SAJC Prelim 2015 H2 Chemistry Paper 1 Worked Solutions

1	2	3	4	5	6	7	8	9	10
C	**B**	**D**	**A**	**B**	**C**	**A**	**B**	**B**	**B**
11	12	13	14	15	16	17	18	19	20
D	**B**	**C**	**D**	**B**	**A**	**D**	**C**	**C**	**C**
21	22	23	24	25	26	27	28	29	30
C	**B**	**C**	**D**	**D**	**B**	**D**	**B**	**C**	**D**
31	32	33	34	35	36	37	38	39	40
C	**A**	**A**	**B**	**B**	**B**	**B**	**A**	**D**	**D**

1 The mass percentage of magnesium in a mixture of magnesium chloride (M_r = 95.3) and magnesium nitrate (M_r = 148.3) was found to be 21.25%. What mass of magnesium chloride is present in 323 g of the mixture?

A 151 g

B 165 g

C 172 g

D 181 g

(24.3/95.3)(x) + (24.3/148.3)(1 – x) = 0.2125
Solving for x, x = 0.5338
Mass of magnesium chloride = 0.5338 x 323 = 172g

2 Which conversion results in a loss of electrons for the underlined species?

A $\underline{N}O_3^-$ to $\underline{N}O_2$ (+5 to +4)

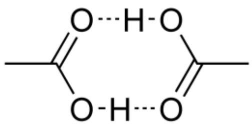
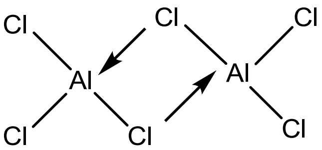
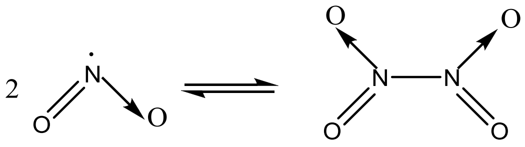
B $\underline{N}O_2^-$ to $\underline{N}O_3^-$ (+3 to +5)

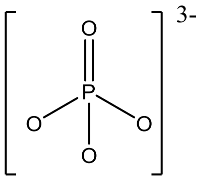
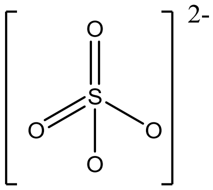
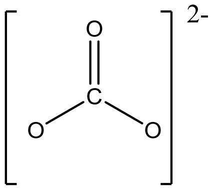
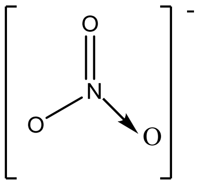
A loss of electrons results in an increase in oxidation state.

C $\underline{S}_2O_8^{2-}$ to $\underline{S}O_4^{2-}$ (+7 to +6)

D $\underline{S}_4O_6^{2-}$ to $\underline{S}_2O_3^{2-}$ (+2.5 to +2)

3	Which of the following pairs shows Gas **Y** deviating more from ideal gas behaviour than Gas **X** at the same temperature and pressure? Gas **X** Gas **Y**	
	A	HF HCl *The pd-pd interactions between HCl molecules are weaker than the hydrogen bonds between HF molecules, so HCl possesses less significant IMF and is more ideal.*
	B	H_2O H_2 *The id-id interactions between H_2 molecules are weaker than the hydrogen bonds between H_2O molecules, so H_2 possesses less significant IMF and is more ideal.*
	C	I_2 Br_2 *The id-id interactions between Br_2 molecules are weaker than the id-id interactions between I_2 molecules, as Br_2 has a smaller electron cloud, so Br_2 possesses less significant IMF and is more ideal.*
	D	O_2 NO_2 *The pd-pd interactions between NO_2 molecules are stronger than the id-id interactions between O_2 molecules, so NO_2 possesses more significant IMF and is less ideal.*
4	*Use of the Data Booklet is relevant to this question.* Which of the following shows the correct increasing trend for the angle of deflection when placed in an electric field?	
	A	$Cl^- < Ru^{3+} < Zn^{2+}$
	B	$Ru^{3+} < Cl^- < Zn^{2+}$
	C	$Cl^- < Zn^{2+} < Ru^{3+}$
	D	$Zn^{2+} < Ru^{3+} < Cl^-$
		Angle of deflection $\alpha \frac{charge}{mass}$ $Cl^- < Ru^{3+} < Zn^{2+}$ *1/35.5 < 3/101 < 2/65.4* 0.0282 < 0.0297 < 0.0306

5	Which of the following **cannot** form dimers?	
	A	CH_3COOH  *dimerization via hydrogen bonds*
	B	CH_3CHO Incapable of forming intermolecular hydrogen bonding between CH_3CHO molecules
	C	$AlCl_3$  *dimerization via dative bonds*
	D	NO_2  *dimerization via formation of covalent bond*

6	Which of the following species is planar and does not have dative bonding?	
	A	PO_4^{3-}  *tetrahedral (non-planar), no dative bonds*
	B	SO_4^{2-}  *tetrahedral (non-planar), no dative bonds*
	C	CO_3^{2-}  *trigonal planar (planar), no dative bonds*
	D	NO_3^{-}  *trigonal planar (planar), 1 dative bond*

7	The behavior of Group II sulfates and hydroxides show different trends down the group. Group II sulfates become less soluble down the group, while Group II hydroxides become more soluble down the group. Which of the following statements helps to explain this trend?	
	A	Down the group, the magnitude of the lattice energy of Group II hydroxides has a more significant decrease than the magnitude of the sum of hydration energies of the ions.
	B	Down the group, the magnitude of the lattice energy of Group II sulfates has a more significant decrease than the magnitude of the sum of hydration energies of the ions.
	C	The hydration energy of the sulfate anion is larger in magnitude than the hydroxide anion.
	D	The magnitude of the lattice energy of Group II ionic compounds increases down the group.
	$\Delta H_{soln} = \Delta H_{hyd} - LE$ *For* ΔH_{hyd}*, it is also always negative, but a decrease in the magnitude of* ΔH_{hyd} *leads to a more positive / less negative* ΔH_{soln} *according to the above expression.* *For LE, as it is always negative (exothermic), a decrease in the magnitude of LE leads to a less positive / more negative* ΔH_{soln} *according to the above expression.* *So if hydroxides become more soluble down the group, their* ΔH_{hyd} *has to become more negative, and that can only be explained by answer A.* *Statement B leads to a more negative* ΔH_{hyd} *and hence increased solubility of the sulfates as we go down the group, which contradicts the information in the question.* *Statement C is wrong as hydration energy is proportionate to charge density. Sulfate ion despite having a -2 charge, is also much larger than the hydroxide ion, and has a lower charge density as a result.* *Statement D is wrong as the cation size increases down group II, and since lattice energy is proportionate to* $q_+q_-/(r_++r_-)$*, lattice energy should decrease in magnitude.*	

8 Phosphorus exists in several allotropes. White phosphorus has the structure P_4, while black phosphorus has a structure similar to graphite.

While the transformation of white phosphorus to black phosphorus is spontaneous, the rate is very slow, and usually involves the use of a metal salt catalyst to increase its rate.

Which of the following is true?

A Black phosphorus has a simple molecular structure.

Untrue as the question stated black phosphorus has a structure similar to graphite, and hence it must have a giant covalent structure.

B ΔH for the transformation of white phosphorus to black phosphorus is less than zero.

True because $\Delta G = \Delta H - T\Delta S$, and since ΔS is negative (see statement C), ΔH must be negative, otherwise the reaction will never be spontaneous.

C ΔS for the transformation of white phosphorus to black phosphorus is greater than zero.

Untrue as the conversion from white phosphorus to black involves merging simple covalent molecules to form a giant covalent molecule. There is a decrease in the number of molecules, hence entropy change is negative.

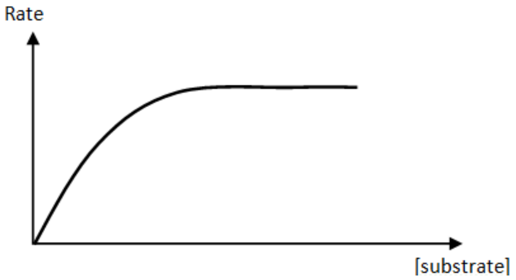
D The uncatalysed reaction of transforming white phosphorus to black phosphorus has a small activation energy.

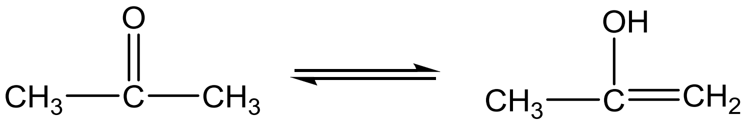
Untrue as the information stated that the rate is very slow without a catalyst, hence it must have a large activation energy.

9 What is the half-life of a first-order reaction where the concentration of the reactant drops to $\frac{1}{5}$ of its initial concentration after 51 minutes?

A 20 min

B 22 min

	C	24 min
	D	26 min
	$[A]_t = [A]_0(1/2)^n$ *where n is the no. of half-life* $1/5 = 1(1/2)^n$ $lg(1/5) = n\ lg(1/2)$ $n = 2.322$ $t_{1/2} = 51 / 2.322 = 22.0$ *min*	
10	The graph below shows the change in rate for an enzyme-catalysed reaction.  Which of the following statements is **incorrect**?	
	A	At low [substrate], the rate is first order with respect to [substrate].
	B	At low [substrate], the reaction slows down due to increasing concentration of the products. *It should be: The reaction slows down as the enzyme active sites are gradually occupied by the substrate molecules.*
	C	At high [substrate], the rate is constant as all the enzyme active sites are used up.
	D	At high [substrate], increasing [enzyme] increases the rate.

11	A ketone such as propanone can undergo a rearrangement of its atoms to form an enol when dissolved in a non-polar solvent. Enols exist together with their ketone forms in equilibrium.  $\Delta H = +48$ kJ mol^{-1} Which of the following statements can be determined from the information above?	
	A	Increasing the temperature results in the shift of the position of equilibrium to the left. *Wrong, as the enthalpy change is positive, an increase in temperature would shift the equilibrium to the right.*
	B	The entropy change of the reaction is positive under aqueous conditions. *Wrong, as there is no change in the no. of molecules, entropy change is negligible.*
	C	Adding of warm alkaline iodine results in the shift of the position of equilibrium to the right. *Wrong, as the iodoform reaction consumes propanone, and the equilibrium should shift left.*
	D	Adding sodium metal results in the shift of the position of equilibrium to the right. *Correct, as sodium metal reacts with the alcohol group and the equilibrium shifts right.*
12	Which of the following mixtures will result in a significant pH change when a small amount of acid is added?	
	A	20 cm^3 of 1 mol dm^{-3} H_2CO_3 and 20 cm^3 of 1 mol dm^{-3} $KHCO_3$ *0.02 mol of H_2CO_3 (weak acid) and 0.02 mol of HCO_3^- (basic salt) make a good buffer, since [weak acid] = [basic salt], hence it is able to resist pH changes.*

B 20 cm^3 of 1 mol dm^{-3} HCl and 20 cm^3 of 1 mol dm^{-3} $CH_3CH_2NH_2$

$CH_3CH_2NH_2 + H^+ \rightarrow CH_3CH_2NH_3^+$

I	0.02	0.02	0
C	-0.02	-0.02	+0.02
F	0	0	0.02

The solution only consists of $CH_3CH_2NH_3^+$ *(acidic salt) and no weak base present to neutralise the small amount of* H^+ *added, hence pH will change significantly.*

C 10 cm^3 of 1 mol dm^{-3} NaOH and 20 cm^3 of 1 mol dm^{-3} NH_4Cl

$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$

I	0.02	0.01	0
C	-0.01	-0.01	+0.01
F	0.01	0	0.01

0.01 mol of NH_3 *(weak base) and 0.01 mol of* NH_4^+ *(acidic salt) makes a good buffer, since [weak base] = [acidic salt], hence it is able to resist pH changes.*

D 10 cm^3 of 1 mol dm^{-3} HCl and 20 cm^3 of 1 mol dm^{-3} $Mg(CH_3CH_2COO)_2$

$CH_3CH_2COO^- + H^+ \rightarrow CH_3CH_2COOH$

I	0.02	0.01	0
C	-0.01	-0.01	+0.01
F	0.01	0	0.01

0.01 mol of CH_3COOH *(weak acid) and 0.01 mol of* $CH_3CH_2COO^-$ *(basic salt) make a good buffer, since [weak acid] = [basic salt], hence it is able to resist pH changes.*

13 The table below shows the numerical values of the solubility products for some salts.

Salt	$Pb(OH)_2$	$Zn(OH)_2$	$ZnCO_3$	Ag_2CO_3
K_{sp}	1.4×10^{-20}	3.0×10^{-17}	1.4×10^{-11}	8.1×10^{-12}

Which statement is **correct**?

A $Pb(OH)_2$ is more soluble than $Zn(OH)_2$.

B $Zn(OH)_2$ is more soluble than $ZnCO_3$.

C Ag_2CO_3 is more soluble than $ZnCO_3$.

D $Pb(OH)_2$ is more soluble than Ag_2CO_3.

Work out solubility value of each salt to compare.

Salt	$Pb(OH)_2$	$Zn(OH)_2$	$ZnCO_3$	Ag_2CO_3
$\mathbf{K_{sp}}$	1.4×10^{-20}	3.0×10^{-17}	1.4×10^{-11}	8.1×10^{-12}
Solubility	1.52×10^{-7}	1.96×10^{-6}	3.74×10^{-6}	1.27×10^{-4}

(Most soluble) $Ag_2CO_3 > ZnCO_3 > Zn(OH)_2 > Pb(OH)_2$ (Least soluble)

14 *Use of the Data Booklet is relevant to this question.*

Pure copper wires when used in electrochemical cells are partially submerged in the electrolyte. Which aqueous electrolyte can be used such that the copper wires do not dissolve?

A KNO_3

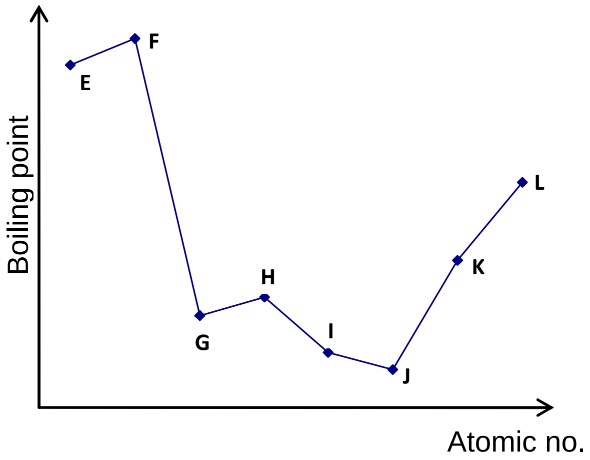
$Cu^{2+} + 2e^- \rightleftharpoons \underline{Cu}$ $E^o = +0.34$ V
$\underline{NO_3}^- + 2H^+ + e^- \rightleftharpoons NO_2 + 2H_2O$ $E^o = +0.81$ V
$\underline{NO_3}^- + 3H^+ + 2e^- \rightleftharpoons HNO_2 + 2H_2O$ $E^o = +0.94$ V
$\underline{NO_3}^- + 10H^+ + 8e^- \rightleftharpoons NH_4^+ + 3H_2O$ $E^o = +0.87$ V
$E_{cell} > 0$

B $K_2S_2O_8$

$Cu^{2+} + 2e^- \rightleftharpoons \underline{Cu}$ $E^o = +0.34$ V
$\underline{S_2O_8}^{2-} + 2e^- \rightleftharpoons 2SO_4^{2-}$ $E^o = +2.01$ V
$E_{cell} = 2.01 - 0.34 = +1.67 \text{ V} > 0$

C $Na_2Cr_2O_7$

$Cu^{2+} + 2e^- \rightleftharpoons \underline{Cu}$ $E^o = +0.34$ V
$\underline{Cr_2O_7}^{2-} + 14H^+ + 6e^- \rightleftharpoons 2Cr^{3+} + 7H_2O$ $E^o = +1.33$ V
$E_{cell} = 1.33 - 0.34 = +0.99 \text{ V} > 0$

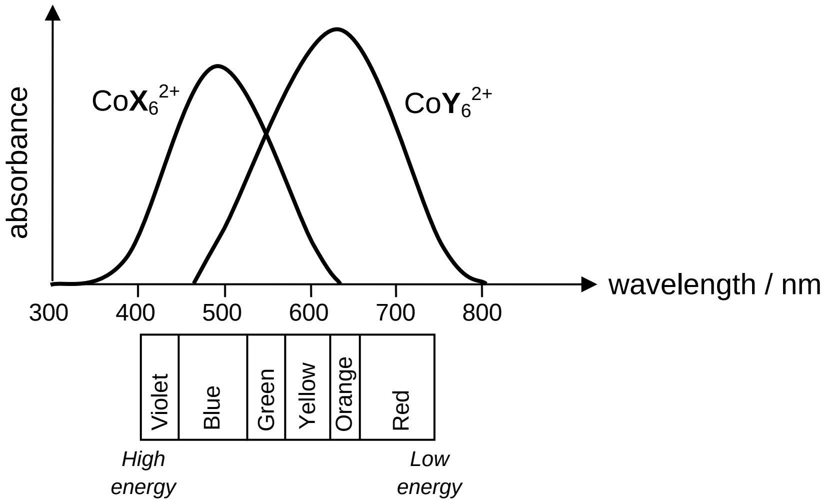
	D	$Na_2S_4O_6$ $Cu^{2+} + 2e^- \rightleftharpoons \underline{Cu}$ E° = +0.34 V $\underline{S_4O_6}^{2-} + 2e^- \rightleftharpoons 2S_2O_3^{2-}$ E° = +0.09 V $E_{cell} = 0.09 - 0.34 = -0.25\ V < 0$ => Cu will not be oxidized/dissolved.
15	3.96 g of metal was deposited when 1.602 x 10^4 C of electricity was passed through a molten electrolyte. Which of the following could be the electrolyte?	
	A	$TiCl$
	B	$TiSO_4$
	C	Ti_2O_3
	D	TiO_2
	Moles of Ti = 3.96 / 47.9 = 0.08267 mol *Moles of* e^- *= 1.602 x* 10^4 */ 96500 = 0.1660 mol* *Ti :* e^- *= 0.08267 : 0.1660 = 1 : 2* $Ti^{2+} + 2e^- \rightarrow Ti$ *Oxidation state of Ti in the electrolyte is +2.*	
16	The graph below shows the variation in the boiling points for eight consecutive elements in the Periodic Table, all with atomic number between 10 and 20.  Which of the following statements is true?	

	A	Element **H** forms an acidic oxide.
	B	Element **K** does not conduct electricity.
	C	Element **E** and beryllium are in the same group.
	D	The element preceding **E** has a smaller atomic radius than **E**.
	*Since **F** has the highest boiling point, it is likely to be silicon, Group IV. We can thus identify each of the other elements by going across the period.* ***H** is sulfur, and it does form sulfur dioxide, which is acidic. Statement A is true.* ***K** is potassium, and it is a metal which conducts electricity.* ***E** is aluminium, and it is in Group III, while beryllium is in Group II.* *Element preceding **E** (aluminium) is magnesium, and it has a larger atomic radius than aluminium. This information can be obtained from the Data Booklet.*	

17	Radium is a radioactive element below barium in the Periodic Table. Which statement concerning radium is **not** true?	
	A	It is a good conductor of electricity.
	B	Radium nitrate has a higher thermal stability than barium nitrate.
	C	Radium dissolves in water at room temperature to form a strongly basic solution.
	D	Radium has an outermost electronic configuration of $6s^2$.
	Statements A, B, and C are true as these properties are all true for barium. *Statement D is not true as radium belong to Period 7, and has an outermost electronic configuration of* $7s^2$.	
18	Chlorine and iodine are both elements in Group VII, but have some differences in their reactivity and properties of their compounds. Which of the following would increase from chlorine to iodine?	
	A	oxidation state of sulfur when the halogens reacts with sodium thiosulfate *When chlorine reacts with thiosulfate, sulfur's oxidation state increases from +2 to +6.* *When iodine reacts with thiosulfate, sulfur's oxidation state increases from +2 to +2.5.*

	B	bond energy of molecules of the elements *The atomic size increases down the group. Hence there is less effective orbital overlap, the bond length is longer and bond strength is weaker.*
	C	strength of the van der Waals' forces between molecules of the elements *The number of electrons and the size of the molecules increase down the group. VDW is correlated to number of electrons and size, hence it increases.*
	D	solubility product of the silver halide *The solubility of the silver halides decreases down the group, so the solubility product must also decrease.*
19	Which of the following statements is true about the d-block elements in Period 4 and their compounds?	
	A	Chromium has the most number of oxidation states. *Untrue as the other d-block elements to the right of Cr can lose more than 6 electrons from the 4s and 3d subshells – they have more oxidation states.*
	B	Cu^+ has 1 unpaired electron in its ground electronic configuration. *Untrue, as the ground electronic configuration of* Cu^+ *is* $[Ar]3d^{10}$. *No unpaired electrons.*
	C	Ni^{2+} is less likely to be reduced when dissolved in aqueous ammonia. *True as the standard reduction potential of* $[Ni(NH_3)_6]^{2+}$ *is more negative than that of* Ni^{2+}. *It is harder to reduce.*
	D	Scandium can form coloured complexes and can exhibit variable oxidation states. *Untrue as scandium does not have +2 oxidation state, and only has +3 oxidation state. With this oxidation state, it does not have partially filled d-orbitals and cannot have coloured complexes.*

20 The diagram below shows the visible spectra of two cobalt(II) complexes, Co$\mathbf{X}_6^{2+}$ and Co$\mathbf{Y}_6^{2+}$. The various colours corresponding to the approximate wavelengths in the visible light region are shown below the x-axis. The shorter the wavelength of light, the higher its energy.



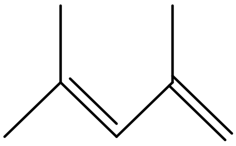
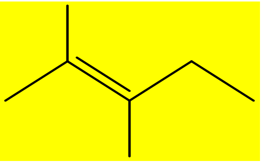
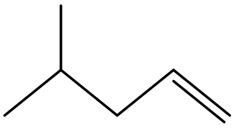
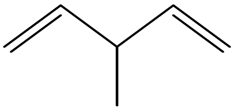
What is the colour of complex Co$\mathbf{Y}_6^{2+}$ and which ligand causes a larger d-orbital splitting?

	colour of Co$\mathbf{Y}_6^{2+}$	ligand which causes a larger d-orbital splitting
A	yellow orange	**X**
B	yellow orange	**Y**
C	violet	**X**
D	violet	**Y**

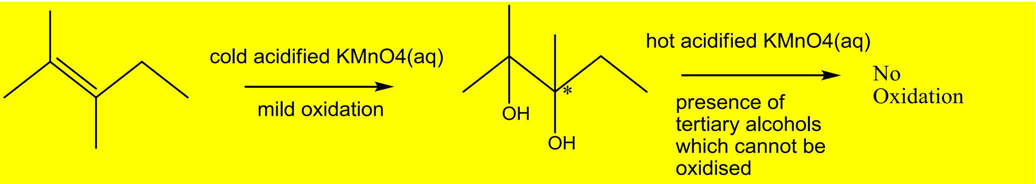
Ligand X has its peak absorption at a higher energy end than Ligand Y, so it implies a larger energy gap. Ligand Y does not absorb in the violet range.

21 An alkene reacted with cold acidified $KMnO_4(aq)$ to form a product which has a single chiral carbon atom. However the product does not react with hot acidified $KMnO_4(aq)$.

Which is the following is a possible structure of the alkene?

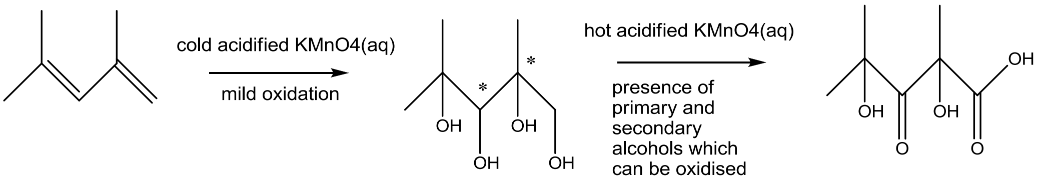
	A			**C**	
	B			**D**	

Alkene C



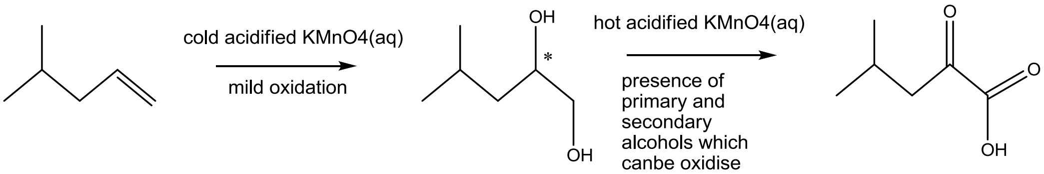
presence of tertiary alcohols which cannot be oxidised

Alkene A



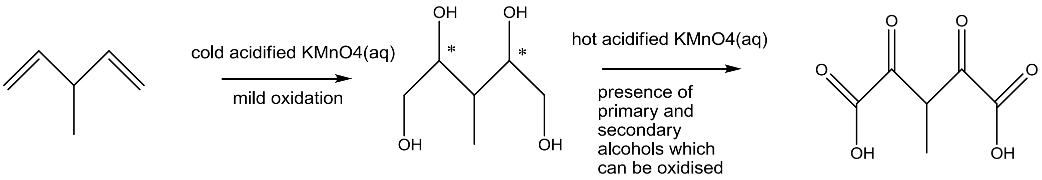
presence of primary and secondary alcohols which can be oxidised

Alkene B



presence of primary and secondary alcohols which canbe oxidise

Alkene D

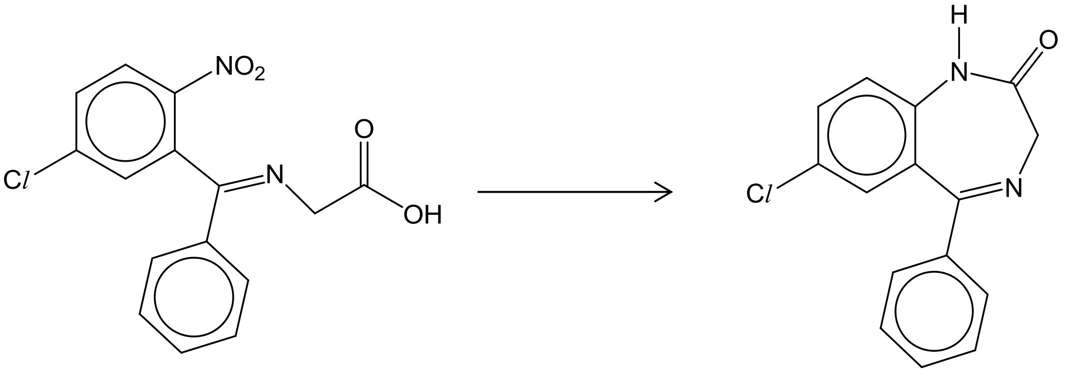


presence of primary and secondary alcohols which can be oxidised

22	**W**, **X** and **Y** are three different organic compounds. Both **X** and **Y** can react with **W** to form an ester each, but **Y** reacts much less readily than **X**. Which of the following could be **Y?**	
	A	propanol
	B	propanoic acid
	C	propanoyl chloride
	D	propanamide
	Alcohol + Carboxylic Acid → Ester *Alcohol + Acid Chloride → Ester* *W: Alcohol* *Y: Carboxylic Acid* *X: Acid Chloride* *Acid Chloride is more reactive then carboxylic acid because the Cl is a good leaving group as compared to the OH group* *OR* *C in COCl bond is highly electron deficient as it is bonded to 2 strongly electronegative atoms, O and Cl thus attracting nucleophiles more strongly*	
23	Which of the following reagents is most suitable to distinguish between dilute methanoic acid and methanal?	
	A	HCN *False: HCN reacts with methanol but no observable change.*
	B	Hot acidified $KMnO_4$ *False: Both can be oxidised to form CO_2. Methanoic acid is a special acid which can be oxidised by $KMnO_4$.*

	C	2,4-DNPH *True: Only methanal reacts with 2,4-DNPH to give orange ppt.*
	D	NaOH *False: Methanoic acid reacts with NaOH via neutralisation reaction with no observable change.*

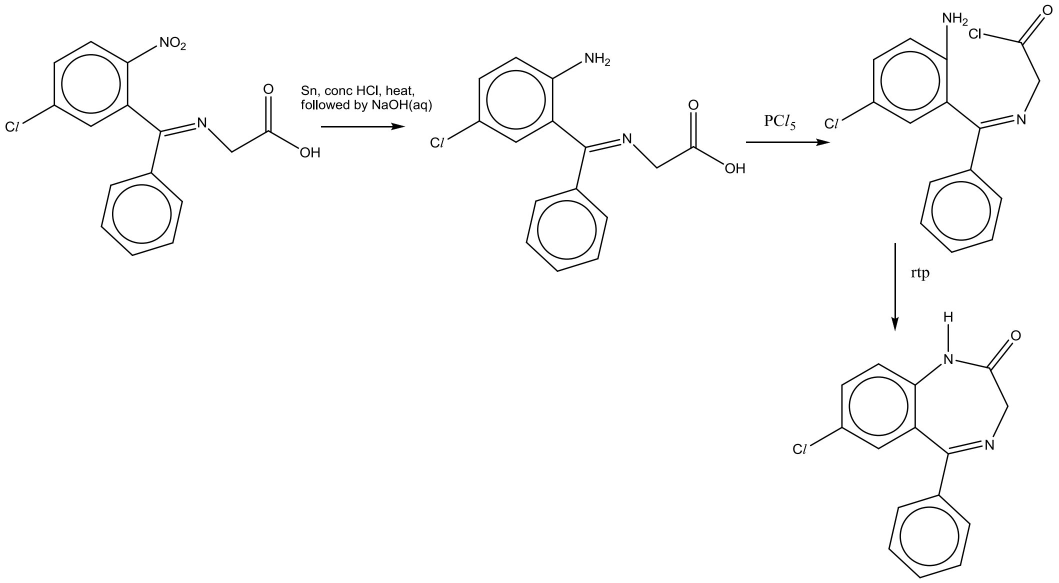
24 Demethylated diazepam can be used as an anti-depressant drug to treat anxiety. Which of the following correctly shows the sequence of reactions to convert compound **X** to demethylated diazepam?



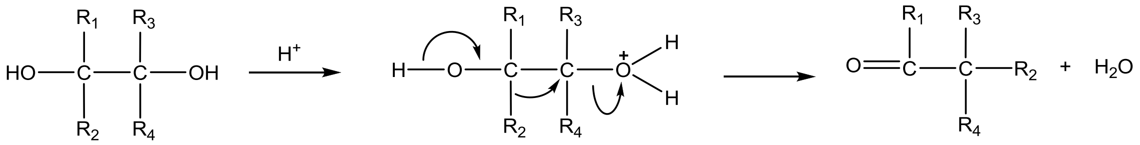
Compound X

demethylated diazepam

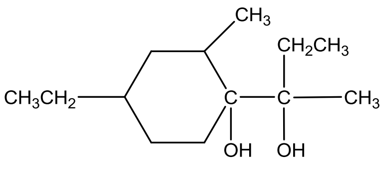
	Step I	**Step II**	
A	PCl_5	$LiAlH_4$ in dry ether	
B	PCl_5	Sn, conc HC*l*, heat, followed by NaOH(aq)	
C	$NaBH_4$	PCl_5	
D	Sn, conc HC*l*, heat,	PCl_5	

		followed by NaOH(aq)		
				

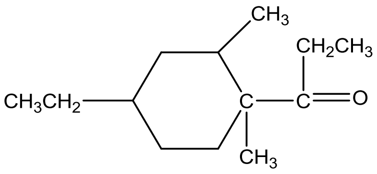
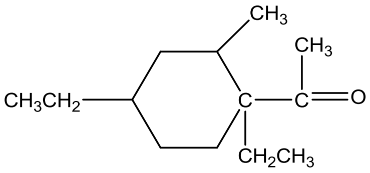
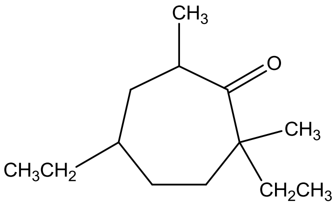
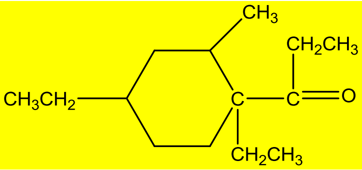
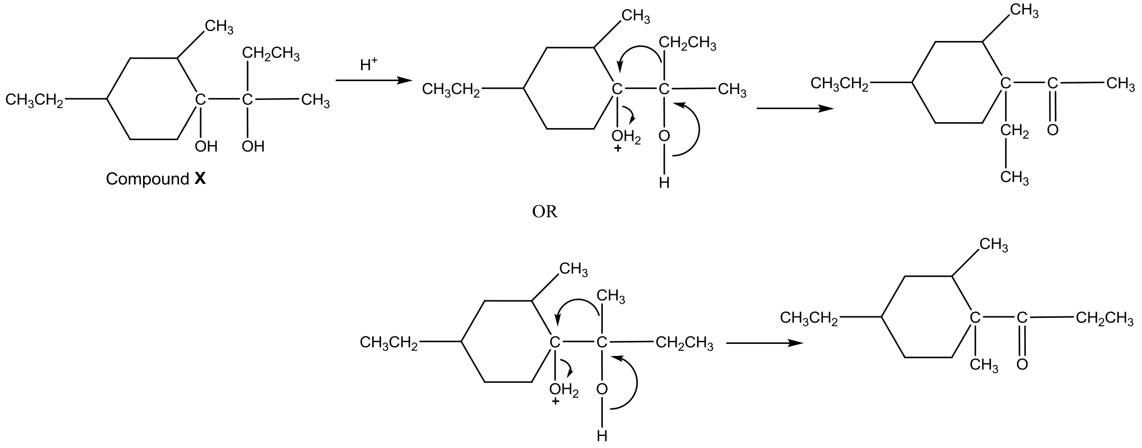
25 The pinacol rearrangement involves the reaction of a diol in acidic conditions to form a carbonyl compound as shown below.

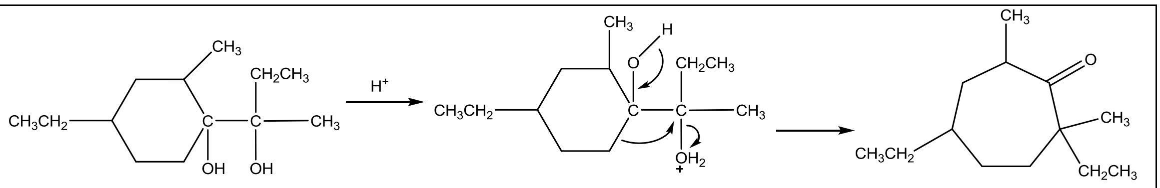


Which structural formulae is **not** a product of the pinacol rearrangement of compound **X**?



Compound **X**

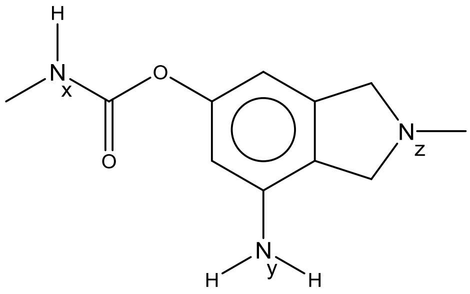
	A	
	B	
	C	
	D	
	 Compound **X** **OR**	



Compound **X**

26 Physostigmine is an alkaloid which occurs naturally in the Calabar bean.

Compound **G** is a derivative of Physostigmine.



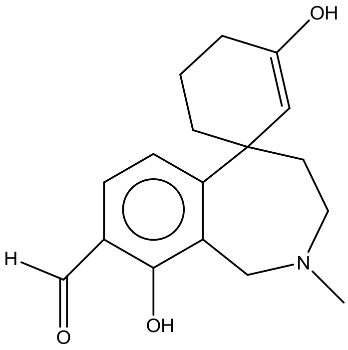
Compound **G**

The 3 nitrogen atoms are labelled as N_X to N_z.

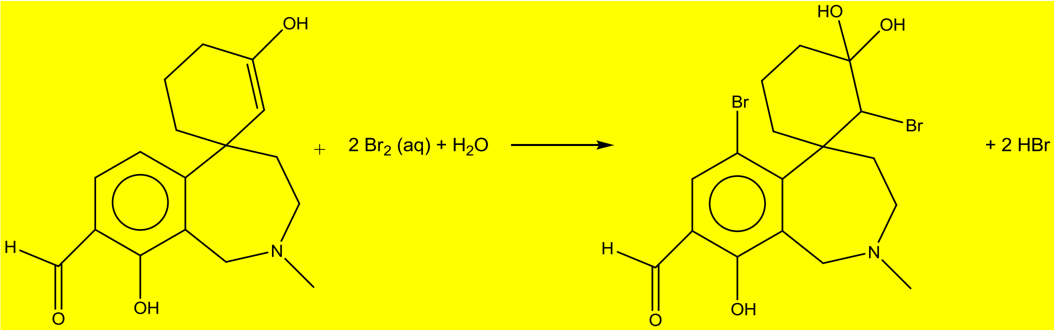
What is the increasing order of basicity of the 3 nitrogen atoms?

A	$N_x < N_z < N_y$
B	$N_x < N_y < N_z$
C	$N_z < N_x < N_y$
D	$N_y < N_x < N_z$

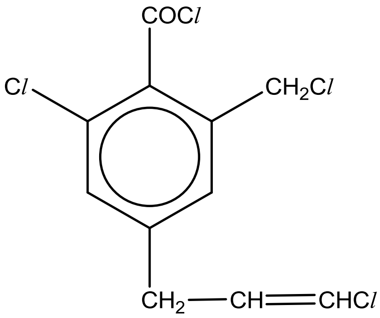
Amides are neutral as the lone pair of electrons on N is delocalised over the O-C-N bond and is therefore unavailable for protonation.
Phenylamine is less basic than aliphatic amines as the lone pair of electrons on N atom is partly delocalised into the benzene ring, thus decreases the availability of lone pair electrons for protonation.

27	Galanthamine is a drug used to treat Alzheimer's disease. Compound **X** is its isomer**.**  Compound **X** Which of the following statements about compound **X** is correct?	
	A	It reacts with alkaline Cu^{2+} to give a brick red ppt. *False: There is no aliphatic aldehyde*
	B	It reacts with 3 moles of ethanoyl chloride. *False: Only phenol and alcohol in Compound **X** reacts with ethanoyl chloride. Tertiary amines do not react with ethanoyl chloride.*
	C	It gives a violet colouration with acidic $FeCl_3$. *False: Phenol reacts with **neutral** $FeCl_3$.*
	D	It reacts with 2 moles of aqueous bromine. *True:*

[Turn Over



28 How many moles of silver chloride will be precipitated when excess aqueous silver nitrate is added to one mole of the compound below?



A 0

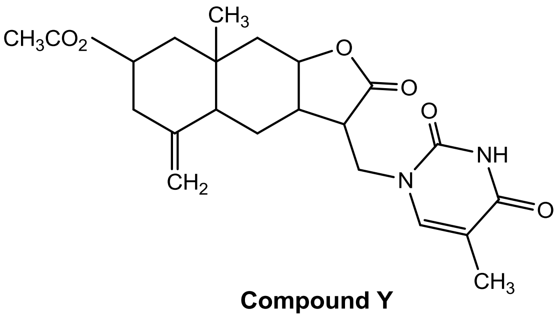
B 1

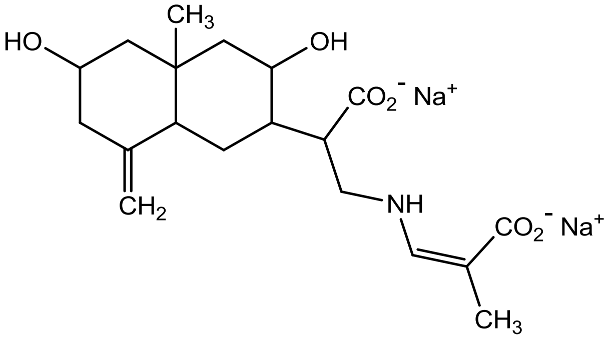
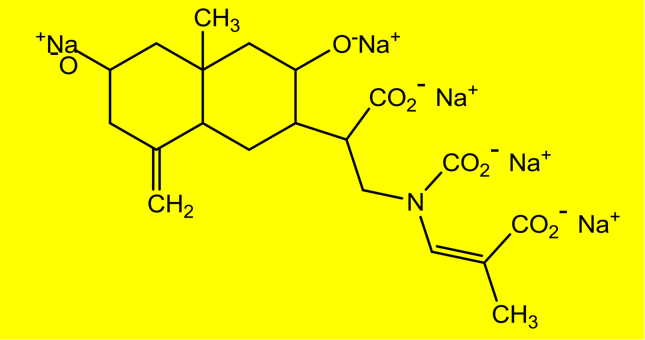
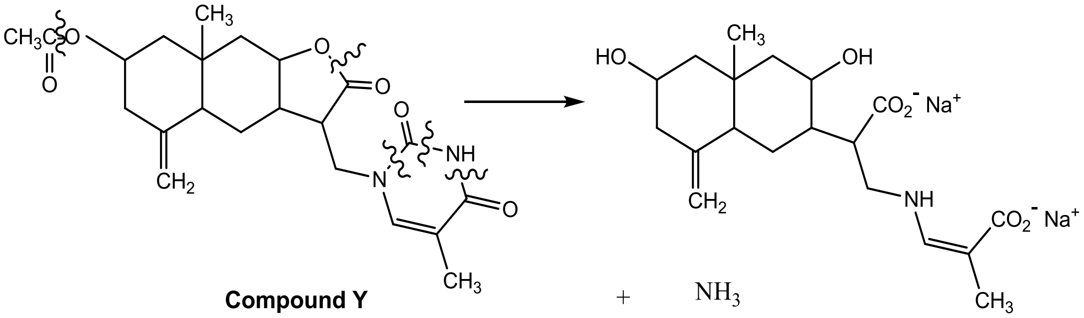
C 2

D 4

Only the acid chloride group will hydrolysed in water to give Cl^- which gives AgCl ppt with $AgNO_3$.

29 In the hydrogenation of CH_2=$CHCH_2CN$ using platinum catalyst, what is the volume of hydrogen gas (measured at s.t.p) that is required to react completely with 1 mole of the

	compound?	
	A	22.4 dm^3
	B	24.0 dm^3
	C	67.2 dm^3
	D	72.0 dm^3
	C=C requires 1 mol of H_2 for addition to form alkane and –CN requires 2 mol of H_2 to be reduced to $–CH_2NH_2$. Hence total of 3 mol of H_2 is required. *Therefore vol of H_2 at stp = 3 x 22.4 = 67.2 dm^3*	
30	Compound **Y** was extracted from sunflowers and was known to possess anti-tumour effects.  **Compound Y** Which of the following will **not** be formed when compound **Y** is reacted with excess hot dilute NaOH?	
	A	NH_3
	B	Na_2CO_3

	C	
	D	
	 **Compound Y** + NH_3 + Na_2CO_3	

Section B

31	Which of the following is equal to one mole of the stated particles?	
	1	Electrons in 4.22 g of fluorine gas *Moles of* F_2 *= 4.22 / 38 = 0.1111 mol* *Moles of* e^- *= 0.1111 x 9 x 2 = 2 mol*
	2	Neutrons in 1.90 g of fluorine gas *Moles of* F_2 *= 1.90 / 38 = 0.05 mol* *Moles of neutrons = 0.05 x 10 x 2 = 1 mol*
	3	Protons in 2.12 g of fluorine gas *Moles of* F_2 *= 2.12 / 38 = 0.05579 mol* *Moles of neutrons = 0.05579 x 9 x 2 = 1 mol*
32	Particle **X** has proton number, n. Particle **Y** has proton number, n+1 and a charge of +2. Particles **X** and **Y** are isoelectronic. Which of the following statements are true?	
	1	**X** has a charge of +1. *Since Particle Y has a charge of +2, Y has electron number of n-1.* *X and Y are isoelectronic, so X also has electron number of n-1.*
	2	**Y** releases more energy than **X** when an electron is added to each particle. *Y has more protons than X, hence it has higher nuclear charge, resulting in stronger attraction for electrons.*
	3	**Y** has a smaller radius than **X**. *X and Y have same no. of electrons. Y has more protons than X, hence it has higher nuclear charge and higher effective nuclear charge, resulting in a smaller radius.*

33 The table below shows the pK_a values of some acids.

Acid	$HClO$	$HBrO$	HCN
pK_a	7.46	8.70	9.21

Which of the following statements are true?

1 $HBrO$ is more acidic than HCN.

$HBrO$ has a higher K_a value than HCN, since $pK_a = -\log_{10}K_a$.

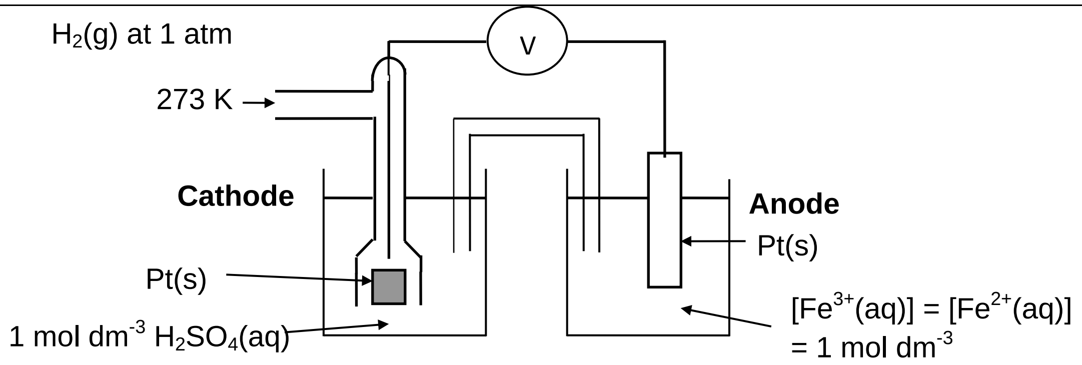
2 BrO^- is more basic than ClO^-.

$HBrO$ is a weaker acid than $HClO$, hence its conjugate base, BrO^- is more basic than ClO, since $K_a \times K_b = K_w$.

3 The maximum buffer capacity for a solution containing HCN and CN^- occurs at a pH of 9.21.

A solution containing HCN and CN^- would make up an acidic buffer which has a MBC of $pH = pK_a = 9.21$.

34



To investigate the standard reduction potential of the Fe^{3+}/Fe^{2+} system, a student devised the following electrochemical cell. His tutor informed him that he made a number of mistakes in his diagram.

What were his mistakes?

1 The cathode and anode were wrongly assigned.

2 The conditions used for the standard hydrogen electrode were incorrect.

3 He used a platinum electrode in the Fe^{3+}/Fe^{2+} half-cell.

Using the Data Booklet, the E_{cell} *of the reaction is +0.77 uner standard conditions if the* Fe^{3+}/Fe^{2+} *half cell is where reduction occurs. Therefore the electrode at the* Fe^{3+}/Fe^{2+} *half cell should be the cathode.*

The concentration of H^+ *in the SHE is actually 2 mol* dm^{-3}*, which is not standard condition.*

Using a platinum electrode is correct for the Fe^{3+}/Fe^{2+} *half cell.*

35

The labels of bottles containing sodium bromide and sodium iodide were accidentally removed. Which chemical tests can be used to distinguish between sodium bromide and sodium iodide?

1 Add aqueous silver nitrate followed by concentrated ammonia.

2 Add concentrated sulfuric acid.

3 Add sodium thiosulfate.

	Adding silver ions would form cream and yellow ppt, which can be further distinguished by concentrated ammonia as the silver bromide ppt would dissolve in concentrated ammonia, but not silver iodide. *Adding concentrated sulfuric acid would produce brown bromine gas for bromide, and a purple vapor along with pungent H_2S gas, thus distinguishing between the two.* *Adding thiosulfate has no effect – thiosulfate reacts with Br_2 and I_2, but not their ion forms.*	

36	Which statements about the chlorides of Period 3 elements are correct?	
	1	When one mole of PCl_5 is reacted completely with water, the resulting solution requires eight molar equivalents of NaOH for neutralisation. $PCl_5 + 4H_2O \rightarrow H_3PO_4 + 5HCl$ *Since there are 8 moles of H^+, 8 moles of NaOH are required.*
	2	$MgCl_2$ gives a pH below 7 when dissolved in water. $[Mg(H_2O)_6]^{2+} + H_2O \rightleftharpoons [Mg(H_2O)_5(OH)]^{+} + H_3O^{+}$
	3	$AlCl_3$ reacts with water to give the colourless complex ion, $[Al(OH)_4]^-$. *Due to the low K_w value, water does not have sufficient OH^- for this to occur.*
37	Propane reacts with chlorine gas in the presence of ultraviolet light to form a mixture of products via free radical substitution. Which statements about this reaction are true?	
	1	Hexane is formed only in the termination step.
	2	Homolytic fission occurs in the initiation and propagation step.
	3	Chloropropane is formed only in the propagation step.
	1. Hexane is only formed in termination step when $\cdot CH_2CH_2CH_3$ reacts with $\cdot CH_2CH_2CH_3$ *2. Homolytic fission takes place in initiation and propagation step forming radicals.* *3. Chloropropane is formed in the propagation and termination steps.*	

38	Thiols are organic compounds containing the −SH functional group. They are sulfur analogues of alcohols. Some common reactions undergone by thiols are shown below: **I** $CH_3CH_2SH + KOH \rightarrow CH_3CH_2S^-K^+ + H_2O$ **II** $CH_3CH_2SH + CH_3CH_2Br \rightarrow (CH_3CH_2)_2S + HBr$ Which of the following statements are correct?	
	1	Thiols are stronger acids than alcohols.
	2	Thiols are stronger nucleophiles than alcohols.
	3	Thiols can react with Na metal
	1. Thiol is a stronger acid than alcohol since it can undergo neutralisation reaction with KOH. *2. In reaction II, CH_3CH_2SH is acting as a nucleophile in the reaction. Alcohol is not a strong enough nucleophile to react with alkyl bromide in a similar reaction.* *3. Since thiols are sulfur analogues of alcohols, it can also undergo redox reaction with Na.*	

39	When a current is passed through a mixture of amino acids, negatively charged species move towards the anode, while positively charged species move toward the cathode. In a buffered solution at pH 7, which amino acid will move towards the anode?	
	1	$H_2NCH(CH_2COOH)COOH$
	2	$H_2NCH(CH_2CH_2NH_2)COOH$
	3	$H_2NCH(CH_2OH)COOH$
	At pH = 7 *The following species exist:* *1. $^+H_3NCH(CH_2COO^-)COO^-$ --- migrates to anode* *2. $^+H_3NCH(CH_2CH_2NH_3^+)COO^-$ --- migrates to cathode* *3. $^+H_3NCH(CH_2OH)COO^-$ ---- does not move*	

40 The structures of some amino acids are shown below.

Amino acid	**Formula of side chain** **(R in $RCH(NH_2)CO_2H$)**
Lysine	$-CH_2CH_2CH_2CH_2NH_2$
Phenylalanine	$-CH_2C_6H_5$
Valine	$-CH(CH_3)_2$
Aspartic acid	$-CH_2COOH$

The R-groups of the amino acids in a globular protein may be found facing outwards or inwards in its tertiary structure.

Which of the following options are correct?

	on the outside	**on the inside**
1	aspartic acid and lysine	valine and phenylalanine
2	phenylalanine and lysine	valine and aspartic acid
3	aspartic acid and valine	phenylalanine and lysine

The R-groups of the amino acids that are non-polar in nature (hydrophobic) will be found facing inwards whereas polar R groups that can form hydrogen bonding with water (hydrophilic) will be found outwards.
Hence aspartic acid and lysine should be found outside whereas phenylalanine and valine should be found inside.

~~~ END ~~~