

 N_2H_4 is a weaker base than NH_3 because in Reaction 2, the POE lies to the right.

8

Reactivity and oxidising power decreases down Group 17.

 $Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$ (reddish-brown gas) $Br_2 + 2I^- \rightarrow 2Br^- + I_2$ (purple gas, dissolves in water to form brown solution)

9 C						
	C _x H _y +	$(x+\frac{y}{4})O_2$	\rightarrow	xCO ₂ +	$\frac{y}{2}H_2O$	
Initial volume	10	90		0		
Change in volume	-10	$-10(x+\frac{y}{4})$		+30		
End volume	0	40		30		

x = 3 $90 - 10(x + \frac{y}{4}) = 40 \rightarrow y = 8$ Hence formula is C₃H₈.

10 D

Amount of $TeO_2 = \frac{1.01}{159.6} = 0.00633$ mol Amount of K₂Cr₂O₇ = 0.070 x $\frac{30}{1000}$ = 0.0021 mol Since solution changes from orange (Cr₂O₇²⁻) to green (Cr³⁺), Cr₂O₇²⁻ + 14H⁺ + 6e⁻ \rightarrow 2Cr³⁺ + 7H₂O, amount of electrons = $6 \times 0.0021 = 0.0126$ mol

 $\frac{\text{amount of e}^{-}}{\text{amount of TeO}_2} = \frac{0.0126}{0.00633} = 2$ Oxidation state of Te in $TeO_2 = +4$ Since 1 mol of TeO₂ loses 2 mol of e^- in the reaction, oxidation state of Te in product = +6

11 B

$$Ca(s) + 2H_2O(I) \xrightarrow{\Delta H_{f}} Ca(OH)_2(s) + H_2(g);$$

$$2\Delta H_{f}(H_2O) \xrightarrow{\bullet} \Delta H_{f}(Ca(OH)_2)$$

$$Ca(s) + 2H_2(g) + O_2(g)$$

By Hess Law,

 $\Delta H_{\rm f}({\rm Ca}({\rm OH})_2) = 2\Delta H_{\rm f}({\rm H}_2{\rm O}) + \Delta H_{\rm f}$ $= 2\Delta H_{\rm c}({\rm H}_2) + \Delta H_{\rm r}$ Hence, other than ΔH_r , enthalpy change of combustion of hydrogen is needed.

12 С

Option A (Wrong) $\Delta S > 0$ and $\Delta H > 0$ $\Delta G = \Delta H - T \Delta S < 0$ for large T only. **Option B (Wrong)** $\Delta S < 0$ and $\Delta H < 0$ $\Delta G = \Delta H - T\Delta S < 0$ for small T only. **Option C (Correct)** $\Delta S > 0$ and $\Delta H < 0$ $\Delta G = \Delta H - T \Delta S < 0$ for all T. **Option D (Wrong)** $\Delta S < 0$ and $\Delta H > 0$ $\Delta G = \Delta H - T\Delta S > 0$ for all T.

13

Δ

Rate law is determined by slow step in proposed mechanism, i.e. Rate = $k'[O_3][O]$. This rate law cannot be compared directly with the experimental rate equation because it contains the concentration of an intermediate, O. Thus we need to express rate law in a way that removes the intermediate O.

From Step 1,

 $K = [O_2][O]/[O_3] \Rightarrow [O] = K[O_3]/[O_2]$ Assuming that Step 1 equilibrium is established quickly before O is reacted with O₃ in Step 2, Rate = $k'[O_3][O]$

 $= k[O_3]^2/[O_2]$ where k = k'K

14 B

$$p_{H_2S} = p_{NH_3} \left(NH_4 HS_{(s)} \rightleftharpoons H_2S_{(g)} + NH_{3(g)} \right)$$

Thus, $p_{H_2S} = p_{NH_3} = \frac{1}{2} \times 66.4 = 33.2 \text{ kPa}$

1 $K_{p} = p_{H_{n}S} \times p_{NH_{n}} = (33.2)^{2} \approx 1100 (kPa)^{2}$

- 2 Removal of H₂S will cause more NH₄HS to dissociate forming not only H₂S but also NH₃. Hence total pressure will increase.
- **3** Addition or removal of a solid has no effect on the position of equilibrium so long as there is still solid present.

15

В

A HA/A⁻ buffer with maximum buffer capacity will have its $pH = pK_a$ of HA.

So, pK_a of HA = 6.38 => pK_b of A⁻ = 14 - pKa = 7.62

Hence, H_2CO_3 / HCO_3^- can be used to prepare a buffer of pH 6.28 with maximum buffer capacity.

16 C

Stage I : oxidation of 2º alcohol to ketone

Stage II : nucleophilic :OH⁻ substitutes for the $-CI_3$ group

Stage III : basic :CI $_3^-$ abstracts a proton from the acid RCO $_2$ H

17 C

18

While all 3 compounds have 2 chiral centres, the compound in option one has a plane of symmetry and is hence not optically active.







19

В

Step 1: Alkylation of benzene to form methylbenzene:

$$+ CH_3Cl \xrightarrow{AlCl_3} + HCl$$

Step 2: Nitration of methylbenzene to give 2–nitromethylbenzene and 4–nitromethylbenzene since –CH₃ group is 2,4–director.

For the formation of 4nitroomethylbenzene:



Step 3: Bromination of 4nitromethylbenzene to give 2-bromo-4nitromethylbenzene since $-CH_3$ group is 2,4-director while $-NO_2$ group is 3director.



20

Option A (incorrect)

C–Br bond in C_6H_5Br experiences partial double bond character, due to overlap of lone pair of electrons of Br with the pi electrons of the benzene ring. Hydrolysis does not take place hence no ppt is formed.

Option B (incorrect)

Silver iodide has a very low K_{sp} . The precipitate is insoluble in both aqueous and concentrated NH₃.

Option C (incorrect)

C–C*l* bond in CH₂=CHC*l* experiences partial double bond character, due to overlap of lone pair of electrons of C*l* with the pi electrons of the C=C. Hydrolysis does not take place hence no ppt is formed.

Option D (correct)

 $\begin{array}{l} \mbox{Only CH}_3CH_2I \mbox{ and CH}_3COC{\it l} \mbox{ undergo hydrolysis.} \\ 1 \mbox{ mole of organic compound will give 1 mole of AgX.} \\ \mbox{No. of moles of AgI = No. of moles of CH}_3CH_2I \\ &= 0.5 \div (12.0 \times 2 + 5.0 + 126.9) \\ &= 3.21 \times 10^{-3} \mbox{ mol} \\ \mbox{Mass of AgI = } 3.21 \times 10^{-3} \times (107.9 + 126.9) \\ &= 0.754 \mbox{ g} \\ \mbox{No. of moles of AgC{\it l} = No. of moles of CH}_3COC{\it l} \\ &= 0.5 \div (12.0 \times 2 + 3 + 16.0 + 35.5) \\ &= 6.37 \times 10^{-3} \mbox{ mol} \\ \mbox{Mass of AgC{\it l} = 6.37 \times 10^{-3} \times (107.9 + 35.5) \\ &= 0.914 \mbox{ g} \end{array}$

21 A

Among the alcohols formed, only 1° and 2° alcohols can be oxidised.



Mole of C₄H₁₀O that has reacted = $\frac{65}{74}$ = 0.878 mol Since yield is 55%, moles of product formed will be $\frac{55}{100} \times 0.878 = 0.483$ mol Mass of butanone: 0.483 × 72 = 34.8 g Mass of butanoic acid: 0.483 × 88 = 42.5 g

Mass of 2-methylpropanoic acid: $0.483 \times 88 = 42.5$

22 A

Ethanal undergoes nucleophilic addition with HCN whereby CN^{-} acts as nucleophile which attacks e deficient C atom in C=O group: CH₃CHO + HCN \rightarrow CH₃CH(CN)(OH)

Similarly, ${}^{-}CH_{2}COCH_{3}$ from CH₃COCH₃ can also act as a nucleophile like CN⁻ (from HCN) and attacks e⁻ deficient C in C=O group of CH₃CHO to form CH₃CH(OH)(CH₂COCH₃)

23 C

Molecular formula of **X** suggests it is an alcohol. However as it can be oxidised to carboxylic acid **Y**, **X** has to be a primary alcohol.

Condensation reaction between carboxylic \mathbf{Y} and butan-2-ol produces an ester \mathbf{Z} .



24

С

Option 1 is incorrect: As the alkyl chain of fatty acid has the formula $R-C_{15}H_{27}$, it would contain C=C bonds, hence it is unsaturated.

Option 2 is correct: condensation between alcohol and carboxylic acid to form ester.



Simple Fat







26 D

A is incorrect: Amide undergoes reduction with LiA/H_4 to give amine. The O in C=O will be replaced with 2 hydrogen atoms and hence W has 2 more H atoms than lidocaine.

B is incorrect: Lidocaine undergoes base hydrolysis with NaOH(aq) to form an amine and a carboxylate salt as the products present in Y.

C is incorrect: Reagents provided will result in acidic hydrolysis to occur first, before oxidation. The



structure of X is

D is correct: No heating involved, therefore only an acid base reaction has occurred without hydrolysis of the amide bond.



27 D

Cathode reduction:

 $\begin{array}{rcl} \text{Cu}^{2+}(\text{aq})+2\text{e}^{-} & \rightarrow & \text{Cu}(\text{s})\\ \text{Ag}^{+}(\text{aq})+\text{e}^{-} & \rightarrow & \text{Ag}(\text{s})\\ \text{Ni}^{2+}(\text{aq})+2\text{e}^{-} & \rightarrow & \text{Ni}(\text{s}) \end{array}$

Since the same current will flow through all the circuit.

Ratio of amount of Cu : Ag : Ni formed will be 1:2:1 Ratio of mass of Cu : Ag : Ni formed will be

Mass of Cu	Mass of Ag	Mass of	
		Ni	
1 (63.5)	2 (107.9)	1 (58.7)	
63.5	215.8	58.7	
1.08	3.68	1.00	

28 C

From the E° values for the half cells, H_2O_2 will be reduced while I^- will be oxidised.

Therefore the two half equations to be used will be: $I_2(aq) + 2e^- \Rightarrow 2I^-(aq) + 0.54V$

 $H_2O_2(aq) + 2H^+(aq) + 2e^- \rightleftharpoons 2H_2O(I) + 1.77V$

 E° cell = $E^{\circ}_{Red} - E^{\circ}_{Oxi} = +1.77 - (+0.54)$ = + 1.23 V > 0 Overall equation for the reaction $2I^{-} + H_2O_2(aq) + 2H^+(aq) \rightarrow I_2(aq) + 2H_2O(I)$ brown solution

29 C

A is incorrect: Each of the three OH^- ions in $[Cr(H_2O)_3(OH)_3]$ each accepts a proton to form $[Cr(H_2O)_6]^{3+}$. $[Cr(H_2O)_3(OH)_3]$ acts as a Bronsted–-Lowry base (proton acceptor) in reaction 1.

B is incorrect: For both reactions, no ligand exchange reactions are occurring. Reaction 1 involves the protonation of the OH⁻ ions, while reaction 2 involves the deprotonation of three water molecules to from three OH⁻ ions.

C is correct: For reaction 1, $[Cr(H_2O)_3(OH)_3]$ is behaving as a Bronsted–Lowry base by accepting protons. For reaction 2, $[Cr(H_2O)_3(OH)_3]$ is behaving as a Bronsted–Lowry acid by donating protons to form OH⁻ ions.

D is incorrect: For both reactions, no change in oxidation number of chromium (+3).

30 B

Since 2 mol of AgC/ is formed from 1 mol of the compound, there are 2 mol of free CF ions that are not ligands, and the complex ion has one chloride ligand.

So the compound is [Co(H₂O)₅Cl]Cl₂.H₂O