Section A
Answer all questions

1 To determine the percentage of nitrogen present in a snack, 1.0 g of the snack was boiled with concentrated sulphuric acid to convert all the nitrogen into ammonium sulphate. The ammonium salt obtained was then boiled with excess aqueous sodium hydroxide to liberate the ammonia, which was passed into 25.0 cm^3 of 0.20 mol dm^{-3} hydrochloric acid. The unreacted hydrochloric acid required 20.0 cm^3 of 0.10 mol dm^{-3} aqueous sodium hydroxide for complete neutralisation.

What is the percentage by mass of nitrogen in the snack?

A	2.8%	**B**	4.2%	**C**	7.2%	**D**	8.4%

Answer: **B**

Amt of NH_3 =($\frac{25}{1000}$x 0.20) – ($\frac{20}{1000}$x 0.10) = 0.003 mol
$2NH_3 \equiv 1(NH_4)_2SO_4 \equiv 2N$
Mass of nitrogen in snack = 0.003 x 14.0 = 0.042 g
% by mass = $\frac{0.042}{1.0}$ x 100 = **4.2%**

2 In an experiment, 25.0 cm^3 of 0.20 mol dm^{-3} solution of K_2AO_4 reacted exactly with 25.0 cm^3 of 0.10 mol dm^{-3} aqueous sodium sulfate(IV). The half-equation for the oxidation of the sulfate(IV) ion is shown below.

$$SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$

Calculate the final oxidation state of **A**.

A	+2	**B**	+3	**C**	+4	**D**	+5

Answer: **D**

$2K_2AO_4 \equiv SO_3^{2-}$
No. of e gained by **A** in K_2AO_4 = No. of e lost by S in SO_3^{2-} = 2e
$2A^{6+} + 2e \rightarrow 2A^{n+}$
12 – 2 = 2n
n = **+5**

3 Two elements **D** and **E** have the following properties.

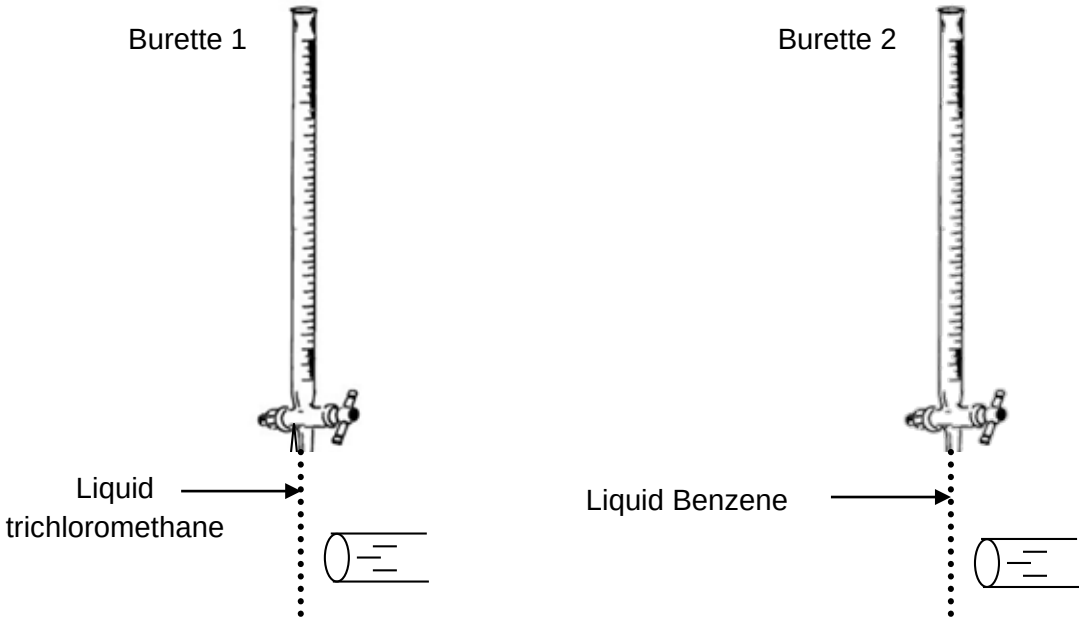
- **D** and **E** form ionic compounds Na_2**D** and Na_2**E** respectively.
- Element **E** forms **E**F_6 molecules whereas **D** is not able to do so.

Which pair of electronic configurations for **D** and **E** is correct?

	D	**E**
A	[He] $2s^2\,2p^2$	[Ne] $3s^2\,3p^4$
B	[He] $2s^2\,2p^2$	[Ne] $3s^2\,3p^2$
C	[He] $2s^2\,2p^4$	[Ne] $3s^2\,3p^2$
D	[He] $2s^2\,2p^4$	[Ne] $3s^2\,3p^4$

Answer: **D**

4 The diagram below shows liquid trichloromethane and liquid benzene flowing from burettes 1 and 2 respectively.



What would happen to the flow of the liquids trichloromethane and benzene when a negatively-charged rod is brought near to each of them?

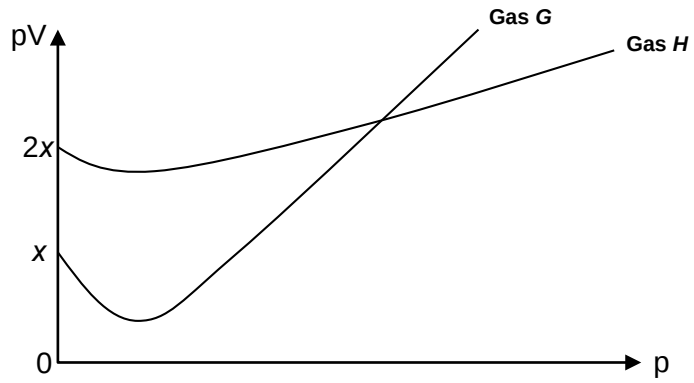
	Liquid trichloromethane	**Liquid benzene**
A	Deflected towards the rod	Deflected towards the rod
B	Undeflected	Deflected towards the rod
C	Deflected towards the rod	Undeflected
D	Undeflected	Undeflected

Answer: **C**

Liquid trichloromethane is polar. The partial positive charge can be attracted by the negatively charged rod.

Benzene is non-polar and does not have partial charges.

5 The value of pV is plotted against p for two gases, **G** and **H**, where p is the pressure and V is the volume of the gas.



Which of the following could be the identities of the gases?

		Gas G	Gas H
A		0.5 mol of H_2 at 25 ºC	0.5 mol of H_2 at 50 ºC
B		0.5 mol of H_2 at 25 ºC	1 mol of SO_2 at 25 ºC
C		0.5 mol of SO_2 at 25 ºC	0.5 mol of SO_2 at 50 ºC
D		0.5 mol of SO_2 at 25 ºC	1 mol of H_2 at 25 ºC

Answer: **D**

Amount of gas **H** should be twice the amount of gas **G**.
According to the shape of the curves, gas **G** should be a less ideal gas than gas **H**.

6 During an inspection, a small spacecraft of capacity 20 m^3 was connected to another of capacity 50 m^3. Before connection, the pressure inside the smaller craft was 40 atm and that inside the larger one was 150 atm.

Given that all measurements were made at the same temperature, What is the pressure of the system after the connection?

A	78 atm	**B**	95 atm	**C**	119 atm	**D**	190 atm

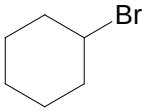
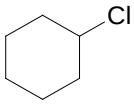
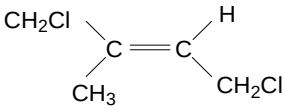
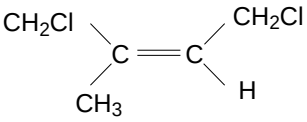
Answer: **C**

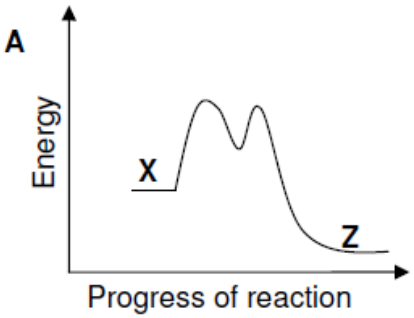
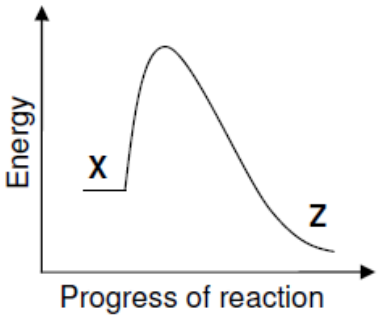
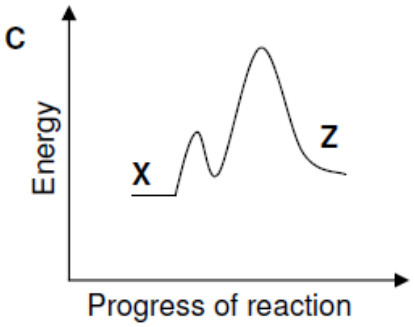
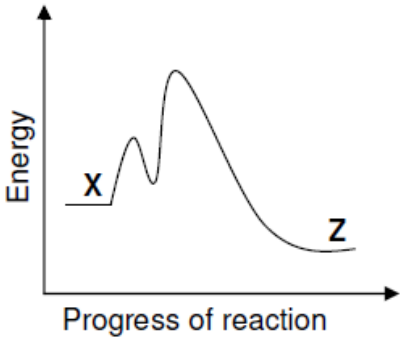
Amt of gas in small spacecraft = $\frac{pV}{RT}=\frac{(40)(20)}{RT}=\frac{800}{RT}$

Amt of gas in large spacecraft = $\frac{pV}{RT}=\frac{(150)(50)}{RT}=\frac{7500}{RT}$

total amt of moles of gas = $\frac{800+7500}{RT}=\frac{8300}{RT}$

Pressure in the combined arrangement = $\frac{nRT}{V}=\frac{\left(8300/RT\right)RT}{(20+50)}=119atm$

7	In which of the following pairs of compounds will compound **II** have a higher boiling point than compound **I**?				
			I	**II**	
	A				
	B		$CH_3CH_2CH_2CH_2CH_3$	$C(CH_3)_4$	
	C		$CH_3CH_2CH_2COOH$	$CH_3CH_2CH_2OH$	
	D				
	Answer: **D** A: I has higher Mr than II and hence has more extensive intermolecular VDW forces of attraction and a higher boiling point. B: I is linear and II is branched and hence has more extensive intermolecular VDW forces of attraction and a higher boiling point. C: I has more extensive intermolecular hydrogen bonding than II and hence a higher boiling point. D: I is non-polar and has temporary dipole-induced dipole interactions while II is polar and has permanent dipole-dipole interactions. Hence II has a higher boiling point.				

8	The conversion of compound **X** into **Z** was exothermic and proceeded by two steps, where **Y** was the intermediate. The steps involved were: Step 1: **X** ® **Y** Step 2: **Y** ® **Z** It was found that Step 1 is the rate-determining step. Which diagram represents the energy level diagram for the reaction?
	A  **B**  **C**  **D** 
	Answer: **A**

9 Pure nitrosyl chloride, NOC*l* gas, was heated at 320°C in a 2.0 dm^3 vessel. At equilibrium, 30% of the NOC*l* gas had dissociated according to the equation below and the total pressure was P atm.

$$2NOCl\ (g) \rightleftharpoons 2NO\ (g) + Cl_2\ (g)$$

What is value of the equilibrium constant, K_p?

A	$\frac{17.9}{p}$	**B**	$\frac{41.7}{p}$	**C**	0.0120p	**D**	0.0130p

Answer: **C**

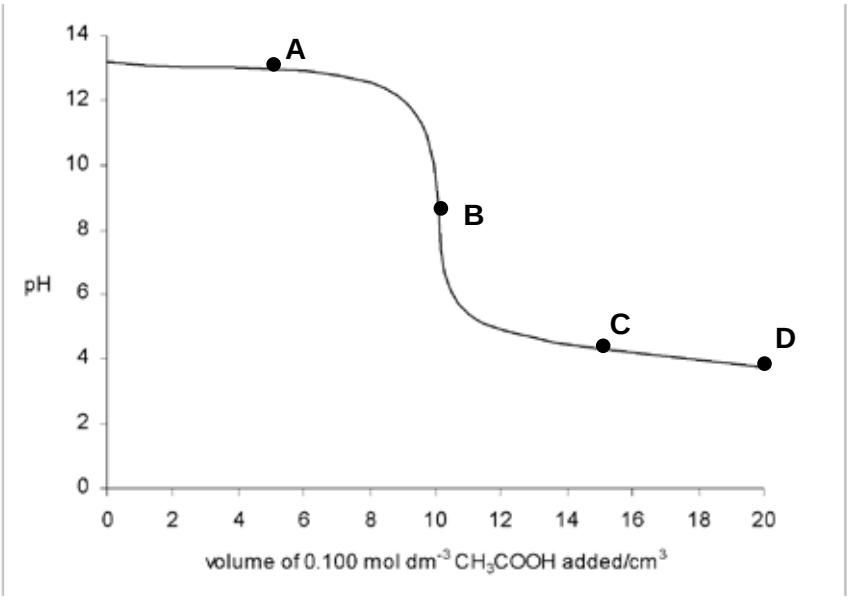
	2NOCl (g) $\rightleftharpoons$ 2NO (g) + Cl_2 (g)		
Initial partial pressure/atm	**x**	0	**0**
Change in partial pressure / atm	-0.3x	+0.3x	+0.15x
Equilibrium partial pressure / atm	0.7x	0.3x	0.15x
	0.6087p	0.2609p	0.1304p

0.7x + 0.3x + 0.15x = p
x = 0.8696p

$K_p = \frac{(0.2609p)(0.1304p)^2}{(0.6087p)^2}$
= 0.01197
= 0.0120p

10 The pH change when 0.100 mol dm^{-3} CH_3COOH is added drop-wise to 10.0 cm^3 of 0.100 mol dm^{-3} NaOH (aq) is shown below.

At which point on the graph does pH = pK_a, where K_a is the acid dissociation constant of the weak acid?



Answer: **D**

Regions **C** and **D** are where there is an excess of weak acid CH_3COOH as well as the salt $CH_3COO^-Na^+$ that is formed. Hence, buffer region.

At Region **D**,

Amt of $CH_3COO^-Na^+$ formed = $\frac{10}{1000} x 0.100 = 0.001$ mol

Amt of excess CH_3COOH added = $\frac{(20 - 10)}{1000} x 0.100 = 0.001$mol

Amt of $CH_3COO^-Na^+$ and CH_3COOH is the same, hence this is the point where there is maximum buffering capacity and pH = pK_a.

11 In an experiment, 70 cm^3 of water at 25ºC was brought to boiling point by burning butane in excess oxygen. Given that the standard enthalpy change of combustion of butane is -2877 kJ mol^{-1}, calculate the volume of butane needed if this process is only 85% efficient.

Assume that the specific heat capacity of water is 4.2 J g^{-1} K^{-1} and that 1 mole of gas occupies 24 dm^3 under the given conditions.

A	0.0721 dm^3	**B**	0.156 dm^3	**C**	0.184 dm^3	**D**	0.216 dm^3

Answer: **D**

Since **Q'** = mcΔT = 70 × 4.2 × (100.0 - 25.0) = 22050 J

Apparent amount of heat absorbed by water, **Q'**

= $\frac{85}{100}$**Q** (**Actual** amount of heat evolved by burning butane)

Actual amount of heat evolved, **Q** = $\frac{100}{85}$ x 22050 = 25941 J

$\Delta H_c^{\ominus}(CH_3CH_2CH_2CH_3) = -\frac{25941}{n} = -2877 \times 10^3$

Amount of butane = 9.017 x 10^{-3} mol

Volume of butane = 9.017 x 10^{-3} x 24 = **<u>0.216 dm^3</u>**

12 Which of the following changes does not alter the E^q value measured for a Cl_2/Cl^- half-cell that is under standard conditions?

	A	Adding water into the half-cell.
	B	Placing the half-cell in an ice bath.
	C	Adding copper(II) ions into the half-cell.
	D	Introducing an inert gas into the half-cell at a pressure of 1 atm through a separate inlet from the Cl_2 gas inlet.

Answer: **D**

A: Dilution causes the concentration of Cl^- ions to be lower than 1 mol dm^{-3}.

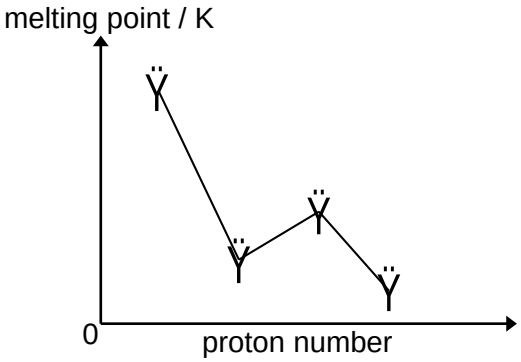
B: The ice bath lowers the temperature of the half-cell to less than 298 K.

C: Cu^{2+} ions will form a complex with Cl^- ions and lower the concentration of Cl^- ions to less than 1 mol dm^{-3}.

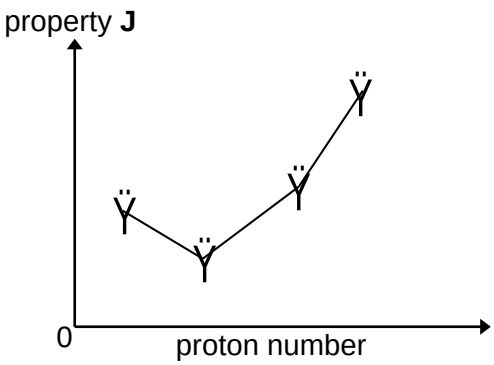
D: Introducing an inert gas through a separate inlet does not affect the pressure of Cl_2 gas hence doing so does not affect the E^q value of the half-cell.

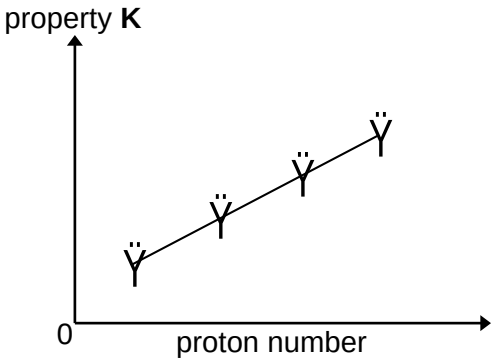
13	Which statement concerning the chlorine-containing compounds of elements in the third period, sodium to argon, is correct?	
	A	NaC*l* dissolves easily in water due to favourable ion-dipole interactions and the compound with the highest electrical conductivity in molten state is A*l*Cl_3.
	B	PCl_3 and Cl_2O_7 are both acidic in nature due to hydration of the compounds in water.
	C	The low boiling points of PCl_3 and Cl_2O_7 are due to the weak bond energies involved in the P-C*l* bonds and the C*l*-O bonds.
	D	The different oxidation states of chlorine in NaC*l* and Cl_2O_7 are due to the relative electronegativities of the pairing element and chlorine.
	Answer: **D** **A**: A*l*Cl_3 is a simple molecular structure, it does not conduct electricity. **B**: PCl_3 and Cl_2O_7 are both acidic in nature due to <u>hydrolysis</u> of the compounds in water. **C**: The low boiling points of PCl_3 and Cl_2O_7 are due to the weak <u>intermolecular</u> forces of attraction present and not related to bond energy.	

14 The diagram represents the melting points of four consecutive elements in the third period of the Periodic Table.



The sketches below represent another two properties of the elements.





What are properties **J** and **K**?

	property **J**	property **K**
A	third ionisation energy	electronegativity
B	number of valence electrons	boiling point
C	ionic radius	nuclear charge
D	electrical conductivity	atomic radius

Answer: **A**

15	Which of the following is true about the thermal decomposition of magnesium nitrate?	
	A	Sodium nitrate is thermally unstable as compared to magnesium nitrate.
	B	Every 1 mole of magnesium nitrate burnt gives 2.5 moles of gaseous products.
	C	The decomposition temperature of magnesium nitrate is higher than that of barium nitrate.
	D	The solid product of the thermal decomposition of magnesium nitrate readily dissolves in water to give an alkaline solution.
	Answer: **B** **A**: Sodium nitrate is more thermally stable than magnesium nitrate due to the lower charge density, and hence lower polarising power, of Na^+ as compared to Mg^{2+}, leading to a smaller polarising effect on the NO_3^- electron cloud. **B**: $2Mg(NO_3)_2$ (s) ® $2MgO$ (s) + $4NO_2$ (g) + O_2 (g) **C**: The decomposition temperature of magnesium nitrate is lower than that of barium nitrate due to the higher charge density, and hence greater polarising power, of Mg^{2+} as compared to Ba^{2+}, leading to a greater polarising effect on the NO_3^- electron cloud. **D**: MgO (s) dissolves very slowly, if at all, in water.	

16	Which of the following gives the best description of the reactions of Group II metals and their compounds?	
	A	All Group II metals react with steam to give hydrogen gas.
	B	Barium oxide is stored in oil due to its explosive reaction with oxygen gas in air.
	C	All Group II oxides undergo neutralisation with hot acids to give a salt and water.
	D	Beryllium hydroxide is amphoteric due to the high charge density of the Be^{2+} ion.
	Answer: **C** **A**: Be (s) does not react with steam. **B**: Ba (s), not barium oxide, is explosive in air. **D**: The acidic nature of $Be(OH)_2$ can be explained by its high charge density but not its basic nature.	

17 The table below shows the results of experiments in which the halogens, P_2, Q_2 and R_2 were added to separate aqueous solutions containing P^-, Q^- and R^- ions.

	P^- (aq)	Q^- (aq)	R^- (aq)
P_2	no reaction	no reaction	**R**$_2$ formed
Q_2	**P**$_2$ formed	no reaction	**R**$_2$ formed
R_2	no reaction	no reaction	no reaction

In which sequence is the solubility of the silver halides in aqueous ammonia arranged in **increasing** order?

A Ag**P** < Ag**Q** < Ag**R**

B Ag**Q** < Ag**P** < Ag**R**

C Ag**Q** < Ag**R** < Ag**P**

D Ag**R** < Ag**P** < Ag**Q**

Answer: **D**

From the table R_2 is the weakest oxidising agent while Q_2 is the strongest oxidising agent.

A logical deduction means Q_2 is chlorine, and R_2 is iodine.

Solubility of silver halides in NH_3 (aq) in increasing order is AgR, AgP and AgQ.

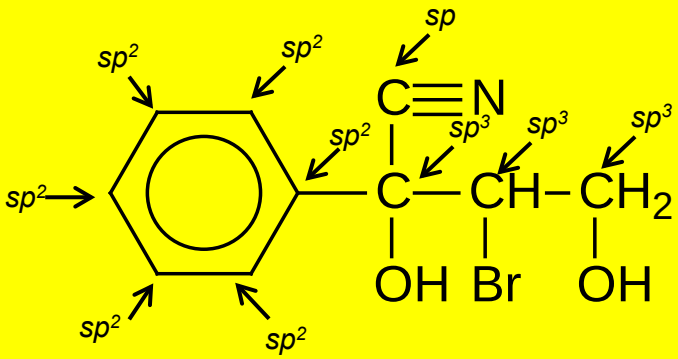
18 Aqueous sodium hydroxide was added to a pale green solution of a mixture of two metal cations. The resulting precipitate was treated with excess ammonia solution giving an intense deep blue mixture. The mixture was filtered giving a reddish−brown residue and a deep blue filtrate. The residue was washed with deionised water and treated with excess acidified ammonium thiocyanate giving a blood red solution.

Which of the following substances best explains these observations?

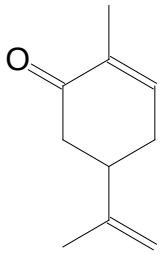
	reddish−brown residue	*deep blue filtrate*	*blood−red solution*
A	$Fe(OH)_2$	$Cu(OH)_2$	$[Fe(H_2O)_6]^{2+}$
B	$Fe(OH)_3$	$[Cu(NH_3)_4]^{2+}$	$[Fe(H_2O)_6]^{3+}$
C	$Fe(OH)_2$	$[Cu(H_2O)_6]^{2+}$	$[Fe(H_2O)_5SCN]^{2+}$
D	$Fe(OH)_3$	$[Cu(NH_3)_4]^{2+}$	$[Fe(H_2O)_5SCN]^{2+}$

Answer: **D**

19	Rhodium and its compounds are used as catalysts in many important reactions. Which of the following properties makes rhodium a suitable heterogeneous catalyst?	
	A	Rhodium has vacant d-orbitals of suitable energy.
	B	Rhodium exhibits variable oxidation states.
	C	Rhodium is able to form stable complexes.
	D	Rhodium is able to form coloured compounds.
	Answer: **A** The only answer to explain the feature of transition elements which allow them to function as heterogeneous catalyst. Statement B is more for homogeneous catalyst.	

20	Compound **S** was used in the following synthesis route.  Compound **S** What are the numbers of *sp*, sp^2 and sp^3 hybridised carbon atoms in compound **U**?			
	A	0, 6, 4	**C**	1, 6, 3
	B	0, 7, 3	**D**	1, 7, 2
	Answer: **C** Compound **U** is  			

21 Carvone is the main active ingredient found in spearmint and it has the following structure:



Carvone

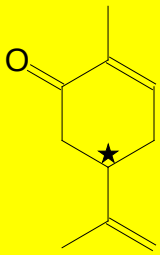
Carvone can be reduced to compound **V** by heating with hydrogen gas in the presence of nickel.

How many stereoisomers do the molecules of carvone and **V** each have?

		Carvone	**Compound V**
A		0	4
B		0	8
C		2	4
D		2	8

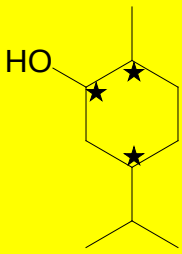
Answer: **D**

Carvone has one chiral carbon as shown:



hence is will have $2^1 = 2$ optical isomers

Compound **V** has 3 chiral carbon as shown:



hence is will have $2^3 = 8$ optical isomers

22	How many alcohols (including both structural and stereoisomers) can have the molecular formula $C_4H_{10}O$?	
	A	3
	B	4
	C	5
	D	6

Answer: **C**

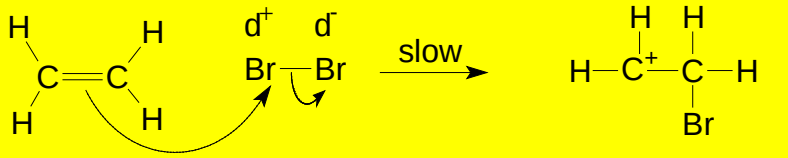
$CH_3CH_2CH_2CH_2OH$ $CH_3CH_2CH(OH)CH_3$ (presence of chiral carbon è 2 isomers)

$CH_3C(CH_3)CH_2OH$ $CH_3C(CH_3)(OH)CH_3$

23	A sample of ethene was added to a solution of Br_2 (aq) and NaC*l* (aq). Which of the following products is **not** likely to be found in the reaction mixture?			
	A	$CH_2(OH)CH_2Br$	**C**	$CH_2(OH)CH_2Cl$
	B	CH_2BrCH_2Cl	**D**	CH_2BrCH_2Br

Answer: **C**

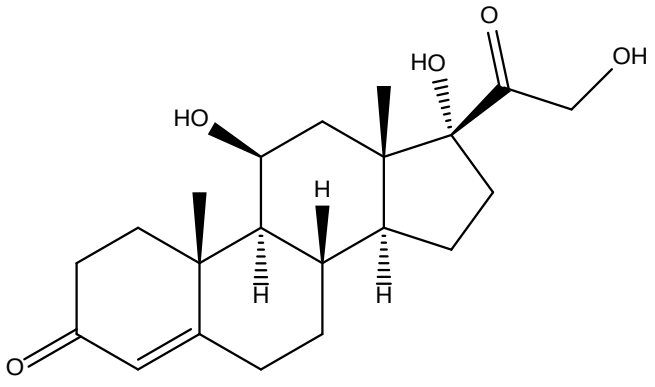
In the electrophilic substitution of ethane and Br_2(aq), the first step is:



carbocation intermediate

Hence, the product must contain at least one Br.

24 Hydrocortisone is a steroid hormone produced by the adrenal gland and is released in response to stress. It is commonly used as an active ingredient in anti-inflammatory creams.



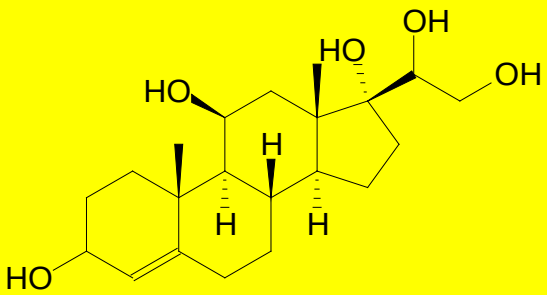
Hydrocortisone

Which of the following statement about hydrocortisone is true?

	A	When treated with an excess of hot concentrated acidified $KMnO_4$, it forms a compound containing 7 carbonyl groups.
	B	When warmed with aqueous alkaline iodine, a yellow precipitate is observed.
	C	When treated with cold dilute $KMnO_4$, it forms a compound containing 2 hydroxy groups.
	D	When treated with $NaBH_4$ in the presence of methanol, it forms a compound containing 5 hydroxy groups.

Answer: **D**

Ketone undergoes reduction to form:

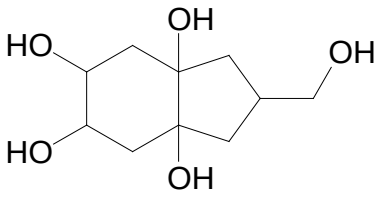


A: C=C, primary and secondary alcohol undergo oxidation to form a compound with 4 carbonyl groups.

B: No CH_3CO- or -$CH(CH_3)(OH)$ group observed.

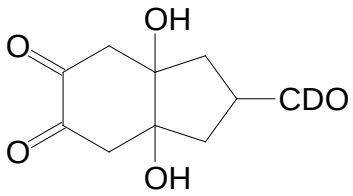
C: Only alkene undergoes mild oxidation to form a diol, a compound with 5 hydroxy groups is formed.

25 Deuterium, D, is an isotope of hydrogen, $^{2}_{1}H$.

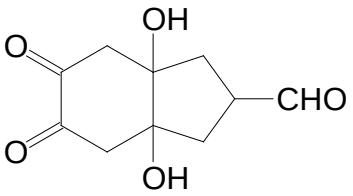


Which of the following is the product formed when the above compound reacts with hot $K_2Cr_2O_7$ in aqueous D_2SO_4 under controlled conditions?

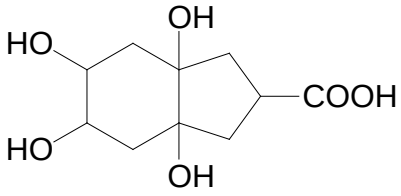
A



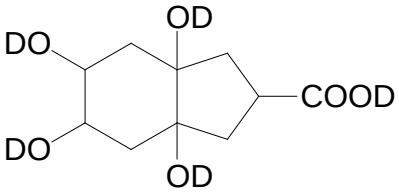
C



B

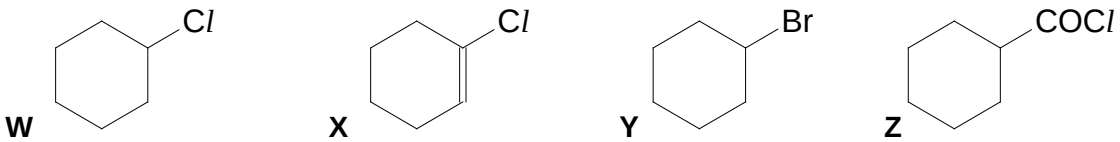


D



Answer: **C**

26 Which of the following shows the correct sequence in order of increasing ease of hydrolysis for the compounds below?



W **X** **Y** **Z**

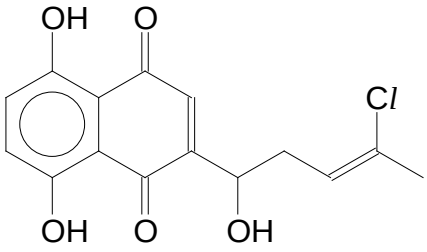
A **X < W < Y < Z**

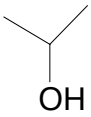
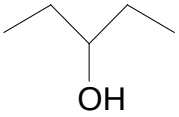
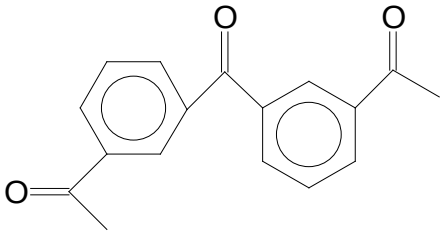
B **Z < X < W < Y**

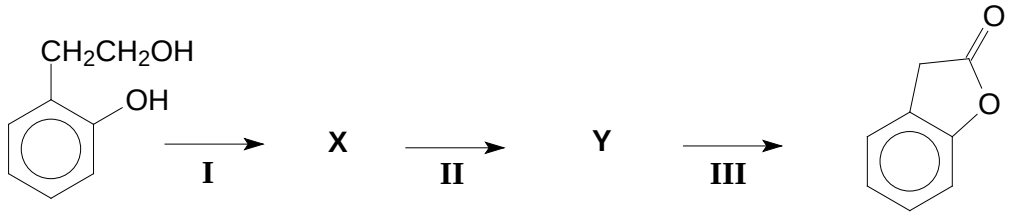
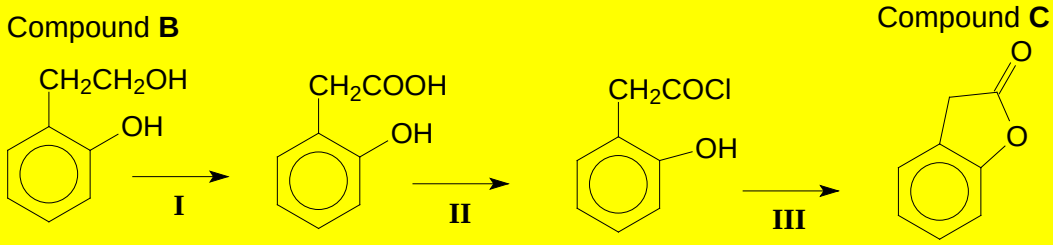
C **Z < Y < X < W**

D **W < X < Y < Z**

Answer: **A**
Acyl chloride, Z undergoes hydrolysis readily at rtp.
Strength of C-X bond: C-C*l* >C-Br
Ease of hydrolysis: R-C*l* < R-Br
For X, presence of double bond strengthen C-Br bond making nucleophilic sub less readily to happen.

27	Which of the following statement about compound **A** is true?  Compound **A**	
	A	When treated with alkaline Tollens' reagent, it forms a compound with molecular formula, $C_{15}H_{13}O_5Cl$.
	B	When reacted with PCl_5, 1 mole of HCl (g) are formed.
	C	When heated with H_2 (g) in the presence of Ni catalyst, it forms a compound containing 3 hydroxy groups.
	D	When treated with sodium hydroxide, hydrolysis occurred.
	Answer: **B** **A**: Compound with formula, $C_{15}H_{11}O_5Cl$ is formed as phenol undergoes neutralisation with alkaline Tollens' reagent. **B**: Only 1 mole of HCl(g) is formed as phenol do not react with PCl_5 **C**: After reduction of ketone and C=C, a compound containing 5 hydroxy groups is formed. **D**: Neutralisation occurred not hydrolysis.	

28	What is the ratio of sodium iodide formed when each of the three compounds reacts with alkaline aqueous iodine?   	
	A	1:1:1
	B	5:0:6
	C	5:0:3
	D	1:1:2
	Answer: **B**	

29	Compound **B** can be converted to compound **C** as shown below.  Compound **B** Compound **C** Which of the following statements is correct with regards to the given reaction scheme?	
	A	Step **I** may involve the use of PCl_5.
	B	Step **I** may involve the use of hot acidified potassium manganate(VII).
	C	Step **III** may involve the use of aqueous sodium hydroxide.
	D	Step **III** may involve the use of hot concentrated sulfuric acid.
	Answer: **C**  Step **I**: hot, acidified $K_2Cr_2O_7$ Step **II**: PCl_5, rtp Step **III**: NaOH (aq), rtp (to form phenoxide)	

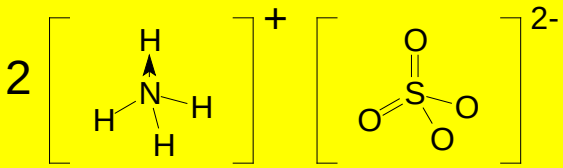
30	A polypeptide, was partially hydrolysed using two different enzymes and the fragments were separated. Analysis of the fragments gave the following results: Using enzyme D: glu-val-phe glu-asp-leu ala-ser val-ala Using enzyme E: val-phe ala-glu-asp val ser-glu leu-ala What is the amino acid sequence of the polypeptide?	
	A	leu-ala-ser-glu-val-phe-val-ala-glu-asp
	B	ala-glu-asp-leu-ala-ser-glu-val-phe-val
	C	glu-val-phe-ala-glu-asp-leu-ala-ser-val
	D	val-ala-glu-asp-leu-ala-ser-glu-val-phe
	Answer: **D**	

Section B

For **questions 31-40**, one or more of the numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct. The responses **A** to **D** should be selected on the basis of:

A	B	C	D
1, **2** and **3** are correct	**1** and **2** only are correct	**2** and **3** only are correct	**1** only is correct

No other combination of statements is to be used as a correct response.

31	The compound ammonium sulfate is primarily used as a fertiliser for alkaline soils. Which type(s) of bonding is/are found in the compound?	
	1	ionic
	2	covalent
	3	dative bond
	Answer: **A** (**1**, **2** and **3**) 	

32	The rate of reaction of a strip of magnesium ribbon and 45 cm^3 of 1.5 mol dm^{-3} HNO_3 is determined at 25°C. Which of the following cases would both conditions contribute to an increase in the rate of reaction?	
	1	Mg powder and 90 cm^3 of 1.5 mol dm^{-3} HNO_3
	2	Mg powder and 45 cm^3 of 2.0 mol dm^{-3} HNO_3
	3	45 cm^3 of 2.0 mol dm^{-3} HNO_3 at 35°C
	Answer: **C** (**2** and **3** only) **1**: Use of Mg powder increases rate of reaction due to increase in surface area of reaction but increase in volume does not increase rate of reaction. **2**: Use of Mg powder increases rate of reaction due to increase in surface area of reaction and increase in concentration of HNO_3 increases rate of reaction due to increase in effective collisions. **3**: Increase in concentration and temperature increases rate of reaction due to increase in effective collisions.	

33 Which of the following statements is/are correct for the following equilibrium?

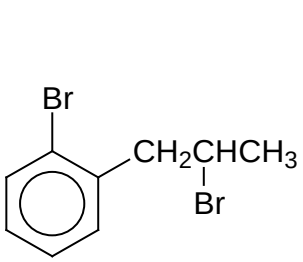
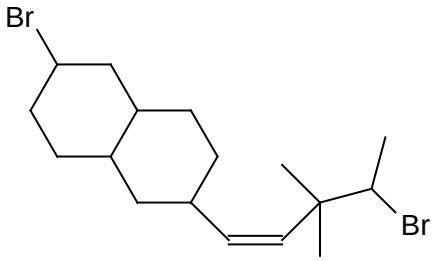
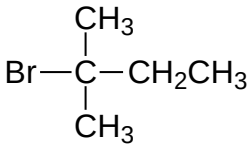
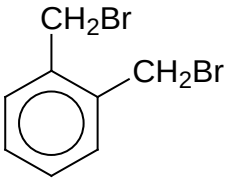
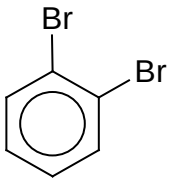
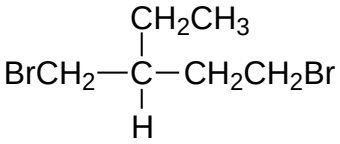
$$3H_2\,(g) + N_2\,(g) \rightleftharpoons 2NH_3\,(g) \qquad \Delta H < 0$$

	Condition	Position of equilibrium	K_p	Rate of formation of NH_3
1	Increase in pressure	Right	No change	Increase
2	Decrease in temperature	Right	Increase	Decrease
3	Addition of catalyst	Left	No change	Increase

Answer: **B** (**1** and **2** only)

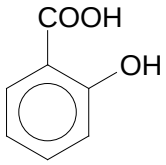
	Condition	Position of equilibrium	K_p	Rate of forward reaction
1	Increase in pressure	Right (Ö) Position of eqm will shift to decrease amt of gases.	No change (Ö) K_p is independent of pressure	Increase (Ö) Increase in pressure results in increase number of effective collisions.
2	Decrease in temperature	Right (Ö) Position of eqm will shift to forward exothermic reaction.	Increase (Ö) Forward rate constant will decrease less than backward rate constant, hence K_p increases	Decrease (Ö) Decrease in temperature leads to lower kinetic energy and decrease in number of effective collisions.
3	Addition of catalyst	Left (x) Catalyst does not affect eqm position	Increase (x) K_p is independent of catalyst	Increase (Ö) Catalyst increases rate of reaction.

34	Which of the following indicators can be used for the titration between ethylamine and hydrochloric acid?				
			Indicator	**pH transition range**	
	1		Naphtholphthalein	7.3 – 8.7	
	2		Congo red	3.0 – 5.0	
	3		Azolitmin	4.5 – 8.3	
	Answer: **C** (**2** and **3** only) For the titration between ethylamine and hydrochloric acid, it is a strong acid/weak base titration. Hence, at equivalence point of titration, pH increases sharply from » 3 to 7. Only Congo red and Azolitmin pH transition range) lies within the rapid pH change (» 3 to 7) over the equivalence point				

35	In which of the following pairs will compound **I** and compound **II** give the same number of cis-trans isomers after reaction with hot ethanolic potassium hydroxide?	
		I **II**
	1	 
	2	 
	3	 
	Answer: **A** (**1**, **2** and **3**) Pair 1 both give 2 cis-trans isomers. Pair 2 and 3 both give 0 cis-trans isomers.	

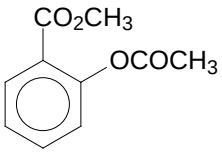
36	Which of the following processes lead(s) to an increase in entropy?	
	1	Diffusion of CFCs into the stratosphere.
	2	Combustion of a piece of charcoal to form CO_2 (g) and H_2O (g).
	3	Desalination of sea water by reverse osmosis (solvent passes from a more concentrated solution to a more dilute solution).
	Answer: **B** (**1** and **2** only) For option 3, there is an increase in orderliness as the solvent passes from a more concentrated solution to a more diluted solution. Hence, entropy will decrease.	

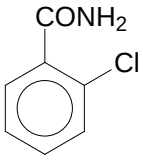
37 The diagram shows the structure of salicylic acid:

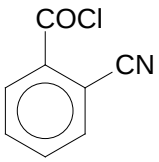


salicylic acid

Which compound(s) give(s) salicylic acid on acidic hydrolysis?

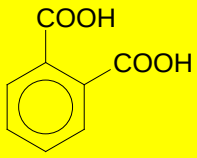
1 

2 

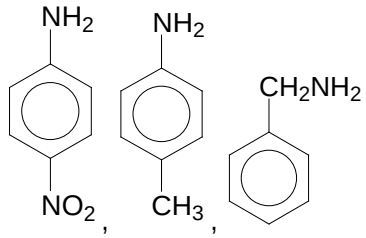
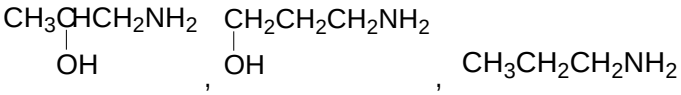
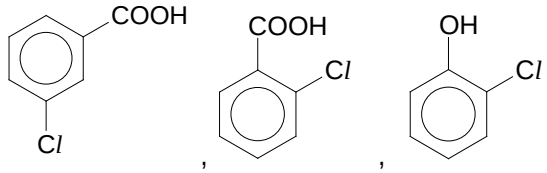
3 

Answer: **D** (**1** only)

2: Halogenoarenes do not undergo nucleophilic substitution.

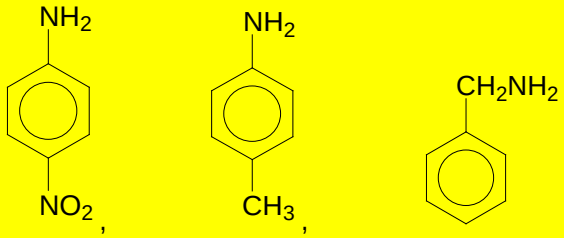
3: 

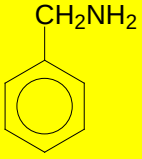
will be formed instead.

38	In which of the following sequences does the value of pK_b decrease?	
	1	
	2	
	3	

Answer: **B** (**1** and **2**)

pK_b decreases means weakest base to strongest base or strongest acid to weakest acid.

1: 

- The **electron donating alkyl** group **increases** the **availability** of the **lone pair of**  **electrons on N** atom **to accept a proton via a dative bond**. Hence, is the strongest base.

4-methylphenylamine is a **stronger** base than 4-nitrophenylamine.

- The presence of the **electron-donating methyl group** in 4-methylphenylamine **reduces** the **delocalization** of the **lone pair of electrons on N into benzene ring**.
- This **increases** the **availability** of lone pair of electrons **to accept a proton via dative bond**.

2: $CH_3\underset{\underset{OH}{|}}{C}HCH_2NH_2$, $CH_2\underset{\underset{OH}{|}}{C}H_2CH_2NH_2$, $CH_3CH_2CH_2NH_2$

· The **electron donating alkyl** group **increases** the **availability** of the **lone pair of electrons on N** atom **to accept a proton via a dative bond**. Hence, $CH_3CH_2CH_2NH_2$ is the strongest base.

· **Proximity** of withdrawing –OH substituent to NH_2 group:

$CH_3\underset{\underset{OH}{|}}{C}HCH_2NH_2$ > $CH_2\underset{\underset{OH}{|}}{C}H_2CH_2NH_2$

Electron withdrawing effect: $CH_3\underset{\underset{OH}{|}}{C}HCH_2NH_2$ > $CH_2\underset{\underset{OH}{|}}{C}H_2CH_2NH_2$

Availability of the **lone pair of electrons on N** atom **to accept a proton via a dative bond:** $CH_2\underset{\underset{OH}{|}}{C}H_2CH_2NH_2$ > $CH_3\underset{\underset{OH}{|}}{C}HCH_2NH_2$

Strength of base: $CH_2\underset{\underset{OH}{|}}{C}H_2CH_2NH_2$ > $CH_3\underset{\underset{OH}{|}}{C}HCH_2NH_2$

3: The order of the acidity is already incorrect to begin.

39	*Use of the Data Booklet is relevant to this question.* A student set up an electrolytic cell for the purpose of purifying copper metal. However, the set-up did not lead to successful purification of copper. Which of the following could explain the failure of the set-up?	
	1	The electrolyte used was aqueous chromium(III) chloride.
	2	The impure copper was used as the cathode and the anode was made of pure copper metal.
	3	The E^{q}_{cell} for the reaction is a negative value.
	Answer: **B** (**1** and **2** only) **1**: Chromium metal would be deposited on the cathode before copper metal, hence leading to the failure of the purification of copper. **2**: Impure copper should be the anode and the cathode should be pure copper metal. When the polarities are switched, the pure copper anode would be oxidised and copper metal would be deposited on the impure copper cathode, leading to the failure of the purification of copper. **3**: Even if E^{q}_{cell} is a negative value, the reaction can still occur because electricity is the source of energy for a chemical reaction to take place in an electrolytic cell.	

40	Vanadium has the electronic structure $1s^2 2s^2 2p^6 3s^2 3p^6 3d^3 4s^2$. Which of the following vanadium compounds is/are likely to exist?	
	1	V_2O_5
	2	VO*Cl*
	3	$K_2V_2O_7$
	Answer: **B** (**1** and **2** only) Oxidation of Vanadium in $V_2O_7^{2-}$ is expected to be 6 which is not possible.	