Eunoia Junior College 8873 H1 Chemistry 2021 Paper 1 Suggested Solution

Atom Q has 70 n + p and 10 more n than p. Thus there are 40 n and 30 p \Rightarrow Q is $_{30}$ Zn.

Atom R has 70 n + p and 2 fewer n than Q. Thus there are 38 n and 32 p \Rightarrow R is $_{32}$ Ge.

 $\Rightarrow A$

2 Small jump between 4th and 5th I.E. and large jump between 6th and 7th I.E.

 \Rightarrow *n*s² *n*p⁴ configuration

 \Rightarrow Group 16

 \Rightarrow C

3

$$\mathbf{D} \checkmark: \mathbf{H} \stackrel{\mathbf{N}}{\underset{\mathbf{H}}{\overset{\mathcal{H}}{\overset{\mathcal{H}}$$

 \Rightarrow D

4 Since N is in Group 15 with 5 valence electrons, N gains 3 electrons to give the monatomic nitride anion, N³⁻, with an octet.

For electrical neutrality, the formula of the solid is $(Z^{y+})_3(N^{3-})_y$.

If the solid is ZN_3 , y = 9 which is not possible since Z^{9+} does not exist.

If the solid is Z_3N , y = 1 which is possible for Z^+ cations.

 \Rightarrow B

5 Cyanogen is

:N $\frac{\frac{\sigma}{\pi}}{\frac{\sigma}{\pi}}C^{-\frac{\sigma}{\pi}}C^{\frac{\sigma}{\frac{\sigma}{\pi}}}N$:

- 1 ✓: There are two σ bonds about each C, hence a linear molecule.
- 2 **<:** There are 4 π bonds and 3 σ bonds.
- 3 *****: There are only two lone pairs of electrons, one on each N atom.

⇒B

The Br–C bond in Br–CH₂CH₃ is polar, while the Br–Br bond in Br₂ is non-polar \Rightarrow id-id and pd-pd in CH₃CH₂Br, and id-id in Br₂ [statement 1]

Br₂ (M_r = 159.8) has a larger and more polarisable electron cloud [statement 4] compared to CH₃CH₂Br (M_r = 108.9) ⇒ stronger id-id in Br₂

 $\Rightarrow \mathbf{B}$

- 1 ✓: When pressure is increased, the gas particles are forced closer together and the strength of IMF increases. If the IMF becomes sufficiently strong such that the potential energy overcomes the kinetic energy at room temperature, the gas will liquefy.
 - 2 *: At high pressure, the gas particles are forced closer together and the strength of IMF becomes significant. When the potential energy overcomes the kinetic energy, the gas will liquify.
 - 3 ✓: At low temperature, the kinetic energy of the gas particles is lower. If the kinetic energy becomes sufficiently low, such that the potential energy due to the IMF becomes more significant, the gas will liquify.

 $\Rightarrow \mathbf{B}$

8 The weaker bond is more reactive as it would takes less energy to break the bond, leading to a decrease in the activation energy.

A more polar bond is more reactive as the partial charges will be sites of reactivity, attracting species of the opposite charge, again lowering the activation energy.

 \Rightarrow D

- 9 A *: HCl(aq) is an Arrhenius acid as it produces H⁺(aq) in solution. But CuO is not an Arrhenius base as it is insoluble and does not produce OH⁻(aq).
 - **B ***: The reaction does not take place in aqueous medium, hence does not involve Arrhenius acid and base.
 - C ★: HC*l*(aq) is an Arrhenius acid as it produces H⁺(aq) in solution. But CaCO₃ is not an Arrhenius base as it is insoluble and does not produce OH⁻(aq).
 - D ✓: HCl(aq) is an Arrhenius acid as it produces H⁺(aq) in solution, and KOH(aq) is an Arrhenius base as it produces OH⁻(aq) in solution.

 \Rightarrow D

10 $H_2O(l) \rightleftharpoons H^+(aq) + OH^-(aq)$

 $K_{w} = [H^{+}][OH^{-}]$

 $NH_3(aq) + H_2O(l) \rightleftharpoons NH_4^+(aq) + OH^-(aq)$

$$K_{\rm b} = \frac{\left[\mathsf{OH}^{-}\right]\left[\mathsf{NH}_{4}^{+}\right]}{\left[\mathsf{NH}_{3}\right]}$$

⇒B

- **11** pH of blood decreases \Rightarrow [H⁺] increases
 - 1 ✓: $H_2CO_3 \rightleftharpoons HCO_3^- + H^+$ shifts to the left, causing [H₂CO₃] to ↑, which in turn causes $CO_2 + H_2O \rightleftharpoons H_2CO_3$ to shift left
 - 2 ★: H₂CO₃ ⇒ HCO₃⁻ + H⁺ shifts left, where HCO₃⁻ acts as a Brønsted-Lowry base, reacting with H⁺
 - 3 ★: $H_2CO_3 \rightleftharpoons HCO_3^- + H^+$ shifts left, resulting in the [HCO₃⁻] to ↓

 \Rightarrow C

- **12** A **≭**: I⁻ is a stronger reducing agent than C*t*, hence reducing C*l*₂ to C*t*, itself oxidised to I₂.
 - **B ***: Solubility of Cl₂ and I₂ does not affect the redox reaction.
 - C ✓: Cl₂ is a stronger oxidising agent than I₂, hence oxidising I⁻ to I₂, itself reduced to Ct⁻.

 \Rightarrow C

13

 $2H-X \rightarrow H_2 + X_2$

Thermal decomposition involves cleavage of H-X bond.

- ⇒ Down Group 17, atomic radius ↑es, hence H–X bond length ↑es
- \Rightarrow H–X bond strength \downarrow es

 \Rightarrow Thermal stability \downarrow es

⇒B

- 14 NaCl is neutral in water (pH 7), while Na₂O dissolves in water to give NaOH (pH 14). Element X is sodium metal.
 - A *: Sodium is a metal consisting of cations immersed in a sea of delocalised 3s electrons, hence is a good conductor of electricity.
 - **B ***: Being a metal, sodium exists in a giant metallic lattice.
 - C ✓: The sodium atom readily loses its single 3s electron to form Na⁺, hence a strong reducing agent.
 - D ★: Being a metal, Na₂O is an ionic oxide, consisting of Na⁺ and O^{2−} ions.

 \Rightarrow C

- **15** A *****: There are 24 atoms in each glucose molecule. 1 mole of glucose contains $24 \times 6.02 \times 10^{23}$ atoms.
 - **B x**: There are 6 carbon atoms in each glucose molecule. 1 mole of glucose contains $6 \times 6.02 \times 10^{23}$ carbon atoms.
 - **C *:** There are 12 hydrogen atoms in each glucose molecule. 1 mole of glucose contains $12 \times 6.02 \times 10^{23} =$ 7.224 × 10^{24} hydrogen atoms.
 - **D** \checkmark : One mole of glucose contains 6.02 × 10²³ molecules.

 \Rightarrow D

16 $Cr_2O_7^{2-}$ + 14H⁺ + 6e⁻ \rightarrow 2Cr³⁺ + 7H₂O

Balancing the number of es transferred.

1 *****:
$$6Br^- \rightarrow 3Br_2 + 6e^-$$

2 **√**: **6**Fe²⁺ → **6**Fe³⁺ + 6
$$e^{-}$$

 $3\checkmark:$ $3SO_2 + 6H_2O \rightarrow 3SO_4^{2-} + 12H^+ + 6e^-$

17 $2Na + 2H_2O \rightarrow 2NaOH + H_2$

$$n_{Na} = \frac{4.60}{23.0} = 0.200 \text{ mol}$$

$$n_{H_2} = \frac{1}{2} n_{Na} = 0.100 \text{ mol}$$

$$V_{H_2} = n_{H_2} \times V_m = 0.100 \times 22.7 = 2.27 \text{ dm}^3$$

$$\Rightarrow \mathbf{A}$$

18
$$Q = -mc\Delta T$$

 $= -((200) \times 1.00) \times 4.18 \times (26.6 - 21.5)$ = -4263.6 J

$$n_{Pb^{2+}} = n_{I^-} = \frac{100}{1000} \times 1.0 = 0.100 \text{ mol}$$

Pb²⁺ + 2I⁻ \rightarrow PbI₂

KI is the limiting reagent.

$$n_{\text{Pbl}_2} = \frac{1}{2} n_{\text{T}} = 0.0500 \text{ mol}$$
$$\Delta H_{\text{reaction}} = \frac{Q}{n_{\text{Pbl}_2}} = \frac{-4263.6}{0.0500}$$
$$= -85272 \text{ J mol}^{-1}$$
$$\approx -85.3 \text{ kJ mol}^{-1}$$
$$\Rightarrow \mathbf{A}$$

19

$$XY(g) \to X^{+}(g) + Y^{-}(g)$$
$$\Delta H = -L.E. = |L.E.| \propto \left| \frac{q_{+}q_{-}}{r_{+} + r_{-}} \right|$$

As
$$q_{+}$$
 and q_{-} are the same for NaC*l*, NaBr, KC*l* and KBr, ΔH is most endothermic for the smallest $(r_{+} + r_{-})$.

Down the group, r_{\perp} and r_{\perp} 1 es.

 \Rightarrow $r_{_{Na^+}} < r_{_{K^+}}$ and $r_{_{Cl^-}} < r_{_{Br^-}}$

 \Rightarrow NaCl has the smallest $(r_+ + r_-)$

20 rate =
$$k[H_2][NO]^2$$

$$k = \frac{1}{[H_2][NO]^2}$$
unit of $k = \frac{\text{mol-dm}^3 \text{ s}^{-1}}{(\text{mol-dm}^3)(\text{mol-dm}^{-3})^2}$

$$= \text{mol}^{-2} \text{ dm}^6 \text{ s}^{-1}$$

$$\Rightarrow \mathbf{C}$$

21 Using expt 1 and 2, when $[O_2]$ \uparrow by 2.5×, initial rate \uparrow by 2.5× hence reaction is first order w.r.t. O2 Using expt 2 and 3, when [NO] \uparrow by 2× and [O₂] \uparrow by 3×, initial rate ↑ by 12x so when [NO] \uparrow by 2x, initial rate \uparrow by 4x

hence reaction is second order w.r.t. NO

rate = $k[NO]^2[O_2]$

using expt 2 and 4, when [NO] is halved and [O2] is halved, initial rate will be $\left(\frac{1}{2}\right)^2 \times \frac{1}{2} = \frac{1}{8}$ times that in expt 2.

22 0.400
$$\xrightarrow{t_1} 0.200 \xrightarrow{t_1} 0.100 \xrightarrow{t_1} 0.050$$

since 2 $t_{\frac{1}{2}} = 600$ s, $t_{\frac{1}{2}} = 300$ s
total time = 3 $t_{\frac{1}{2}} = 900$ s
⇒ C

23 Since pepsin catalyses the hydrolysis of the amide bond in X, i.e. the rate of hydrolysis increases with pepsin, the rate constant is larger when pepsin is present.

Since pepsin only catalyses the hydrolysis of the amide bond in X but not in Y, pepsin has specific activity.

⇒А

24
$$N_2O_4(g) \rightleftharpoons 2NO_2(g)$$

initial amt/mol 2.0 0
change in amt/mol -1.0 +2.0
eqm amt/mol 1.0 2.0
$$(NO_2)^2 \quad \left(\frac{2.0}{1.0}\right)^2$$

$$K_{c} = \frac{[NO_{2}]^{2}}{[N_{2}O_{4}]} = \frac{(\overline{1.0})}{\frac{1.0}{1.0}} = 4.0 \text{ mol } dm^{-3}$$

$$\Rightarrow$$
 D

25 For a system in dynamic equilibrium, the rates of the forward and reverse reactions are the same, but non-zero. Hence there is no net change in the concentrations of the reactants and products.



28 Substitution of H by Cl occurs:

$$H H$$

$$H - C - C - H M_r = 30$$

$$H H$$

$$H - C I$$

$$H - C - H M_r = 64$$

$$H H$$

$$H - C - C - H M_r = 64$$

$$H H$$

$$H - C - C - H M_r = 98$$

$$H H$$

$$H = 0$$



30 Compound Y reacts with compound Z to give ester, CH₃CH₂CO₂CH₂CH₂CH₃.

Since Y is the reduced form of X, while Z is the oxidised form of X,

Y must the alcohol, CH₃CH₂CH₂OH, while

Z must be the acid, CH₃CH₂CO₂H

Hence, X is the aldehyde, CH₃CH₂CHO

 \Rightarrow D

Answer Key

Qn Ans С

11 12

13

14 15

16

17

18

19

20

С

В С

D

D

А

А

А

С

Qn	Ans	
1	А	
2	С	
3	D	
4	В	
5	В	
6	В	
7	А	
8	D	
9	D	
10	В	

Qn	Ans
21	В
22	С
23	А
24	D
25	А
26	А
27	В
28	В
29	С
30	D