2021 TJC JC2 H2 Chemistry
Prelim MCQ Worked Solutions

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

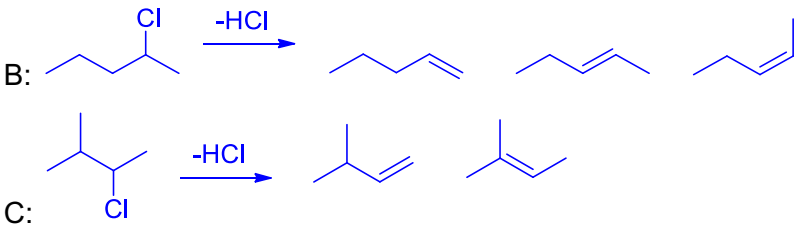
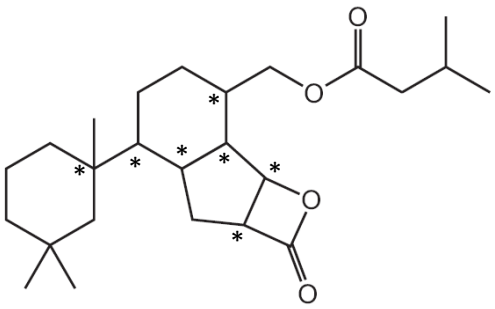
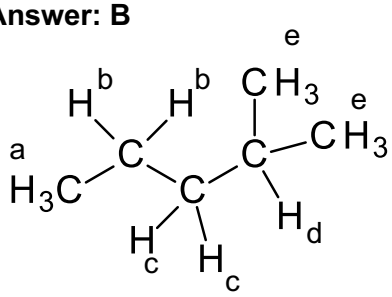
Qn	Worked Solution
1.	**Answer: D** M_r of E_2 = $(1.18 \times 10^{-22}) \times (6.02 \times 10^{23})$ = 71.0 M_r $C_2H_4E_2$ = 99.0 Amount of $C_2H_4E_2$ in 49.5 g = (49.5/99.0) = 0.500 mol No. of E atoms in 49.5 g of $C_2H_4E_2$ = $2 \times 0.5 \times 6.02 \times 10^{23} = 6.02 \times 10^{23}$
2.	**Answer: C** $^{223}_{88}Ra \longrightarrow {}^{219}_{86}\mathbf{Q} + {}^{4}_{2}He$ Number of neutrons in Q = 219 – 86 = 133
3.	**Answer: A** The long hydrophobic carbon chains on lecithin can form id-id with non-polar molecules. The bond angle with respect to C for –COO group is 120°. It contains delocalized electrons due to the pi bonds.
4.	**Answer: D** Of the seventeenth carbon atoms in the ring, two are sp^2 hybridized while fifteen are sp^3 hybridised. Because these carbon atoms are bonded in a ring, the atoms can't be lying on the same plane (sp^3 hybridization requires electron pairs to be arranged in a tetrahedral configuration). The C=C double bond is found in a ring, For the molecule to exhibit cis-trans isomerism at this double bond requires the ring to be twisted and bond will be broken. So cis-trans isomerism for a C=C double bond found in a ring is not possible. Cholesterol has a secondary alcohol which is non-acidic.
5.	**Answer: A** For gas at stp, PV = nRT

	$1x10^5$ x 22700 = 1 x R x 273 R = $\frac{10^5 \times 22700}{273}$ pV = nRT, pV = (mass/M)RT Density = mass/V = pM / RT = $\frac{p \times M \times 273}{T \times 10^5 \times 22700}$
6.	**Answer: C** pV = nRT Since V and n are constant, p $\propto$ T and pV $\propto$ T (not constant), thus Graph 2 is correct and Graph 1 is incorrect. PV = nRT, concentration = n/V, c = P/R (1/T). Since pressure is constant, c $\propto$ 1/T
7.	**Answer: D** In cold/limited amount of water (or when PCl_5 : H_2O = 1 : 1): $PCl_5(s)$ + $H_2O(l)$ → $POCl_3(l)$ + 2HCl(g) Colourless liquid White fumes
8.	**Answer: B** Since both **X** and **Y** form oxides that react with aqueous sodium hydroxide, they cannot be SiO_2 (which only react with molten NaOH at high temperature). Oxide of **X** is likely to be SO_2 where S has an oxidation state of +4.
9.	**Answer: C** Iodide ions are better reducing agents since S in SO_4^{2-}(+6) is reduced to SO_2(+4), S(0) and H_2S(–2).
10.	**Answer: D** Keeping pressure constant, when temp increases % of N_2 increases ⇒ position of equilibrium shifts left to absorb heat. Backward reaction is endothermic, hence forward reaction is exothermic. Keeping temperature constant, there is an increase in % N_2 when pressure changes from P_2 to P_1. Since equilibrium position shifts left where more gaseous molecules are produced, $P_1 < P_2$.
11.	**Answer: A** Statement 1: HC*l*O is a bronsted acid as it donates a proton. Hence the **product formed (C*l*O- ion) is a conjugate base.** Statement 2: $N_2H_5^+$ is the Bronsted acid in **Reaction 2 as it donates a proton**. Statement 3: Since the POE lies to the right for both reactions, HC*l*O is a stronger acid than $N_2H_5^+$ from Reaction 1 as it prefers to donate a proton. Likewise for Reaction 2 where $N_2H_5^+$ is a stronger acid than NH_4^+. Statement 4: N_2H_4 is the Lewis base in **Reaction 1** as it donates a lone pair of electrons for dative bonding to a proton from HC*l*O.
12.	**Answer: C** Both options A & B have excess sodium hydroxide and HC*l* respectively after mixing.

	Option C forms phenylamine and unreacted phenylammonium chloride after mixing which is an alkaline buffer. Option D forms CH_3CO_2H and unreacted HCl.
13.	**Answer: D** Enthalpy change of solution = -457 – 390 + 918 kJ mol^{-1} = +71.0 kJ mol^{-1} Amount of NaF = 8.4/42 mol = 0.200 mol Heat absorbed by 0.200 mol NaF = 14.2 kJ 14.2 x 1000 = mcΔT 14.2 x 1000 = 250 x 4.2 x ($T_{initial}$ – 20) $T_{initial}$ = 33.52 ^oC
14.	**Answer: C** $\Delta H_{reaction}$ = 2(-243) – 2(-20.5) kJ mol^{-1} = -445 kJ mol^{-1} As T increases, position of equilibrium shifts left, decreasing yield of sulfur(s).
15.	**Answer: B** Consider a pseudo 1st order reaction: rate = $k[A]^1[B]^b$, where B is in excess. So rate = $k'[A]^1$, where $k' = k[B]^b$ Hence, k' depends on temperature (which affect k), conc of B (excess reactant) and presence of catalyst (which affects activation energy).
16.	**Answer: D** Total volume is constant, so vol is proportional to conc of reactants. Relative initial rate of reaction is proportional to (vol of T / time). Hence, Comparing experiment 1 and 2, when [S] is halved, initial rate is halved too → order wrt [S] = 1 Comparing experiment 1 and 4, when [T] is halved, initial rate is remains constant → order wrt [T] = 0 Comparing experiment 1 and 3, when [U] is halved, initial rate is halved too → order wrt [U] = 1

Experiment	Volume of S / cm^3	Volume of T / cm^3	Volume of U / cm^3	Initial rate
1	10	5	5	0.250
2	5	5	5	0.125
3	10	5	2.5	0.125
4	10	2.5	5	0.250

17.	**Answer: D** Option 1: wrong as there are 4 bond pairs around B atom and should be tetrahedral shape (sp^3 hybridised).

	Option 2: Each boron uses two electrons in bonding to the terminal hydrogen atoms and has one valence electron remaining for additional bonding. The bridging hydrogen atoms provide one electron each. Option 3: Due to 3-center 2-electron bonds, the B-H bond in the ring is a "half-bond" and thus is weaker than the terminal B-H bonds.
18.	**Answer: C** A & D: achiral, so does not exist as enantiomers. 
19.	**Answer: C** 
20.	**Answer: B**  There are 5 different types of hydrogen for substitution.
21.	**Answer: B** A: Acidified potassium manganate would oxidise the alkene. The ester would be hydrolysed too. Ethanedioic acid is produced which can be further oxidised to form carbon dioxide. B: Carboxylic acid needs to be converted to a more reactive acyl chloride. C: X can undergo neutralisation with the carboxylic acid group under room conditions. When heated, the ester group would be hydrolysed. D: Na metal reacts with both the carboxylic acid and alcohol groups to produce 2 moles of hydrogen gas.
22.	**Answer: C** P contains either alcohol or carboxylic acid since it gives white fumes with PCl_5.

	A is incorrect as tertiary alcohols cannot be oxidised. B is incorrect as ketones cannot be oxidised. D is incorrect as side chain oxidation of benzene ring requires acidified potassium manganate(VII) instead.
23.	**Answer: B** Statement 2 is incorrect as LiAlH_4 would also reduce the ester group. Hydrogen with platinum catalyst can be used instead to only reduce the nitrile. Statement 3 is incorrect as W reacts with excess bromoethane to form $RN^+(CH_2CH_3)_3$ which is not basic. Statement 4 is correct. Y is ethanol and gives a positive iodoform test.
24.	**Answer: B** According to Markovnikov's rule, H would be added to the carbon atom in the C=C with more H. The structures of A and D are incorrect. Step 2: From molecular formula of E, bromine is substituted by –CN.
25.	**Answer: B** A is incorrect as the reaction does not involve the ester. C is incorrect as it has one missing -CH_2. D has the double bond at the wrong position.
26.	**Answer: B** Propagation: $CH_2CCl_2 + Cl\bullet \rightarrow \bullet CHCl_2 + \underline{HCl}$ $\bullet CHCl_2 + Cl_2 \rightarrow \underline{CHCl_3} + Cl\bullet$ $CHCl_3 + Cl\bullet \rightarrow \bullet CCl_3 + HCl$ $\bullet CCl_3 + Cl_2 \rightarrow \underline{CCl_4} + Cl\bullet$ Termination: $\bullet CCl_3 + \bullet CHCl_2 \rightarrow \underline{CCl_3CHCl_2}$
27.	**Answer: B (CLT for 2021 exam)**
28.	**Answer: A** **A:** 2-nitrophenol or 4-nitrophenol is formed which is a pale yellow precipitate. **B & C:** -$COCH_3$ is ring deactivating while –CH_2CH_3 and –NH_2 are ring activating. Hence, the electron density in phenylethanone is lower. It would undergo nitration at a slower rate and higher temperature. **D:** As –OH is ring activating, it does not require concentrated sulfuric acid to generate the electrophile.
29.	**Answer: D** During discharging, the cell behaves as a galvanic cell, hence reaction is spontaneous, ΔG is negative. At electrode X, Pb is oxidised to $PbSO_4$, hence X is anode, and $E^{\ominus}_2$ is more positive than $E^{\ominus}_1$.

	For 2 mol of electrons transferred during discharge, the overall equation is $Pb + PbO_2 + 2H^+ + 2HSO_4^- \rightarrow 2PbSO_4 + 2H_2O$. As the cell discharges, $[H^+]$ decreases, hence pH increases.
30.	**Answer: C** $2Cl^- \rightarrow Cl_2 + 2e^-$ $4OH^- \rightarrow O_2 + 2H_2O + 4e^-$ Same 10 cm^3 volume i.e. same mole of Cl_2 and O_2 are produced, hence amount of electron transfer in electrolysis 2 is double that of electrolysis 1. $Q = It = nF$, since time t and F are constant, doubling n would double current I.