ANGLO-CHINESE JUNIOR COLLEGE
DEPARTMENT OF CHEMISTRY
Preliminary Examination

CHEMISTRY **9729/01**
Higher 2

Paper 1 Multiple Choice

16 September 2020

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, index number and tutorial class on the Answer Sheet in the spaces provided unless this has been done for you.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A**, **B**, **C** and **D**.

Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

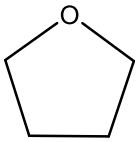
Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

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

1 In July 2020, some households in Singapore reported a Pandan smell in their tap water. This was caused by an organic solvent tetrahydrofuran, THF, which has the following structure.



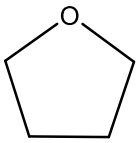
The laboratory found that the concentration of THF in the Pandan smelling water was less than 10 ppb (10 parts per billion) by mass, which was significantly lower than the levels of THF that would cause health concerns.

What is the concentration of 10 ppb of THF in mol dm^{-3}?

Given:
- 1 billion = 10^9
- density of water = 1.0 g cm^{-3}

	A	1.39 x 10^{-10}	
	B	1.39 x 10^{-7}	
	C	1.56 x 10^{-7}	
	D	6.40 x 10^{-4}	

Answer: B



M_r of THF = (12 x 4) + (1 x 8) + 16 = 72.0

In 10^9 g of water, there is 10g of THF (10ppb)

1 dm^3 = 1000 cm^3 of water
Since density is 1.0 gcm^{-3}
1000 cm^3 of water is 1000 g

Hence, in 1000 g of water, mass of THF = $\frac{10}{10^9} \times 1000$

= 1.00 x 10^{-5} g

	Amount of THF = $1.00 \times 10^{-5} \div 72.0$ $= 1.39 \times 10^{-7}$ mol dm^{-3}

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

The approximate percentage composition of the atmospheres on four planets are given below.

The density of a gas may be defined as the mass of 1 dm^3 of the gas.

Which mixture of gases has the greatest density?

		planet	gases / % by volume
	A	Jupiter	H_2 88.8, He 10.2, Ar 1.0
	B	Neptune	H_2 80.0, He 19.0, CH_4 1.0
	C	Saturn	H_2 92.3, He 7.2, CH_4 0.5
	D	Uranus	H_2 82.5, He 15.2, CH_4 2.3

Answer: D

Density of mixture in option A = $\frac{88.8 \times 2.0 + 10.2 \times 4.0 + 1.0 \times 39.9}{100}$ = 2.583
Density of mixture in option B = $\frac{80.0 \times 2.0 + 19.0 \times 4.0 + 1.0 \times 16.0}{100}$ = 2.52
Density of mixture in option C = $\frac{92.3 \times 2.0 + 7.2 \times 4.0 + 0.5 \times 16.0}{100}$ = 2.214
Density of mixture in option D = $\frac{82.5 \times 2.0 + 15.2 \times 4.0 + 2.3 \times 16.0}{100}$ = 2.626

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

An element **E** can exist in a few oxidation states. 0.01 mol of $\mathbf{E}^{2+}$ is completely reacted with 0.004 mol of acidified $KMnO_4$.

What is the final oxidation state of **E**?

A	+4	**B**	+3	**C**	0	**D**	−1

Answer: A

MnO_4^- + $8H^+$ + $5e^-$ ⇌ Mn^{2+} + $4H_2O$
0.004 mol MnO_4^- gains 0.004 × 5
= 0.020 mol of e^-.
0.01 mol $\mathbf{E}^{2+}$ loses 0.020 mol of e^-.
⇒ 1 mol $\mathbf{E}^{2+}$ loses 2 mol of e^-.
O.S. of **E** increases from +2 to +4.

4 The successive ionisation energies (IE) of two elements, **M** and **N**, are given below.

IE / kJ mol^{-1}	1st	2nd	3rd	4th	5th	6th	7th	8th

M	550	1065	4138	5500	6910	8760	10230	11800
N	1140	2103	3470	4560	5760	8550	9940	18600

What is the likely formula of the compound that is formed between **M** and **N**?

A	**MN**	**B**	**MN_2**	**C**	**M_2N**	**D**	**M_3N_2**

Answer: B

M shows the largest increases from the 2nd to 3rd IE, so it has 2 valence electrons and it is from group 2.

N shows the largest increases from the 7th to 8th IE, so it has 7 valence electrons and it is from group 17.

M^{2+} and N^- ions form MN_2.

5 Which of the following statements best explains why the first ionisation energy of argon is higher than that of sulfur?

A	Sulfur is more electronegative than argon.
B	Argon has a complete octet, while sulfur does not.
C	The nuclear charge in argon is greater than that in sulfur.
D	The electron removed from sulfur is unpaired, while that removed from argon is paired.

Answer: C

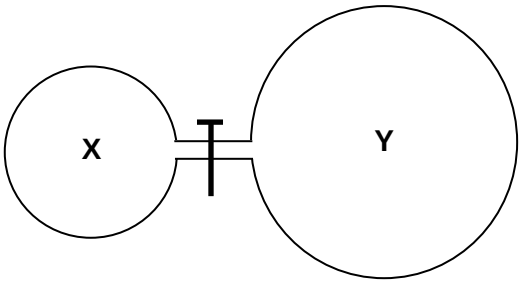
Statement **A** is wrong because electronegativity describes the attraction of the nucleus and a bonding pair of electrons between two covalently bonded atoms, and not the energy needed for removing a valence electron from a gaseous atom.

Statement **B** is wrong the complete octet does not describe the strength of attraction between the nucleus and its valence electrons.

Statement **C** is correct because stronger nuclear charge and approximately constant shielding effect in Ar leads to stronger effective nuclear charge. Thus Ar has greater nuclear attraction and more energy is needed to remove an electron from the valence shell, thus 1st IE is greater in Ar than S.

Statement **D** is wrong because the first electron removed from sulfur and argon are both from an electron pair.

6 Two glass bulbs **X** and **Y** are connected by a closed valve.



X contains neon at 20 °C at a pressure of 1 x 10^5 Pa. **Y** is initially empty, and has three times the volume of **X**. In an experiment, the valve is opened and the temperature of the whole apparatus is raised to 100 °C.

What is the final pressure in the system?

	A	3.18 × 10^4 Pa
	B	4.24 × 10^4 Pa
	C	1.25 × 10^5 Pa
	D	5.09 × 10^5 Pa

Answer: A

Since amount of Ne remains constant,
pV= nRT simplifies to

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

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

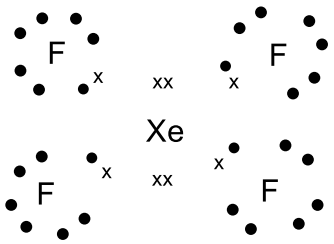
$$p_2 = 3.18\times10^4$$

7 Which of the following species is **not** planar?

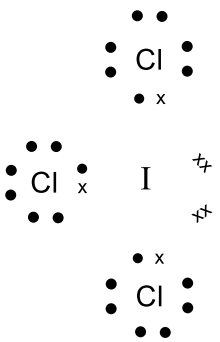
A	XeF_4	**B**	ICl_3	**C**	PCl_4^+	**D**	C_2Cl_4

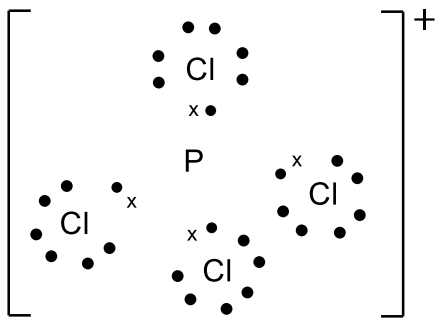
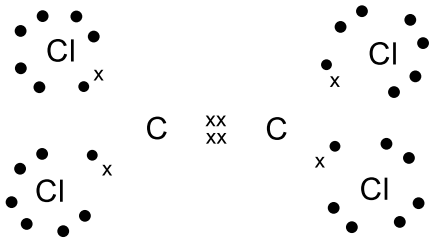
Answer: C

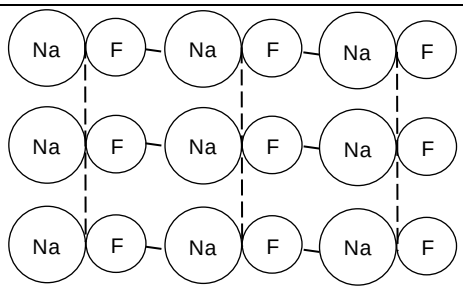
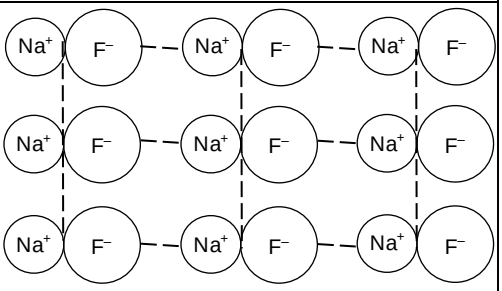
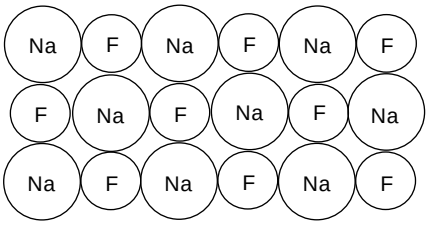
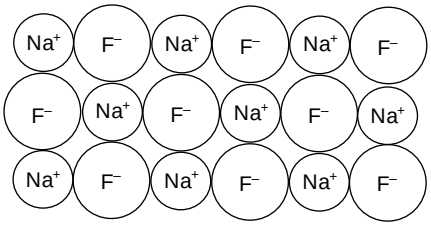
A: Square planar



B: T-shaped



	C: Tetrahedral  	**D: Planar (Trigonal planar about each C atom** 

8	Which diagram best represents the structure of sodium fluoride?			
	A	 	**C**	
	B	 	**D**	
	Answer: D A and B are wrong because they are made up of atoms of Na and F. A and C also show Na & F (or Na^+ & F^-) particles in pairs, instead of an alternating lattice structure. The giant ionic lattice does not consist of ionic pairs or atomic pairs with intermolecular forces. D is the only diagram that correctly depict all three features coorectly - Na^+ & F^- ions (not Na & F atoms), - Na^+ & F^- ions that are larger than Na+ ions, and - Alternating arrangement of Na^+ & F^- ions in a giant ionic lattice structure			

9 An experiment was carried out to investigate the kinetics of reaction between potassium peroxodisulfate, $K_2S_2O_8$, and potassium iodide, KI.

$$2I^- + S_2O_8^{2-} \rightarrow I_2 + 2SO_4^{2-}$$

In each experiment, $K_2S_2O_8$ and KI solutions are mixed with fixed volumes of $Na_2S_2O_3$ and starch solutions. The initial concentrations of the $K_2S_2O_8$ and KI solutions in the mixture and the time taken for the mixture to turn dark blue for the various experimental runs are given below.

experiment	initial concentration of $K_2S_2O_8$ / mol dm^{-3}	initial concentration of KI / mol dm^{-3}	time taken to turn dark blue / s
1	0.010	0.020	35
2	0.005	0.020	70
3	0.010	0.004	175
4	0.020	0.040	

What is the time taken (in seconds) for the mixture to turn dark blue in experiment 4?

A	8.75	**B**	17.5	**C**	35	**D**	140

Answer: A

Comparing experiment 1 and 2, when $[K_2S_2O_8]$ doubles from 0.005 mol dm^{-3} to 0.01 mol dm^{-3}, relative rate of reaction doubles from $\frac{1}{70}$ to $\frac{1}{35}$. Hence the reaction is 1st order wrt to $[K_2S_2O_8]$.

Comparing experiment 1 and 3, when [KI] increases by 5 times from 0.004 mol dm^{-3} to 0.02 mol dm^{-3}, relative rate of reaction increases by 5 times from $\frac{1}{175}$ to $\frac{1}{35}$. Hence the reaction is 1st order wrt to KI.

Comparing reaction 1 and 4, when [KI] doubles and $[K_2S_2O_8]$ doubles, rate of reaction quadruples from $\frac{1}{35}$ to $\frac{1}{8.75}$. Hence the expected time taken in experiment 4 is 8.75 s.

10 In which of the following is the underlined species behaving as a Bronsted-Lowry base?

1 $NH_4^+ + \underline{H_2O} \rightleftharpoons NH_3 + H_3O^+$

2 $H_2SO_4 + \underline{HNO_3} \rightleftharpoons HSO_4^- + H_2NO_3^+$

3 $CH_3COCH_3 + \underline{NaNH_2} \rightleftharpoons CH_3OCH_2^- + Na^+ + NH_3$

A	1 only	**C**	3 only
B	1 and 2 only	**D**	1, 2 and 3 only

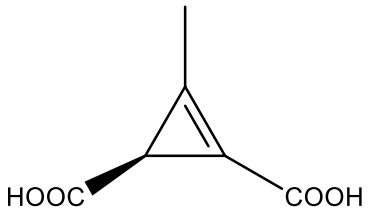
	Answer: D In 1, H_2O accepted a proton from NH_4^+, HNO_3 accepted a proton from H_2SO_4 and NH_2^- accepted a proton from CH_3COCH_3 hence they are all Bronsted-Lowry bases.

11	Which of the following statements best explains why AgC*l* is soluble in aqueous NH_3, but AgI is not?	
	A	AgC*l* forms a complex with NH_3 but AgI does not.
	B	The solubility product, K_{sp}, of AgC*l* is greater than that of AgI.
	C	The M_r of AgI is greater than that of AgC*l*.
	D	The ionic bonds between Ag^+ and I^- are stronger than the ionic bonds between Ag^+ and Cl^-.
	Answer: B Ag^+ in both AgCl and AgI forms a complex $[Ag(NH_3)_2]^+$ with aqueous ammonia. Ionic product will decrease. However, since AgCl has a larger K_{sp} value than AgI, the formation of the complex only causes the ionic product to decrease below the Ksp of AgCl, hence only AgCl is soluble in aqueous ammonia but not AgI. Ionic bonds between Ag^+ and Cl^- are stronger since Cl^- has a smaller ionic radius than I^- hence, lattice energy of AgCl is more exothermic. This does not explain the solubility of AgCl in aqeuous ammonia. The relative molar mass of AgI and AgCl are irrelevant to the solubility in aqueous ammonia	

12 In 1893, a new compound Feist's acid was discovered and found to be optically active.

Based on the above information, which of the following could be the structures of Feist's acid?

1



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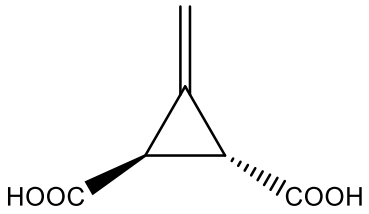

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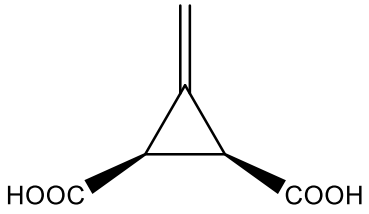


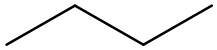
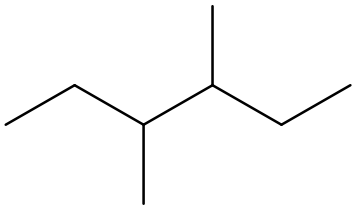
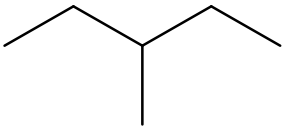
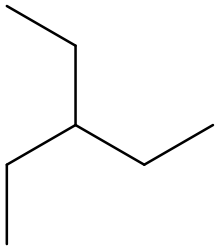
	A	1 only	**C**	1 and 3 only
	B	1 and 2 only	**D**	1, 2 and 3

Answer: B

1 has a chiral centre and no plane of symmetry, so it is a chiral compound.
2 has two chiral centres and no plane of symmetry, so it is a chiral compound.
3 has two chiral centres and a plane of symmetry, so it is NOT a chiral compound.

13 In the presence of ultraviolet light, ethane and bromine react to give a mixture of products.

Which compound **cannot** be present in the mixture of products?

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

Answer: D

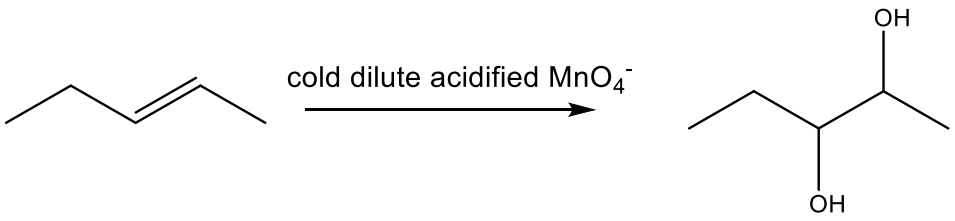
During the combination of alkyl radicals to give alkanes, the total number of carbons present in the final product need to be even numbers because the initial alkane has two carbons.

Structure in option **D** has seven carbons which is an odd number of carbons and hence cannot be a product of the reaction.

14 When pent-2-ene is reacted with cold dilute acidified potassium manganate(VII), what will be the major product(s)?

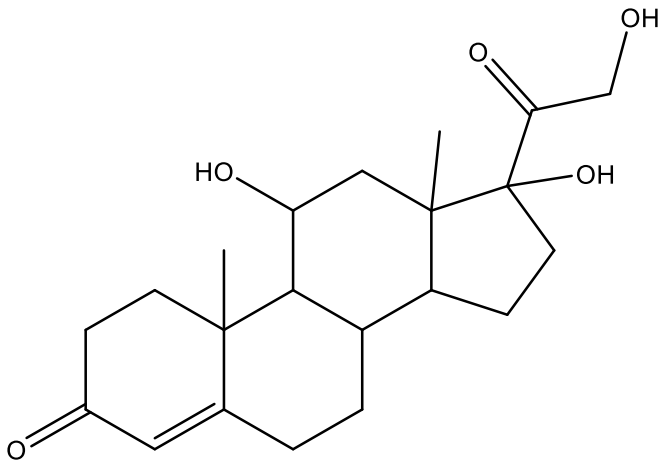
	A	$CH_3CH_2COCOCH_3$
	B	$CH_3CH_2CH_2CH(OH)CH_3$
	C	$CH_3CH_2CH(OH)CH(OH)CH_3$
	D	CH_3CH_2COOH and CH_3COOH

Answer: C



With cold dilute acidified manganate(VII), alkenes undergo mild oxidation to give diols hence **C** is the correct answer.

15 Cortisol is a hormone involved in the metabolism of fats, proteins and carbohydrates.

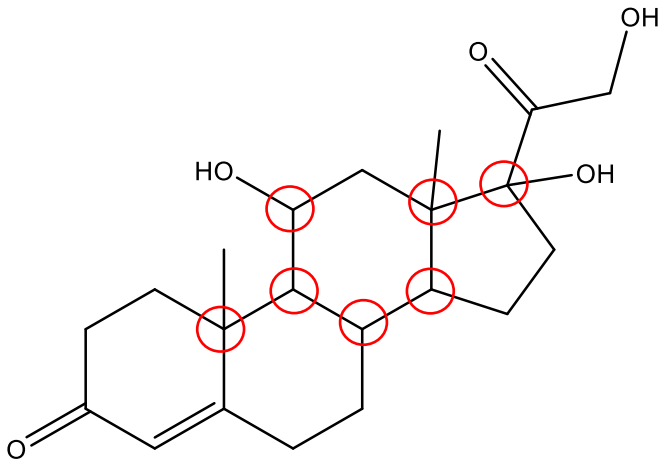


cortisol

How many chiral centres are there in one molecule of cortisol?

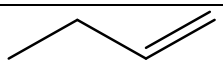
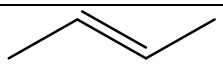
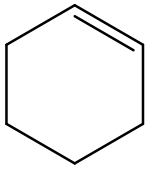
A	5	**B**	6	**C**	7	**D**	8

Answer: C



Chiral centres are circled

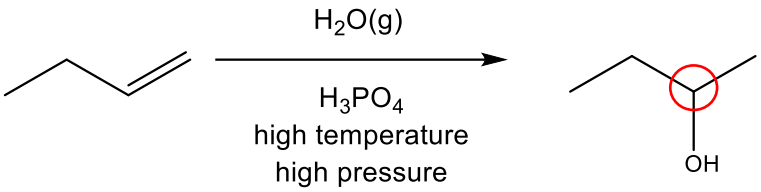
16 Which alkenes, on reaction with steam at high temperature and pressure in the presence of a phosphoric acid catalyst, could produce an alcohol containing a chiral carbon atom?

1	
2	
3	

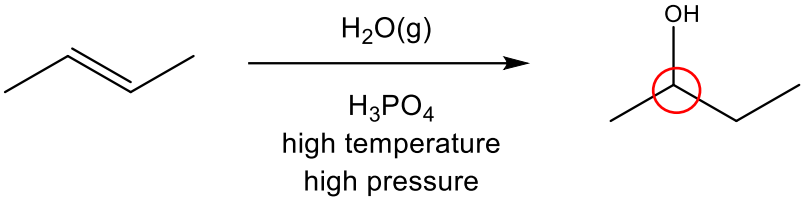
A	1 only	**B**	1 and 2 only	**C**	2 and 3 only	**D**	1, 2 and 3

Answer: B

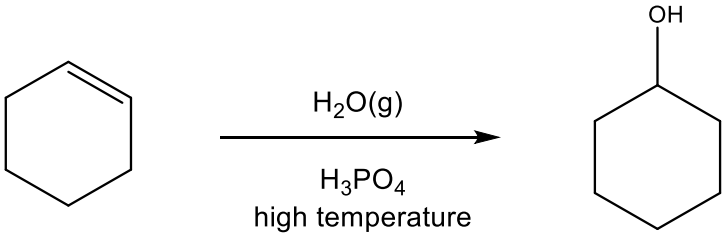
1. chiral carbon circled



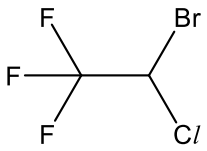
2. chiral carbon circled



3. no chiral carbon present



17 Halothane is a general inhalation anesthetic used for the induction and maintenance of general anesthesia.



halothane

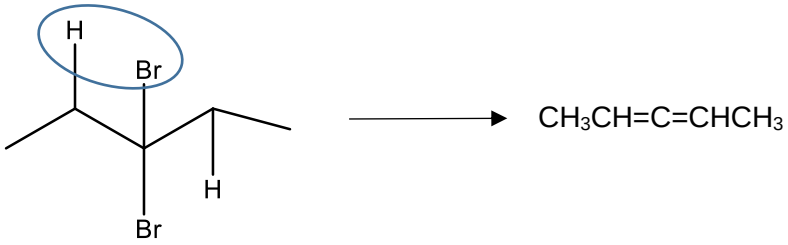
Which statement about halothane is correct?

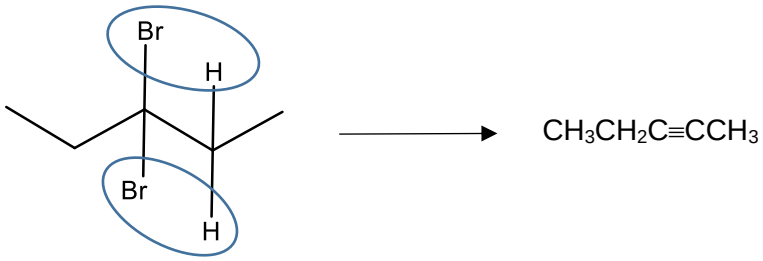
	A	Halothane is highly flammable.
	B	The molecule has two chiral centres.
	C	It may cause the depletion of the ozone layer.
	D	Its IUPAC name is 1-bromo-2-chloro-1,1,1-trifluroethane.

	Answer: C Option A Incorrect. Chlorofluorocarbons (CFCs) are not flammable and can be used in fire extinguishers. Option B Incorrect. The $–CF_3$ carbon is achiral. Option C Correct. The C–C*l* and C–Br bonds might be homolytically cleaved under ultraviolet light to produce halogen radicals that attack ozone. Option D Incorrect. The correct IUPAC name is **2**-bromo-2-chloro-1,1,1-trifluroethane.

18	When $CH_3CH_2CBr_2CH_2CH_3$ is heated with ethanolic KOH, which hydrocarbons could be produced?						
	1	$CH_3CH_2C{\equiv}CCH_3$					
	2	$CH_3CH{=}C{=}CHCH_3$					
	3	$CH_3CH_2CH{=}C{=}CH_2$					
	A	2 only	**B**	1 and 2 only	**C**	2 and 3 only	**D** 1, 2 and 3

Answer: B

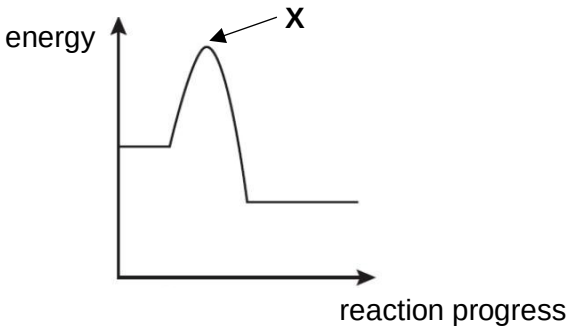




19 When (bromomethyl)benzene was heated with NaOH in dimethyl sulfoxide solvent, the following reaction takes place.

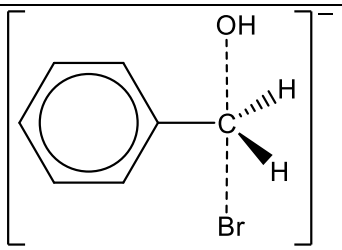
$$C_6H_5CH_2Br + OH^- \rightarrow C_6H_5CH_2OH + Br^-$$

The energy profile diagram for the reaction is shown below.

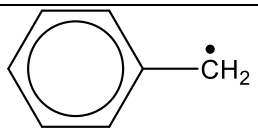


Which of the following represents the species at point **X**?

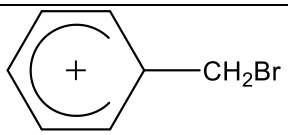
A



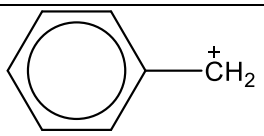
B



C



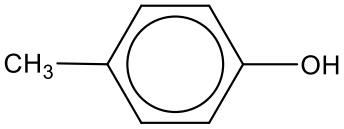
D



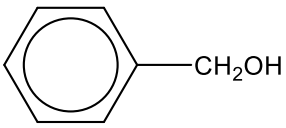
Answer: A

This is a nucleophilic substitution because the attacking species is the nucleophile :OH^-. Since the reaction profile only has one hump, the mechanism occurs in one step (concerted bond forming and bond breaking). Therefore, it is a bimolecular nucleophilic substitution, S_N2, mechanism. And it occurs via a trigonal bipyramidal transition state (ie. option A).

20 4-methylphenol and phenylmethanol are isomers.



4-methylphenol



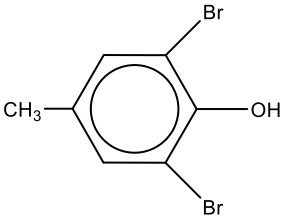
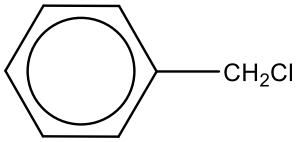
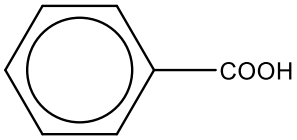
phenylmethanol

Which of the following reagents can be used to distinguish between 4-methylphenol and phenylmethanol?

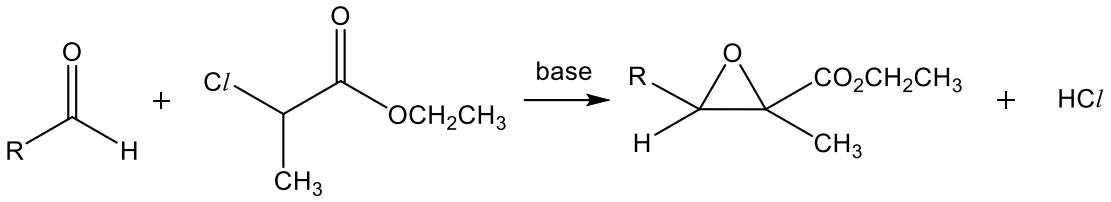
	1	aqueous bromine
	2	phosphorus(V) chloride

	3	neutral iron(III) chloride solution		
	4	hot acidified potassium dichromate(VI)		
	A	1 and 3 only	**C**	1, 2 and 3 only
	B	3 and 4 only	**D**	1, 2, 3 and 4

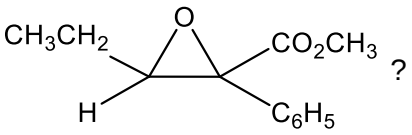
Answer: D

reagent	tests positively for	product	observation(s)
Br_2(aq)	4-methylphenol only		orange Br_2 decolourised. white ppt formed.
PCl_5	phenylmethanol only		white fumes of HCl(g) evolved
neutral $FeCl_3$	phenylmethanol only	phenylmethanol will form a violet complex with Fe^{3+}	violet complex formed
hot acidified $K_2Cr_2O_7$	phenylmethanol only		orange solution turns green

21 In the Darzens reaction, an aldehyde can react with an α-haloester in the presence of a base to form a three-membered ether ring known as an epoxide.

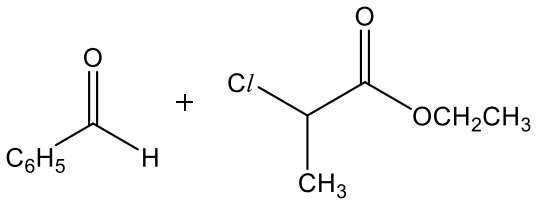


Which pair of reactants will react to produce

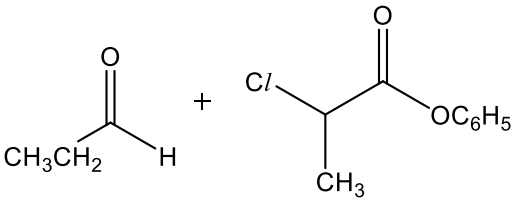


?

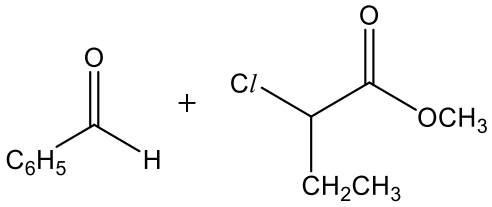
A



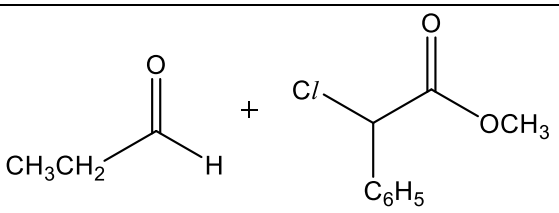
B



C

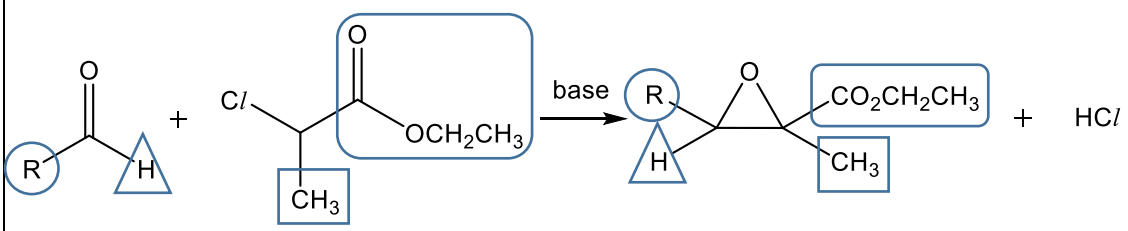


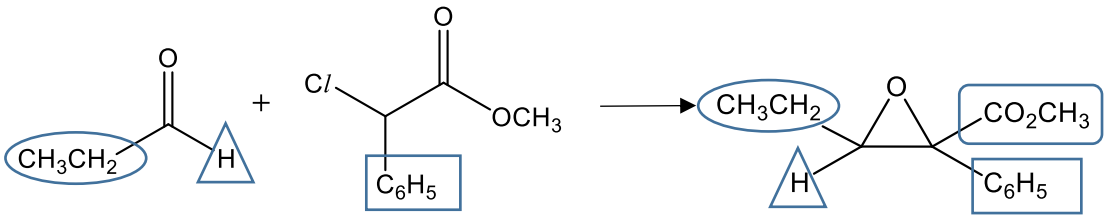
D



Answer: D

Recognise the pattern:





22 Given the following information:

acid	pK_a
HF	3.1
HC*l*	–6.0
H_2O	15.7

Which of the following statements are correct?

	1	A solution containing 0.1 mol dm^{-3} of NaF has the same pH as 0.1 mol dm^{-3} of NaC*l*.
	2	When excess Na_2CO_3 is added, 20 cm^3 of 0.1 mol dm^{-3} of aqueous HF evolves the same volume of CO_2 gas as 20 cm^3 of 0.1 mol dm^{-3} of aqueous HC*l*.
	3	NH_3 ionises to a greater extent in liquid HF than in liquid H_2O.

A	1 only	**B**	2 only	**C**	1 and 3 only	**D**	2 and 3 only

Answer: D

HF is a weak acid, thus F^-, the conjugate base will undergo hydrolysis in water:

$$F^- + H_2O \rightleftharpoons HF + OH^-$$

Hence, the pH of NaF will be more than 7, higher than NaCl which is 7. (note that Cl^- is the conjugate base of the strong acid HCl thus will not have hydrolysis).

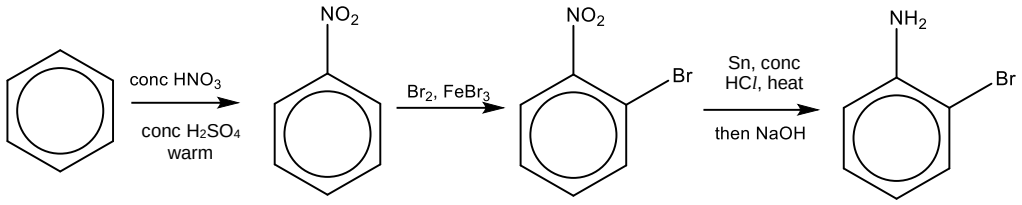
When excess Na_2CO_3 is added, 20 cm^3 of 0.1 mol dm^{-3} of aqueous HF evolves the same volume of CO_2 gas as 20 cm^3 of 0.1 mol dm^{-3} of aqueous HC*l*, this is true. Even though HF is a weak acid: $HF + H_2O \rightleftharpoons H_3O^+ + F^-$, when carbonate is added, it reacts with H_3O^+ to form CO_2 and water.

The position of equilibrium shifts right to replenish H_3O^+ until HF fully dissociates. Thus, the same volume of CO_2 will be formed since the same amount of HF and HCl was used.

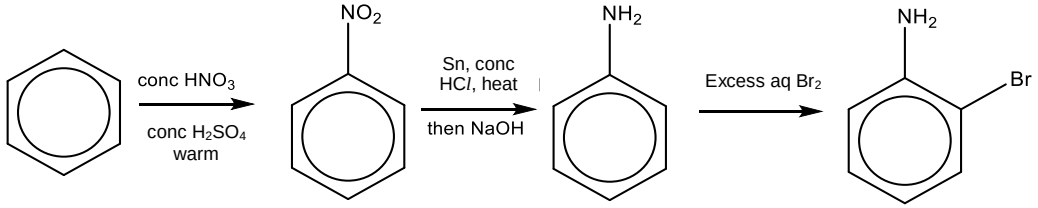
Since HF is a stronger acid than H_2O from the pKa values. Thus, the base NH_3 will accept H^+ to a greater extent from HF which a stronger acid as compared to H_2O to form NH_4^+.

23 Which of the following is the best method to prepare 2-bromophenylamine from benzene?

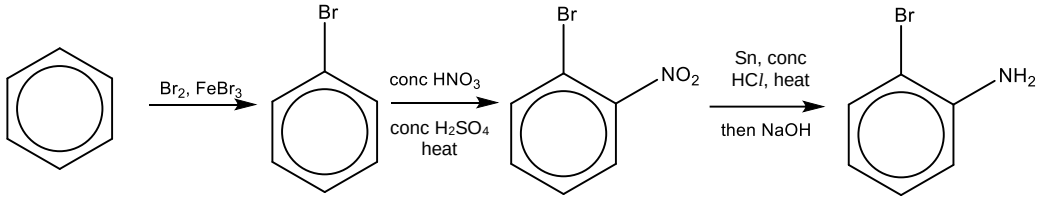
A



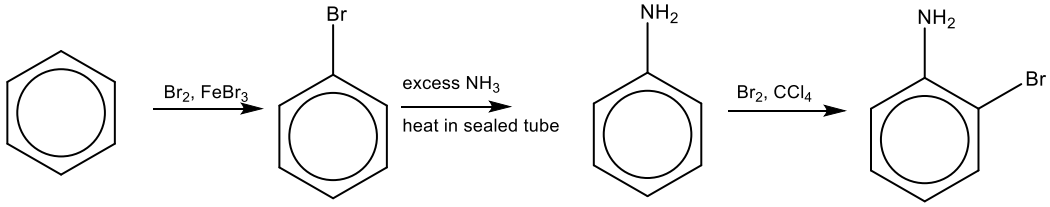
B



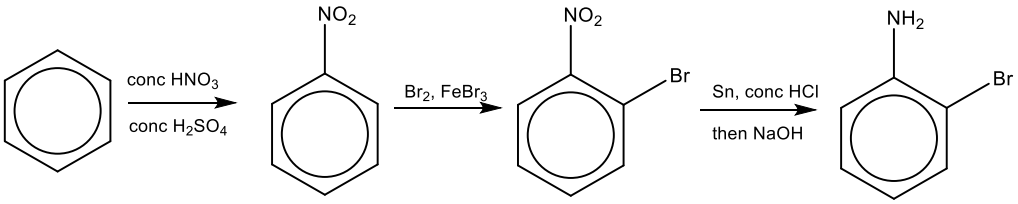
C



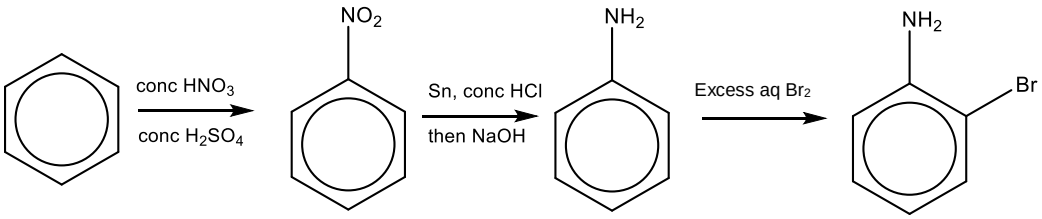
D



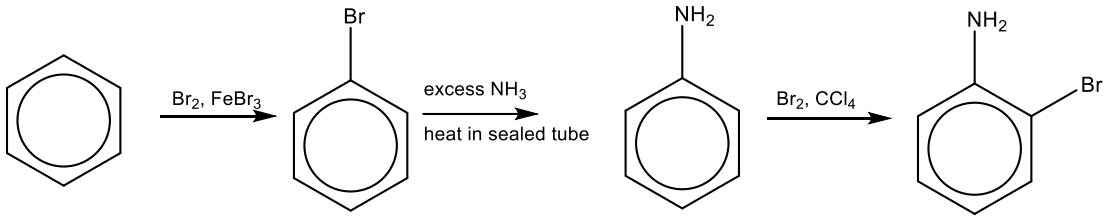
Answer: C



Option A is wrong as step 2 will produce 3-bromonitrobenzene as the major product since NO_2 is 3-directing.

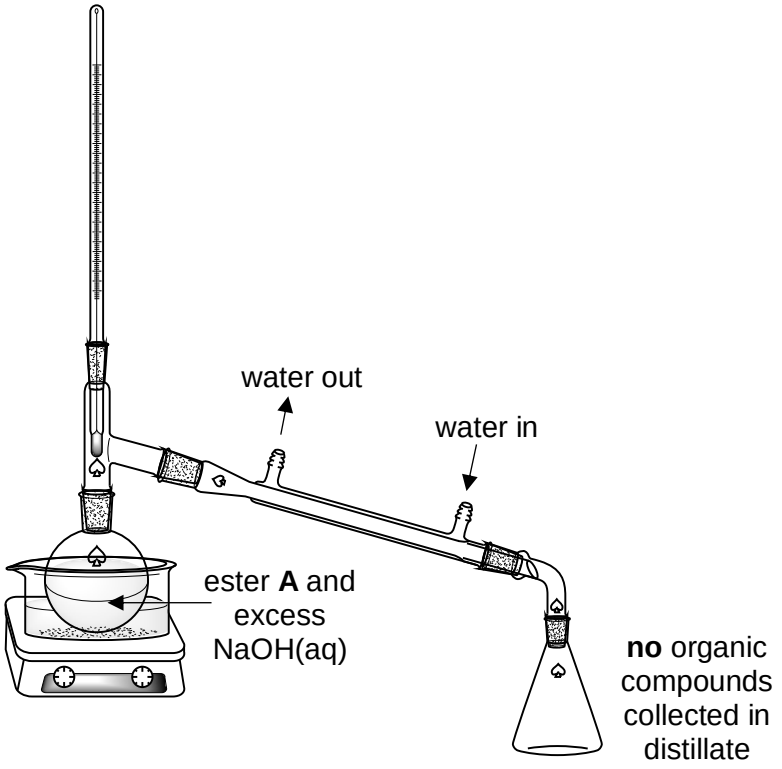


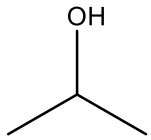
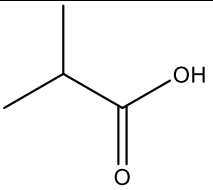
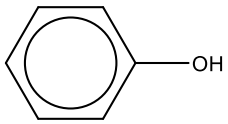
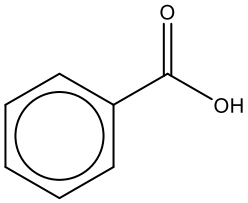
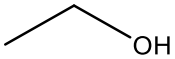
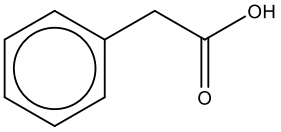
Option B is wrong as step 3 will 2,4,6-tribromophenylamine (even with aq Br_2 without $FeBr_3$) as the lone pair on N of NH_2 will delocalise into benzene ring making the benzene ring very electron rich and susceptible to electrophilic attack with Br_2.



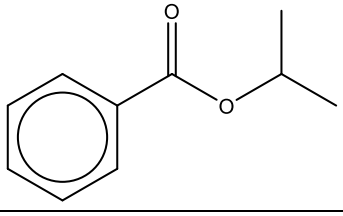
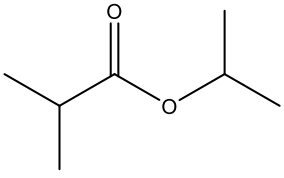
Option D is wrong as NH_3 will not substituted Br directly bonded to benzene ring as the C-Br bond has partial double bond character and is difficult to break.

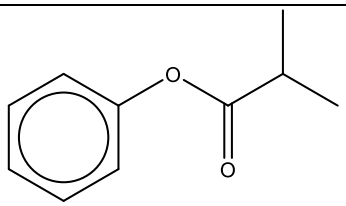
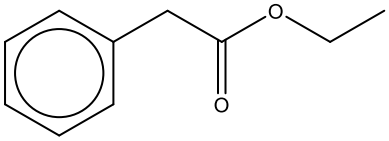
24 In this experiment, ester **A** was boiled with NaOH(aq) and then distilled as shown below. It was found that the distillate did **not** contain any organic compounds.

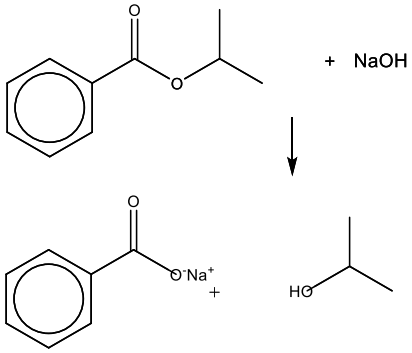
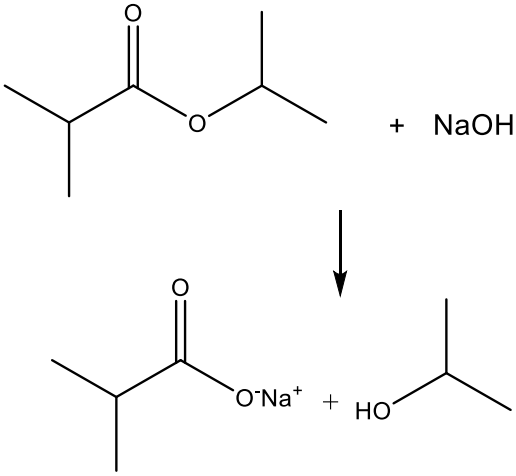
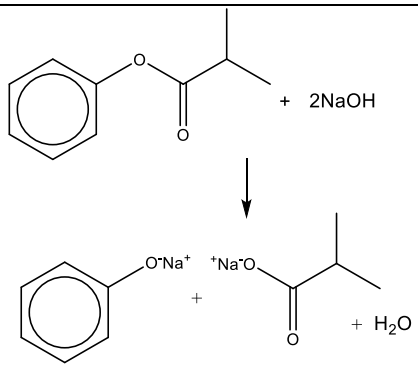
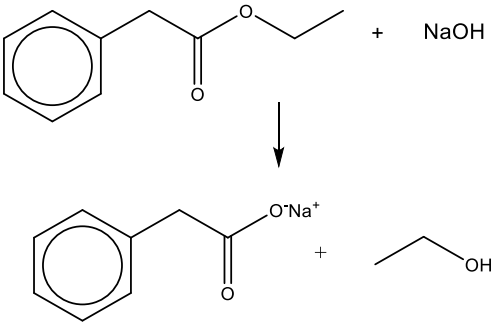


compound	boiling point / °C	compound	boiling point / °C
	83		155
	182		250
	78		266

Given the information on **page**, which is the correct structure of ester **A**?

A		**C**	

	B		**D**	

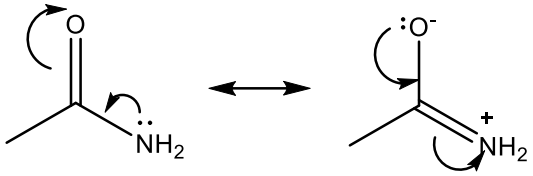
		Answer: B		
	A	 The ester hydrolyse to give the sodium ethanoate and propan-2-ol. Propan-2-ol is an alcohol with low boiling point and will be distilled out as a carbon-containing product.	**C**	 The ester hydrolyse to give the sodium salt of a carboxylic acid and propan-2-ol. Propan-2-ol is an alcohol with low boiling point and will be distilled out as a carbon-containing product.
	B	 The ester hydrolyse to give sodium phenoxide and sodium 2-methylpropanoate (phenol and 2-methylpropanoic acid are acidic and react with NaOH). Hence, no organic product is distilled out as the sodium salts have high boiling points.	**D**	 The ester hydrolyse to give the sodium salt of a carboxylic acid and ethanol. Ethanol is an alcohol with low boiling point and will be distilled out as a carbon-containing product.

25	Which of the following shows the correct arrangement of the compounds according to increasing pH in solution?	
	A	CH_3CONH_2, $CH_2{=}CHNH_2$, $CH_3CH_2NH_2$, $CH_3CH_2NH_3^+Cl^-$
	B	$CH_2{=}CHNH_2$, CH_3CONH_2, $CH_3CH_2NH_3^+Cl^-$, $CH_3CH_2NH_2$
	C	$CH_3CH_2NH_3^+Cl^-$, CH_3CONH_2, $CH_2{=}CHNH_2$, $CH_3CH_2NH_2$
	D	$CH_3CH_2NH_3^+Cl^-$, $CH_2{=}CHNH_2$, $CH_3CH_2NH_2$, CH_3CONH_2

Answer: C

$CH_3CH_2NH_3^+ + H_2O \rightleftharpoons CH_3CH_2NH_2 + H_3O^+$
Hence, the pH of $CH_3CH_2NH_3^+$ will be less than 7.

CH_3CONH_2 is an amide which is neutral with pH 7. The lone pair on N is delocalised into the C=O as shown below:



Since oxygen atom is more electronegative, the electron pair on N is more effectively delocalised, thus the electron pair on N is not available for donation to H^+.

For $CH_2{=}CHNH_2$, the p-orbitals of N overlap with the π-electron cloud of the C=C, thus the electron pair on N is delocalised into the C=C making it less available for donation to H^+ than $CH_3CH_2NH_2$, hence $CH_2{=}CHNH_2$ is a weaker base with a lower pH than $CH_3CH_2NH_2$.

26	Which compound dissolves in water to give a solution with the lowest pH?			
	A	SO_3	**C**	P_4O_{10}
	B	$MgCl_2$	**D**	Al_2O_3

Answer: A

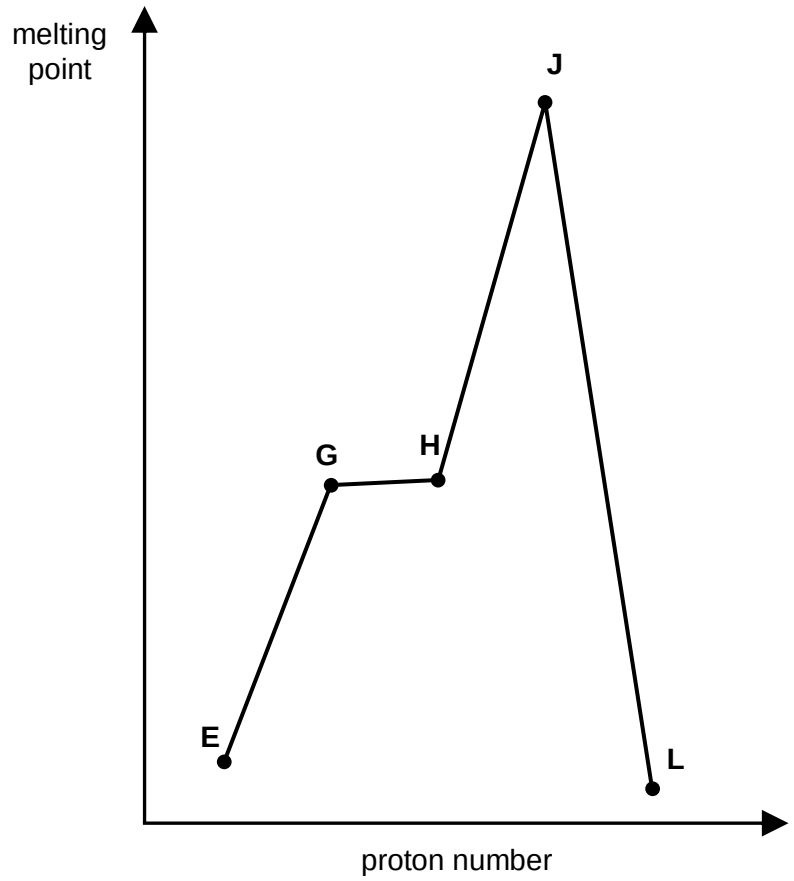
(A) $SO_3 + H_2O \rightarrow H_2SO_4$ (sulfuric acid is a strong acid)

(B) $MgCl_2$ dissolves in water to give a weakly acidic solution of a pH about 6.5 due to the polarizing power of Mg^{2+}
$[Mg(H_2O)_6]^{2+} \rightleftharpoons [Mg(H_2O)_5(OH)]^+ + H^+$

(C) $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ (H_3PO_4 is a weaker acid compared to H_2SO_4)

(D) Al_2O_3 does not dissolve in water due to insufficient energy released during hydration to overcome the lattice energy

27 The melting points of five consecutive elements in Period 3 are represented in the diagram below.



Which option describes the structures of these elements correctly?

	simple molecular	giant metallic lattice	giant molecular
A	**E** & **L**	**G, H** & **J**	none
B	**L**	**E**, **G**, **H** & **J**	none
C	**E** & **L**	**G** & **H**	**J**
D	**L**	**E**, **G** & **H**	**J**

Answer: D

E: Na, **G**: Mg, **H**: Al (giant metallic lattice)

J: Si (giant molecular)

L: P_4 (simple molecular)

28 Three reactions involving H_2O_2, H_2S and Ag_2O are shown below.

reaction 1 $H_2O_2 + H_2S \longrightarrow 2H_2O + S$

reaction 2 $Ag_2O + H_2O_2 \longrightarrow 2Ag + O_2 + H_2O$

reaction 3 $Ag_2O + H_2S \longrightarrow 2Ag + S + H_2O$

Which statements are correct?

	1	The oxidation number of oxygen in H_2O_2 is −1.
	2	H_2S is the strongest reducing agent of the three species.
	3	Ag_2O behaves as an oxidising agent in reaction 2.

	A	1, 2 and 3	**B**	1 and 3 only	**C**	2 and 3 only	**D**	1 and 2 only

Answer: A

Statement 1 is true:

Oxidation number of H is +1. Let oxidation number of O be x.
2(+1) + 2x = 0
x = −1

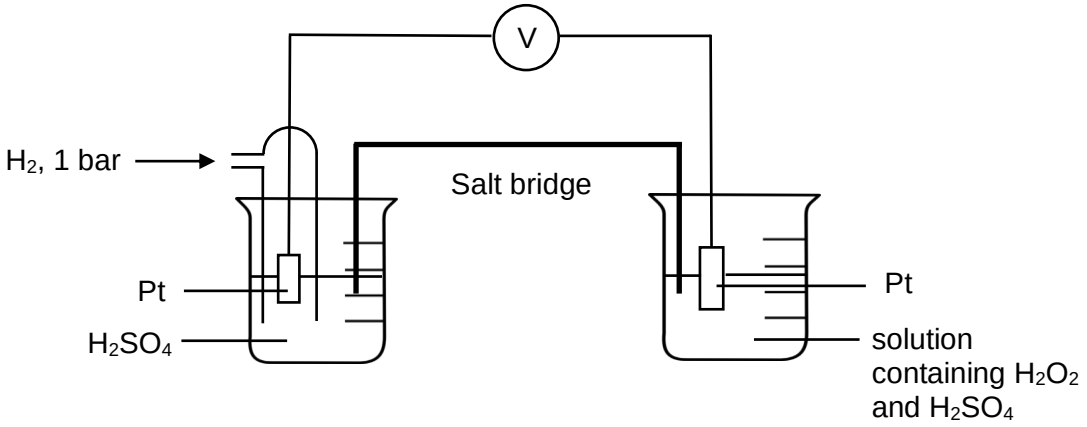
Statement 2 is true:

In reaction 1: H_2S reduced H_2O_2 to H_2O (itself is oxidised to S)
In reaction 3: H_2S reduces Ag_2O to Ag (itself is oxidised to S)

Statement 3 is true:
Ag_2O oxidised H_2O_2 to O_2 (itself is reduced to Ag)

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

The following apparatus is assembled to measure the standard electrode potential of a half-cell. All measurements are made at 298 K.



Which row correctly describes the concentration of H_2SO_4 used and the reading on the voltmeter?

		$[H_2SO_4]$ / mol dm^{-3}	voltmeter reading / V		
	A	0.5	+0.68		
	B	0.5	+1.77		
	C	1	+0.68		
	D	1	+1.77		
	Answer: B $[H^+]$ = 1 mol dm^{-3} under standard conditions The above setup measures the electrode potential for the reduction of H_2O_2 ($H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$) It does not measure the electrode potential for the oxidation of H_2O_2 ($O_2 + 2H^+ + 2e^- \rightleftharpoons H_2O_2$) as there is no O_2 present in the half cell on the right				

30	*Use of the Data Booklet is relevant to this question.* Which reaction occurs spontaneously?	
	A	$2Pb^{2+} \longrightarrow Pb^{4+} + Pb$
	B	$2Sn^{2+} \longrightarrow Sn^{4+} + Sn$
	C	$2Cu^{+} \longrightarrow Cu^{2+} + Cu$
	D	$3Cr^{2+} \longrightarrow 2Cr^{3+} + Cr$
	Answer: C **(A)** $E^{\ominus}_{cell}$ = (−0.13) − (+1.69) = −1.82 V < 0 (non spontaneous) **(B)** $E^{\ominus}_{cell}$ = (−0.14) − (+0.15) = −0.290 V < 0 (non spontaneous) **(C)** $E^{\ominus}_{cell}$ = (+0.52) − (+0.15) = +0.370 V > 0 (spontaneous) **(D)** $E^{\ominus}_{cell}$ = (−0.91) − (−0.41) = −0.500 V < 0 (non spontaneous)	