A: 7 B: 9
C: 8 D: 6

2017 JC2 Prelim H2 CHEMISTRY MCQ Worked Solution

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

1 Answer: B

Since $Ba(NO_3)_2 \equiv N_2$, M_r of $Ba(NO_3)_2$ = 261.3
No. of moles of N_2 = No. of moles of $Ba(NO_3)_2$
$= \frac{1}{261.3} = 3.83 \times 10^{-3}$ mol
Volume of $N_2 = 3.83 \times 10^{-3} \times 24000 = 91.8\ cm^3$

2 Answer: D

Definition – Relative molecular mass is the average mass of one molecule of an element or compound on a scale on which one atom of the ^{12}C isotope of carbon has a mass of 12 units.

Option **1** is incorrect. Relative molecular mass is a ratio.
Option **2** is incorrect. It should be the ratio of the average mass of a molecule to 1/12 the mass of a ^{12}C atom.
Option **3** is correct.

3 Answer: C

A is incorrect as SO_2 is an oxidizing agent and oxidises H_2S in reaction.
B is incorrect as SO_2 is the intermediate and is not regenerated in the reaction.
C is correct as H_2S (oxidation state of sulfur is -2) is oxidized to S (oxidation state 0).
D is incorrect as reaction II is a comproportionation reaction.

4 Answer: A

Angle of deflection $\theta \propto q/m$. So $\theta_{Ca} m_{Ca}/q_{Ca} = \theta_X m_X/q_X$
Mass of X = 20(40.1)/2 / 5.08 = 79 (Se)
Atomic number of **X** = 34

5 Answer: D

A: Ethene is a planar molecule which has all atoms on the plane

B: Tri-iodide has 3 lone pairs and 2 bond pairs, hence the ion is linear and all atoms lie on the same plane

C: XeF_4 has 4 bond pairs and 2 lone pairs, hence shape is square planar and all atoms lie on the same plane

D: $BeCl_4^{2-}$ has a total of 4 bond pairs (2 covalent bonds and 2 dative bonds) around Be atom. The shape is tetrahedral.

6 Answer: B

A: HF has hydrogen bonding between its molecules and hence require a larger energy to overcome compared to pd-pd between HI molecules.

B: MgO has a higher boiling point. MgO has a higher lattice energy than NaCl due to larger charge and smaller ionic radii of Mg^{2+} and O^{2-} ion compared to Na^+ and Cl^-.

C: SiH_4 has a higher boiling point as its M_r is larger than CH_4 and thus the id-id interactions are stronger and more extensive than CH_4.

D: *trans*-$C_2H_2Cl_2$ has a lower boiling point as it has no net dipole moment so the molecule is non-polar and only has id-id interactions between the molecules. *cis*-$C_2H_2Cl_2$ has pd-pd interaction between the molecules and more energy is needed to overcome the stronger pd-pd interactions.

7 Answer: A

PV = nRT
At r.t.p,
$R = PV/nT = (1\ atm \times 24000\ cm^3)/(1\ mol \times 293K)$

$M_r = mRT / PV = (m \times T \times 24000) / (p \times V \times 293)$

8 Answer: D

A & C: Wrong as the concentration of manganate would decrease slowly at the start of the reaction before decreasing more quickly as more Mn^{2+} catalyst is generated.

B: Wrong as the volume of CO_2 cannot be increasing rapidly at the start of the reaction due to slow rate of reaction.

9 Answer: B

A: HBr will complete dissociate to give free H^+ ions and Br^- ions. Since there is a change in the number of ions as the reaction progresses, so conductivity of the solution increases over time and can be monitored using a conductivity meter.

B: Although CO_2 gas is produced, the reaction is done at atmospheric pressure and not in a closed system, so pressure of the system will not change over time.

C: $Br_2(aq)$ is reddish-brown and all the products are colourless, so the intensity of the solution would decolourise over time.

D: As the reaction progresses, more HBr (a strong acid) is produced, so concentration of H^+ would increase over time and can be monitoring by quenching and titration against standard NaOH.

10 Answer: B

No. of moles of bromine = 32/(79.9 x 2) = 0.200 mol

When bromine vapourises, ΔG = 0 since it is an equilibrium reaction.

$\Delta H = T\Delta S$

$\Delta S = \Delta H/T = (30.9 \times 10^3 \times 0.2)/(58.8 + 273)$

$= 18.6\ J\ K^{-1}$

11 Answer : D

Heat released when **E** is burnt = 200 x 4.18 x 26.4

= 22070 J

No. of moles of **E** = 22076 ÷ (3290 x 10^3)

= 0.00671 mol

M_r of **E** = 0.47/0.00671

= 70 (C_5H_{10})

Option 1 is incorrect as it is short of a CH_2. Options 2 & 3 are isomers of C_5H_{10}.

12 Answer : C

From reaction I,

$K_c = \frac{[X_2Y]}{[X_2][Y_2]^{\frac{1}{2}}} = 2$

For reaction II,

$K_c' = \frac{[X_2]^2[Y_2]}{[X_2Y]^2} = \frac{1}{K_c^2} = \frac{1}{4}$

13 Answer : D

A:	P	+	Q	$\rightleftharpoons$	R	+	3S
Initial amt/mol	-		0.5		0		-
Change in amt/mol	-		-0.1		+0.1		-
Eqm amt/mol	-		0.4		0.1		-

$K_c = \frac{[R]}{[Q]} = \frac{0.1}{0.4} = 0.25$.

B: When temperature increases, the forward reaction is favoured by Le Chatelier's Principle to absorb heat. At equilibrium, there will be greater no. of moles of R and lesser no. of moles of S. Thus, K_p increases.

C: There is equal number of moles of gas on both sides of the equation. Increasing pressure will not affect equilibrium.

D: **P** is a solid and is not included in the equilibrium constant. Changing its concentration will not affect the equilibrium.

14 Answer: A

Buffers are formed when roughly equal amount of the conjugate acid-base pair is present.

A is not a buffer as the resultant mixture only contains $CH_3CH_2CO_2H$ from the reaction between HCl and $CH_3CH_2CO_2^-$.
B is buffer as it contains HCO_3^- and CO_3^{2-}.
C is a buffer as $CH_3CH_2NH_2$ is in excess and $CH_3CH_2NH_3^+$ is formed from the reaction between $CH_3CH_2NH_2$.
D is a buffer as NH_4^+ is in excess and NH_3 is formed from the reaction between NH_4^+ and NaOH.

15 Answer: C

A & B: During rusting, oxygen is being reduced to hydroxide ions and iron being oxidised to iron(II) ions.

C: $O_2 + 4H^+ + 4e^- \rightleftharpoons 2H_2O$ +1.23 V

$E^{\ominus}_{cell}$ = +1.23 – (-0.44) = +1.67 V

Since $E^{\ominus}_{cell} > 0$, the reaction is spontaneous. Hence, it is not inhibited a low pH.

D: $E^{\ominus}_{Fe2+/Fe}$ = - 0.44 V $E^{\ominus}_{Mg2+/Mg}$ = -2.38 V

Since $E^{\ominus}_{Mg2+/Mg}$ is more negative than $E^{\ominus}_{Fe2+/Fe}$, magnesium will be oxidised instead of iron. Hence, magnesium acts as a sacrificial metal and prevents corrosion.

16 Answer: A

1: $E^{\ominus}_{Cu2+/Cu}$ = +0.34 V $E^{\ominus}_{Mg2+/Mg}$ = -2.38 V
$E^{\ominus}_{Ag+/Ag}$ = +0.80 V

At the anode, copper is preferentially oxidised over water to form copper(II) ions. As $E^{\theta}(Mg^{2+}/Mg)$ is more negative than $E^{\theta}(Cu^{2+}/Cu)$, magnesium will also be preferentially oxidised.

Ag will not be oxidised as $E^{\theta}(Ag^{+}/Ag)$ is more positive than $E^{\theta}(Cu^{2+}/Cu)$. Ag will be collected below the anode as 'anode sludge'.

The decreased in mass at the anode is due to oxidation of copper and magnesium. Silver is not being oxidised but is collected as anode sludge.

2: At the cathode, only copper(II) ions were reduced to copper. As $E^{\theta}(Mg^{2+}/Mg)$ is more negative than $E^{\theta}(Cu^{2+}/Cu)$, magnesium will not be preferentially reduced together with copper.

3: The amount of copper deposited is dependent on the magnitude of the current and time in which the current was supplied. It is not affected by the size of the electrode.

17 Answer: C

A The covalent character increase across the period.
B The melting point increase then decrease across the period.
C The pH change from basic to neutral to acidic across the period.
D Only Al_2O_3, P_4O_{10} and SO_3 are soluble in NaOH, so there is actually no trend.

18 Answer: A

The charge density decreases with increasing atomic no., hence the tendency to form complexes, acidity of the aqueous chloride solution (because ease of hydrolysis decreases) and magnitude of hydration energy decreases

The reduction potential becomes more negative with increasing atomic no., hence the metal's reducing power increases.

19 Answer: B

Since X^- can react with both Y_2 and Z_2 in the process forming X_2, it is the strongest reducing agent.

Since Y^- cannot react with both X_2 and Z_2 to form Y_2, it is the weakest reducing agent.

20 Answer: C

A is incorrect. For the complex to be red it must have absorbed blue light (complementary colour).

B is incorrect. $[FeF_6]^{3-}$(aq) is colourless when edta^{4-} is added. $[Fe(edta)]^{-}$(aq) is formed and solution will turn yellow. *(Charge on edta is 4-).*

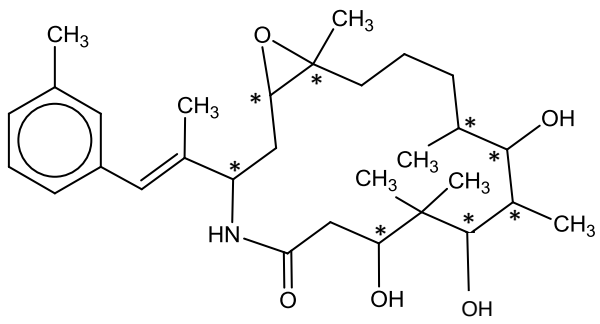
C is correct. $[Fe(CN)_6]^{3-}$(aq) has a greater K_{stab} hence is more likely to be formed thus SCN^- and H_2O ligands will be displaced. The solution will turn orange yellow.

$E^{\theta}_{Cl_2/Cl^-} = +1.36V$
$E^{\theta}_{Fe^{3+}/Fe^{2+}} = +0.77V$
D is incorrect. Cl_2 will oxidise Fe^{2+} to Fe^{3+} turning the solution yellow. Upon addition of F^- the solution will turn colourless as $[FeF_6]^{3-}$(aq) has a greater K_{stab}.

21 Answer: B

A: a σ bond formed by $sp^2 – sp^2$ overlap between C3 and C4
C: a σ bond formed by $sp – sp^2$ overlap between C5 and C6
D: a π bond formed by p – p overlap between C2 and C3

22 Answer: C



Since there are 8 chiral centers and 1 C=C that can exhibit cis-trans isomerism, no. of stereoisomers = 2^9.

23 Answer: D

1. Tertiary halogenoalkane undergoes S_N1 reaction with aqueous KOH. Formation of carbocation that is planar about the positively charged carbon. The nucleophile OH^- can attack the positively charged C from top and bottom with equal probability resulting in a racemic mixture that is optically not active.
2. Elimination of HBr results in alkenes that are optically not active.
3.Electrophilic addition of HBr to alkene results in formation of intermediate carbocation that will give racemic products.
4.The nucleophile CN^- attacks the planar carbonyl carbon in butanone from top and bottom with equal probability forming a racemic mixture.

24 Answer: B

$CH_3–C\equiv C–H$ will give CH_3COCH_3

25 Answer: B

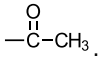
A: Alkylation followed by nitration will place the alkyl and nitro gps at 1,2 or 1,4 positions. Thus the $–CO_2H$ gp and $–NH_2$ will not be at 1,3 position.
C: The last chlorination step results in –Cl at position 2 or 4 from $–NH_2$ gp.
D: Chlorination followed by nitration results in nitro gp placed at positions 2 or 4 from –Cl gp.

26 Answer: A

2 –OH groups in 1 mol of EMB react with Na to give 1 mol of H_2 gas.

2 R-OH + 2Na → 2 $RO^-Na^+ + H_2$

27 Answer: A

Positive test with tri-iodomethane test means  or  .

The H-atoms in the $-CH_3$ group in the methyl alcohol and methyl ketone group when replaced by iodine atoms, are still tri-iodomethane test positive.

28 Answer: B

Compound **Y** has 2 C=C, 1 COOH and 1 ketone functional group. Every functional group in Compound **Y** that gets reduced would have 2 H atoms incorporated per molecule of Compound **Y**.

	Reducing agent	No. of hydrogen atoms incorporated per molecule of Compound **Y**	Functional group reduced
1	H_2 / Ni	6	2C=C + 1 ketone
2	LiA/H_4 in dry ether	**4**	1 ketone and 1 –COOH group
3	$NaBH_4$ in ethanol	2	1 ketone group

29 Answer: C

Option A: Orange dichromate turns green for methyl methacrylate as ester bond cleave and the primary alcohol part of the ester gets oxidised. Orange dichromate remains orange for benzophenone.

Option B: orange ppt formed for benzophenone and no orange ppt formed for methyl methacrylate.

Option C: Tollen's reagent is negative for both compounds as both compounds do not have an aldehyde functional group.

Option D: reddish-brown bromine water decolourise for methyl methacrylate due to C=C. Reddish brown bromine remain for benzophenone.

30 Answer: C

Reaction 1 – conversion of alcohol to halogenoalkane: nucleophilic substitution