Answer Keys to 2019 SH2 H2 Chemistry Prelim MCQ

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

1 Amount of Ag deposited = $\frac{0.216}{107.9}$ = 0.002002 mol

Amount of Ag per cm^2 = $\frac{0.002002}{150}$ = 0.00001335 mol per cm^2

No of Ag atom per cm^2 = $0.00001335 \times 6.02 \times 10^{23} = 8.034 \times 10^{18}$ atom per cm^2

Ans: **A**

2 Angle of deflection $\propto \frac{\text{charge}}{\text{mass}}$

Mass of electron is approximately $\frac{1}{2000}$ the mass of a proton, hence electron has the largest angle of deflection.

Ans: **A**

3 Amount of SO_3^{2-} = $\frac{25.0}{1000} \times 0.10 = 0.0025$ mol
Amount of electron transferred = $0.0025 \times 2 = 0.005$ mol
Amount of M^{3+} reacted = $\frac{50.0}{1000} \times 0.10 = 0.005$ mol
Mol ratio $M^{3+} : e^- = 1 : 1$

During **reduction**, 1 mol of M^{3+} gains 1 mol of e^-.
Oxidation state of M^{3+} **decreases by 1 unit** from **+3** to **+2**.

Ans: **B**

4 The sharp rise between 2nd and 3rd I.E. shows that there are 2 valence electron in the outermost shell. Hence it is in Group 2.

The next inner quantum shell contains 8 electrons, for d-block element, the next inner quantum shell should contain 3s, 3p and 3d electrons, which would be more than 8.

It cannot be a Period 3 Group 2 element as Mg only has 12 electrons.

Ans: **C**

5 The species are isoelectronic (same number of electrons) with same shielding effect.
Nuclear charge increases from Ar < K^+ < Ca^{2+}
Hence nuclear attraction towards valence electrons increases from Ar < K^+ < Ca^{2+}.

Ca^{2+} would have the smaller radius while Ar has the largest radius.

Ans: **C**

6 Bond angle 1 is 109.5° (4b.p. 0l.p. → tetrahedral)

Bond angle 2 is 120° (3b.p. 0l.p. → trigonal planar)

Bond angle 3 is 104.5° (2b.p. 2l.p. → bent)

Ans: **C**

7 $p_1V_1 = nRT_1$
$p_2V_2 = nRT_2$

$$\frac{p_1V_1}{p_2V_2} = \frac{T_1}{T_2}$$

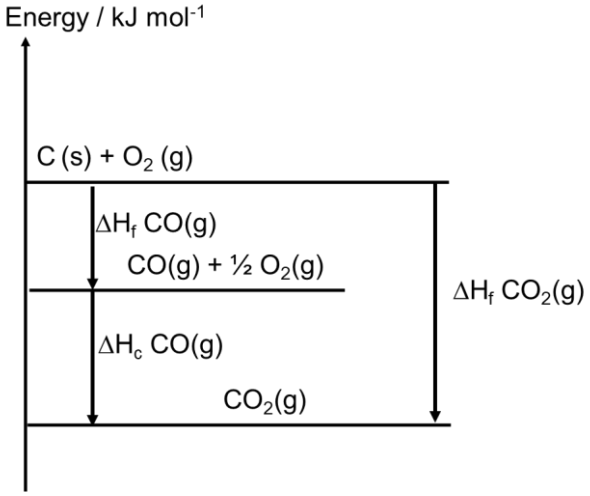
$$\frac{(1\times10^5)\times V_1}{p_2\times 4V_1} = \frac{(20+273)}{(100+273)}$$

p_2 = 31830 Pa

Ans: **A**

8 $CO(g) + ½ O_2(g) \rightarrow CO_2(g)$

Combustion is an exothermic process, this means that energy level of CO_2 is lower than CO. Hence option 1 is correct.

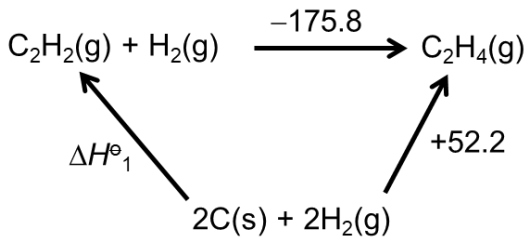


Option 2 is wrong. $\Delta H_f\ CO_2(g)$ should be more negative than that of CO(g).

Since the combustion spontaneous (burns readily), the K_c for the equilibrium would be a very large value.

Ans: **C**

9



$\Delta H^{\ominus}_1 = 52.2 + 175.8 = +228\ kJ\ mol^{-1}$

Ans: **D**

10 Option A is wrong. Increase in temperature would increase the kinetic energy.

Option B is wrong. Catalyst increases the frequency of **effective** collision.

Option D is a correct statement but does not explain "how" fumarase speed up the reaction.

Option C is correct. Fumarase is an enzyme that provides alternative reaction pathway with lower activation energy.

Ans: **C**

11 Rate of reaction = $\frac{change\ in\ vol\ of\ MnO_4^-}{time\ taken}$

Expt	Volume / cm^3				Time / s	rate
	$C_2O_4^{2-}$(aq)	MnO_4^-(aq)	Mn^{2+}(aq)	water		
1	20	30	5	25	30	1
2	20	30	10	20	15	2
3	20	15	10	35	15	1
4	20	20	20	20	10	2

Comparing expt 1 & 2, $[C_2O_4^{2-}]$ and $[MnO_4^-]$ is kept constant but when $[Mn^{2+}] \times 2$, rate × 2. Hence it is first order w.r.t. Mn^{2+}. Option 1 is correct.

Comparing expt 2 & 3, $[C_2O_4^{2-}]$ and $[Mn^{2+}]$ is kept constant but when $[MnO_4^-] \div 2$, rate ÷ 2. Hence it is first order w.r.t. MnO_4^-.

We cannot determine the order of reaction w.r.t. $C_2O_4^{2-}$.

Rate = $k[Mn^{2+}]\ [MnO_4^-]\ [C_2O_4^{2-}]^x$

The slow step would involve one Mn^{2+} and one MnO_4^- ion and **<u>maybe</u>** $C_2O_4^{2-}$ ion. Option 2 is correct.

We cannot deduce the order of reaction w.r.t. $C_2O_4^{2-}$ and hence we cannot conclude the units of the rate constant.

Ans: **B**

12 Lewis base is an electron pair donor.

In reaction 1 and 2, NH_3 donates electron pair to H^+.

In reaction 3, NH_3 donates electron pair to Ag^+.

Ans: **D**

13 $CuS\ (s) \rightleftharpoons Cu^{2+}\ (aq) + S^{2-}\ (aq)$
s s

$K_{sp} = s^2$
$s = \sqrt{(8.5 \times 10^{-45})}$
$= 9.22 \times 10^{-23}$ mol dm^{-3}

$Ag_2S\ (s) \rightleftharpoons 2Ag^{+}\ (aq) + S^{2-}\ (aq)$
2s s

$K_{sp} = (2s)^2(s)$
$4s^3 = 1.6 \times 10^{-49}$
$s = 3.42 \times 10^{-17}$ mol dm^{-3}

$Bi_2S_3\ (s) \rightleftharpoons 2Bi^{3+}\ (aq) + 3S^{2-}\ (aq)$
2s 3s
$K_{sp} = (2s)^2(3s)^3$
$108s^5 = 1.1 \times 10^{-73}$
$s = 1.00 \times 10^{-15}$ mol dm^{-3}

Ans: **B**

14 At cathode (−ve electrode):
Species present: Na^+ and H_2O
[R] $2H_2O + 2e^- \rightarrow H_2 + 2OH^-$
Blue litmus remains blue

At anode (+ve electrode):
Species present: Cl^- (concentrated) and H_2O
Note: Concentrated Cl^- will be oxidized in preference over H_2O.
[O] $2Cl^- \rightarrow Cl_2 + 2e^-$
Chlorine bleaches the litmus paper.

Ans: **C**

15 Statement A is correct. $SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

Statement B is correct. Al_2O_3 is amphoteric oxide that can react with both acid and base to give soluble products.

Statement C is correct.
$Na_2O + H_2O \rightarrow 2NaOH$
$SO_3 + H_2O \rightarrow H_2SO_4$
$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$

Statement D is wrong. Acidity of Period 3 chlorides in water **increase** from $NaCl$ to PCl_5. pH of the resultant solution decreases from pH 7 to pH 1.

Ans: **D**

16 $M(NO_3)_2(s) \rightarrow MO(s) + 2NO_2(g) + ½\ O_2(g)$

Mass loss is due to NO_2 and O_2.
We can assume 3.29 g of $N_2O_5(g)$ is loss.

$M(NO_3)_2(s) \rightarrow MO(s) + N_2O_5(g)$
Amount of $N_2O_5 = \frac{3.29}{14.0\times2+16.0\times5}$ = 0.03046 mol

Amount of $M(NO_3)_2$ = 0.03046 mol

M_r of $M(NO_3)_2 = \frac{5.00}{0.03046}$ = 164.1

A_r of M = 164.1 – 2×(14.0+16.0×3) = 40.1
M is calcium.

Ans: **B**

17 Statement A is wrong. Ag^+ is reduced.

Statement B is correct. Cu^+ is used up in reaction 2 and regenerated in reaction 3.

Statement C is wrong. Cu^+ acts as a reducing agent in reaction 2.

Statement D is wrong. The depth of colour should be related to concentration of Ag(s).

Ans: **B**

18 Oxides of nitrogen can contribute to

- formation of smog through reaction with other air pollutants. PAN is a major component of smog which is harmful to plants and humans.

  Hydrocarbons + O_2 + NO_2 + light $\rightarrow$ peroxyacetyl nitrate (PAN)

- formation of ozone at lower atmosphere. **High concentration of ozone at lower atmosphere causes respiratory problems.**

  $NO_2 \rightarrow NO + O$
  $O + O_2 \rightarrow O_3$

- NO_2 **acts as a catalyst for the oxidation** of SO_2 to SO_3, $SO_2 + ½\ O_2 \rightarrow SO_3$

  $NO_2 + SO_2 \rightarrow SO_3 + NO$
  $NO + ½\ O_2 \rightarrow NO_2$ (regenerated)
  SO_3 dissolves in rainwater to cause acid rain (H_2SO_4).

Ans: **D**

19 Option 1 is correct. The molecule contains a secondary alcohol group.

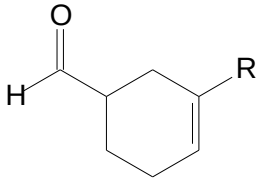
Option 2 is wrong. The C=C bond consists of one σ and one π bond.

Option 3 is wrong. Most of the C atoms are sp^3 hybridized with tetrahedral geometry. This shows that the C atoms are not in the same plane.

Ans: **D**

20 The C=C bond between C11 and C12 is in a cis arrangement.

Considering the following structure with aldehyde and cyclohexene ring,



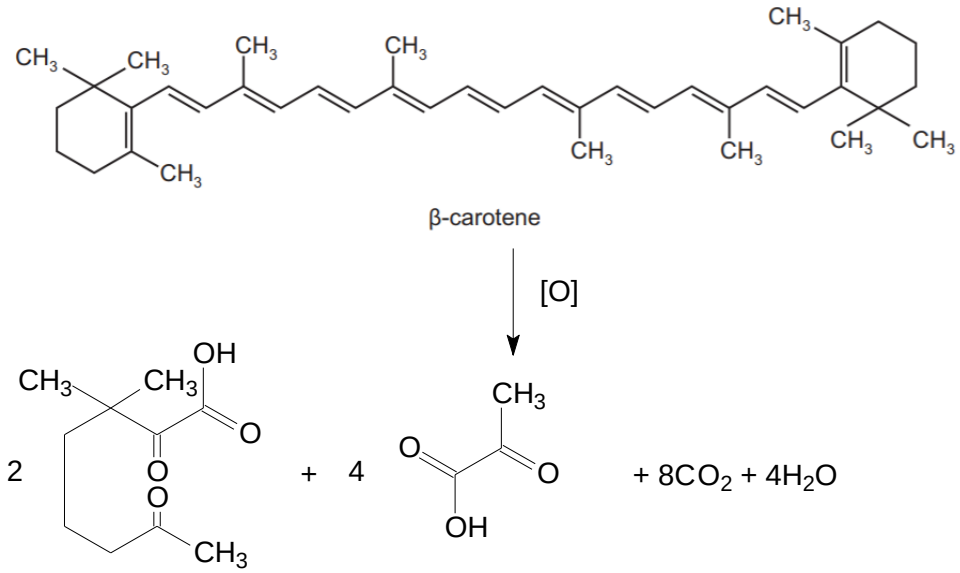
The long aliphatic side chain has a formula of $C_{13}H_{19}$.

When drawing out, there will need to have 4 C=C in the long aliphatic side chain.

Total number of C=C in the molecule = 5

Ans: **A**

21

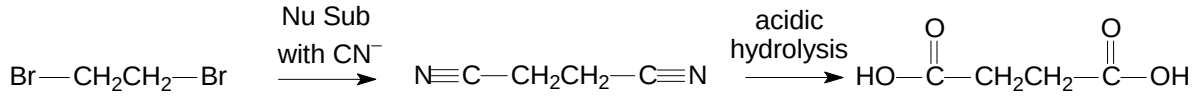


Ans: **B**

22 The example shows that CN^- can undergo nucleophilic substitution with C−Br at a faster rate than I^-. Option C is the best explanation.

Ans: **C**

23



Ans: **C**

24 Reaction A can occur at room temperature.

Reaction B requires heating with ethanolic KCN for nucleophilic substitution.

Reaction C requires heating with concentrated H_2SO_4 for elimination.

Reaction D requires heating for hydrolysis.

Ans: **A**

25 Ethanol, C_2H_5OH (M_r = 46.0), reacts with hot acidified $KMnO_4$ to gives ethanoic acid, CH_3COOH (M_r = 60.0).

Amount of ethanol = $\frac{2.76}{46.0}$ = 0.06 mol
Theoretical yield of ethanoic acid = 0.06 × 60.0 = 3.6 g
Mass of 75% yield of ethanoic acid = 0.75 × 3.6 = 2.7 g

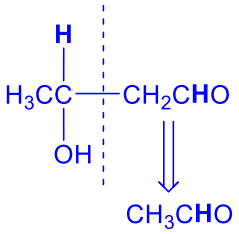
Ans: **C**

26 Compound N

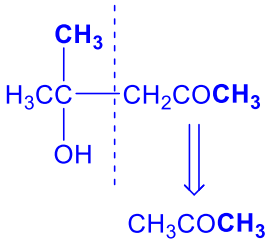
- does not contain carboxylic acid/phenol/amine
- contains a carbonyl group that undergoes condensation reaction with 2,4−DNPH
- contains an alcohol or carboxylic acid group that undergoes substitution with PCl_5

Ans: **C**

27 From the question, the following pattern is observed:



Replacing the bold –H with –CH_3 and working backwards,



Ans: **A**

28 Statement 1 is wrong. There is no chiral carbon in the compound.

Statement 2 is correct. There are two carboxylic functional group.

Statement 3 is correct. Tertiary alcohol group can react with carboxylic acid to form ester. Carboxylic acid groups can react with alcohol to form ester.

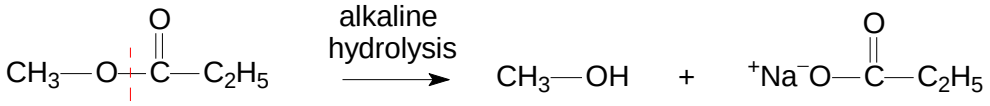
Ans: **C**

29

	L	**M**
Acidified $AgNO_3(aq)$	No ppt	No ppt
Acidified $KMnO_4(aq)$	Purple $KMnO_4$ turns colourless	Purple $KMnO_4$ turns colourless
Na(s)	Effervescence of $H_2(g)$	Effervescence of $H_2(g)$
$Na_2CO_3(aq)$	Effervescence of $CO_2(g)$	No effervescence of $CO_2(g)$

Ans: **D**

30



Ans: **C**