INNOVA JUNIOR COLLEGE
JC 2 PRELIMINARY EXAMINATION
in preparation for General Certificate of Education Advanced Level
Higher 1

CANDIDATE NAME **WORKED SOLUTIONS**

CLASS _____ INDEX NUMBER _____

CHEMISTRY **8872/01**

Paper 1 Multiple Choice **15 Sep 2017**

50 minutes

Additional Materials: Data Booklet
Multiple Choice Answer Sheet

READ THESE INSTRUCTIONS FIRST

Write your name and class on all the work you hand in.
Write in soft pencil.
Do not use staples, paper clips, highlighters, glue or correction fluid.

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.

Answers

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

This document consists of **18** printed pages.

Section A

For each question there are four possible answers, **A**, **B**, **C**, and **D**. Choose the **one** you consider to be correct.

1 How many neutrons are present in 0.13g of ^{13}C?
[L = the Avogadro constant]

A 0.06L
B 0.07L
C 0.13L
D 0.91L

Answer is **B**

No. of mol of ^{13}C = 0.13/13 = 0.01
No. of atoms of ^{13}C = 0.01 L
No. of neutrons per ^{13}C atom = 7
No. of neutrons in 0.01L of ^{13}C = 0.07L

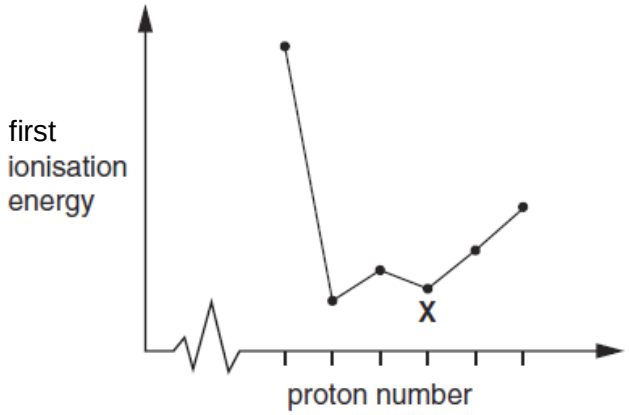
2 Which factor helps to explain why the first ionisation energies of the Group I elements decrease from lithium to rubidium?

A The nuclear charge of the elements increases.
B The outer electron is in an 's' subshell.
C The repulsion between spin-paired electrons increases.
D The distance between the nucleus and the valence electron increases.

Answer is **D**

The valence electron is further away from the nucleus as you go down the group due to an increase in the number of principal quantum shells.

3 The sketch below shows the variation of first ionisation energy with proton number for six elements of consecutive proton numbers between 1 and 18 (H to Ar).



What is the identity of the element **X**?

A Mg
B A*l*
C Si
D P

Answer is **B**

The lowest first IE represent group **1** element, as when going across the period the increase in nuclear charge outweighs the negligible increase in shielding effect (due to ineffective shielding of electrons added to the same outermost shell).

Hence X is A*l*. Moreover, A*l* first IE is lower than Mg as its electron is removed from 3p orbital which is further away from nucleus as compare to 3s orbital.

4 Which orbital must an electron with the principal quantum n = 2 occupy?

A a spherically-shaped orbital
B either an s or p orbital
C the orbital closest to the nucleus
D a dumb-bell shaped orbital

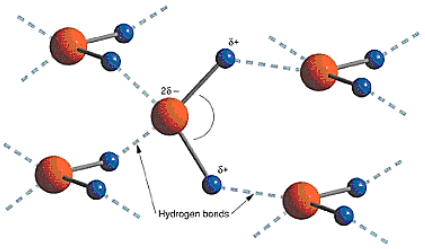
Answer is **B**

Orbitals available at principal quantum *n* = 2 are 2s (spherically-shaped) and 2p (dumb-bell-shaped) orbital

5 Which of the following statements describes a phenomenon which **cannot** be explained by hydrogen bonding?

A Ice floats on water.
B The boiling point of carboxylic acids increase with increasing relative molecular mass.
C 2-nitrophenol is more volatile than 4-nitrophenol.
D Ethanoic acid molecules forms dimers when dissolved in benzene.

Answer is **B**



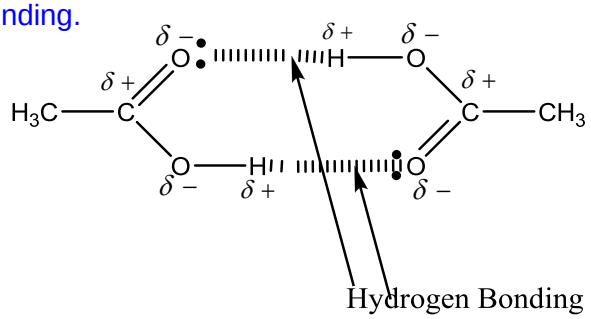
H-bonding in ice

Option **A** is incorrect as it is the hydrogen bonding between H_2O that caused the molecules to be more spaced out and less dense. Hence, ice float on water.

Option **B** is correct as carboxylic acid relative molecular mass increases when the carbon chain increases. However, this will result in the instantaneous dipole-induced dipole forces of attraction to increase which results in an increase in boiling point. The hydrogen bond does not affect the boiling point.

Option **C** is incorrect as 2-nitrophenol can form an intramolecular hydrogen bond due to the proximity of the OH and NO_2 groups so less intermolecular hydrogen bond occurs. Hence, 2-nitrophenol has a lower boiling point and is more volatile.

Option **D** is incorrect as ethanoic acid does form dimers in benzene via hydrogen bonding.



6 Ammonia, NH_3 reacts with boron trifluoride, BF_3 to give an addition product. Which of the following statements about the addition product is **not** true?

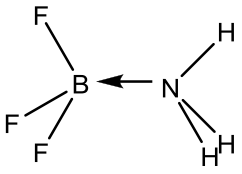
A The B atom is electron deficient.

B It contains a dative covalent bond.

C It is polar.

D There are seven sigma bonds.

Answer is **A**



Addition product

Option **A** is correct as with the dative bond formed from N to B in the product, B is no longer electron deficient.

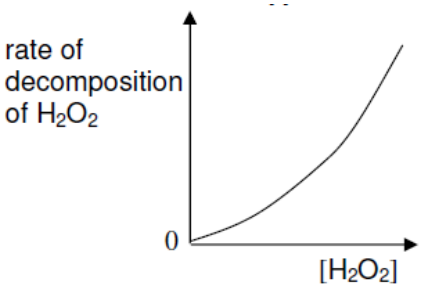
Option **B** is incorrect as the dative bond is between N and B.

Option **C** is incorrect as it is polar as the sum of all the dipole moments do not cancel out.

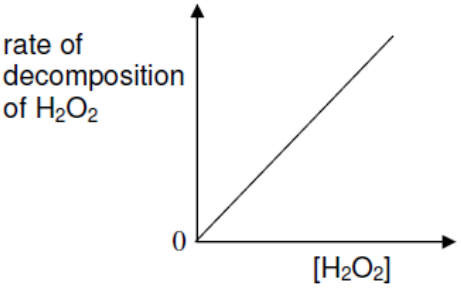
Option **D** is correct as there are 7 sigma bonds in the product after counting all the single bonds in the diagram above.

7 Which graph would confirm that the rate of decomposition of hydrogen peroxide is first order with respect to the concentration of hydrogen peroxide?

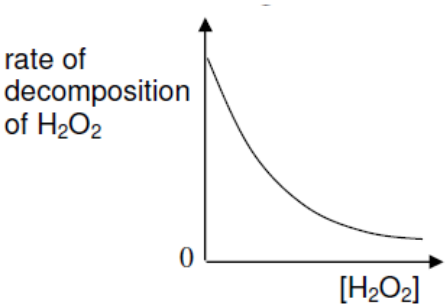
A



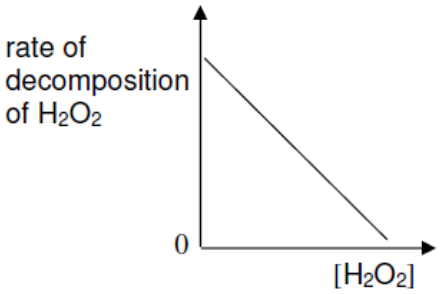
B



C



D



Answer is **B**.

Rate = k $[H_2O_2]$
|| ||
y-axis x-axis

So it is a y=mx +c graph, a straight line that passes through the origin.

8 The reaction of a compound **RS** is shown below.

$$\mathbf{RS}(g) \longrightarrow \mathbf{R}(g) + \mathbf{S}(g)$$

The rate equation for the reaction is rate = k[**RS**] and the rate constant is found to be 3.6×10^{-3} s^{-1}. If the initial concentration of **RS** is 2.0×10^{-2} mol dm^{-3}, what will be the concentration of **RS** after 385 seconds?

A 1.0×10^{-2} mol dm^{-3}

B 5.0×10^{-3} mol dm^{-3}

C 2.5×10^{-3} mol dm^{-3}

D 2.0×10^{-3} mol dm^{-3}

Answer is **B**

Using $t_{1/2} = \ln 2/k$

$t_{1/2} = \ln 2 / (3.6 \times 10^{-3})$

$= 192.5s$

385 seconds = 2 half lives

$2.0 \times 10^{-2} \rightarrow 1.0 \times 10^{-2} \rightarrow 0.5 \times 10^{-2} (= 5.0 \times 10^{-3})$

9 Which one of the following is a correct statement about the effect of a catalyst on a reaction at equilibrium?

A It provides an alternative route for the reaction to take place.

B It increases the equilibrium constant for the forward reaction.

C It increases the yield of product in equilibrium.

D It increases the rate of the forward reaction only.

Answer is **A**

Option **A** is correct as a catalyst will lower the activation energy of a reaction by providing an **alternative pathway** for the reaction to occur.

Option **B** is wrong as the equilibrium constant is only affected by **temperature**.

Option **C** and **D** are wrong as a catalyst will only speed up **both forward and backward reaction** but It will **not** increase the yield of reaction.

10 Which of the following statements does **not** describe a reaction at equilibrium?

A Forward and backward reactions occur at equal rate.

B The reaction takes place in a closed system.

C K_c increases as the reaction progresses.

D Concentrations of reactants and products are constant.

Answer is **C**

Option **A** and **D** are wrong as based on the definition of dynamic equilibrium, a system at equilibrium is when the rate of forward reaction is the same as the backward reaction and the concentration of both reactants and products are constant.

Option **B** is wrong as an equilibrium system must take place in a closed system.

Option **C** is correct as if Kc is increasing, it means that either the reactants concentration is dropping or the product concentration is increasing. So equilibrium position is still shifting, hence the reaction has not reached equilibrium yet.

11 Which of the following enthalpy changes is positive?

A $H_2O(l) \longrightarrow H_2O(s)$

B $2C_2H_6(g) + 7O_2(g) \longrightarrow 4CO_2(g) + 6H_2O(l)$

C $2Br(g) \longrightarrow Br_2(g)$

D $Na(g) \longrightarrow Na^+(g) + e^-$

Answer is **D**

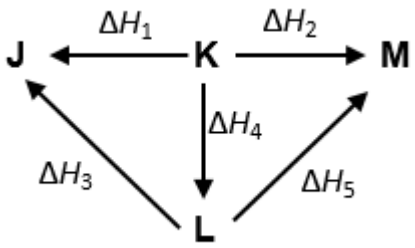
Option **A** is wrong as the equation represents the freezing of water and freezing is exothermic as more H-bonds are formed during freezing.

Option **B** is wrong as the equation represents the combustion of ethane. All combustion reactions are exothermic.

Option **C** is wrong as the equation represents the formation of the Br-Br bond. It is exothermic as bond formation is always exothermic.

Option **D** is correct as the equation represents the first ionisation energy of sodium. The first ionisation energy is always endothermic as energy is needed to remove the most loosely held electron.

12 The energy cycle below shows the reaction pathways between Compounds **J** – **M**.



What is the enthalpy change for the following reaction?

Compound **J** ⟶ Compound **M**

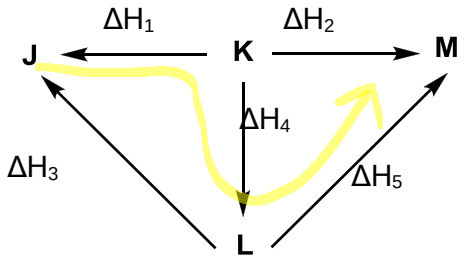
A $\Delta H_1 + \Delta H_2$

B $\Delta H_2 - \Delta H_3 + \Delta H_4$

C $-\Delta H_3 - \Delta H_5$

D $\Delta H_4 + \Delta H_5 - \Delta H_1$

Answer is **D**



By Hess's law, following the yellow arrow:

enthalpy change from **J** to **M** = $-\Delta H_1 + \Delta H_4 + \Delta H_5$

= $\Delta H_4 + \Delta H_5 - \Delta H_1$ (option **D**).

13 What is the enthalpy change for the following process equivalent to?

$$Al(g) \longrightarrow Al^{2+}(g) + 2e^-$$

A the second ionisation energy of aluminium

B the enthalpy change of vaporisation of aluminium

C the sum of the first ionisation energy and second ionisation energy of aluminium

D the sum of the enthalpy change of vaporisation, first ionisation energy and second ionisation energy of aluminium

Answer is **C**

Option **A** is wrong as the second ionisation energy of aluminium is

$$Al^{+}(g) \longrightarrow Al^{2+}(g) + e^{-}$$

Option **B** is wrong as the enthalpy change of vaporisation of aluminium is

$$Al(s) \longrightarrow Al(g)$$

Option **C** is correct as the equation is the sum of the first ionisation energy and second ionisation energy of aluminium

$$Al(g) \longrightarrow Al^{+}(g) + e^{-} \quad (1^{st}\ \text{I.E.})$$
$$Al^{+}(g) \longrightarrow Al^{2+}(g) + e^{-} \quad (2^{nd}\ \text{I.E.})$$

Option **D** is wrong as the equation shows $Al(g)$ forming $Al^{2+}(g)$ and not $Al(s)$ forming $Al^{2+}(g)$.

14 A mixture was made by adding 20 cm^3 of a solution of pH 2.5 to 30 cm^3 of another solution of pH 4.5. What is the final pH of the mixture?

A 1.2 **C** 3.5

B 2.9 **D** 3.7

Answer is **B**

$[H^+]$ in first solution = $10^{-2.5}$ mol dm^{-3}

$[H^+]$ in second solution = $10^{-4.5}$ mol dm^{-3}

$[H^+]$ in mixture = $\frac{0.020 \times 10^{-2.5} + 0.030 \times 10^{-4.5}}{0.050}$ = 1.284 x 10^{-3} mol dm^{-3}

pH of mixture = - $\log_{10}(1.284 \times 10^{-3})$ = 2.89 = 2.9 (1d.p.)

15 Which of the following pairs of solutions will produce an alkaline buffer solution upon mixing equal volumes of each solution?

A 1.50 mol dm^{-3} of HC*l* and 1.00 mol dm^{-3} of NaOH

B 1.00 mol dm^{-3} of NH_3 and 2.00 mol dm^{-3} of HC*l*

C 0.50 mol dm^{-3} of H_2SO_4 and 2.00 mol dm^{-3} of NH_3

D 1.00 mol dm^{-3} of $C_6H_5CO_2H$ and 0.50 mol dm^{-3} of KOH

Answer is **C**

Assume that the volumes of each solution is 1 dm^3

Option **A** contains 1.5 mol of HC*l* reacting with 1 mol of NaOH, the resulting solution will contain 0.5 mol of HC*l*.

Option **B** contains 1 mol of NH_3, a weak base, reacting with 2 mol of HC*l*, the resulting solution will contain 1 mol of HC*l*.

Option **C** contains 2 x 0.5 = 1 mol of H^+ from 0.5 mol of H_2SO_4 reacting with 2 mol of NH_3. The resulting solution will contain 1 mol of NH_3 and 1 mol of NH_4^+, an alkaline buffer.

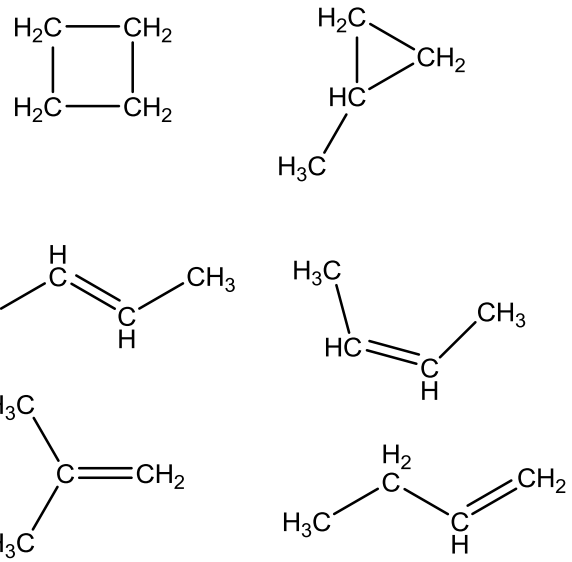
Option **D** contains 1 mol of $C_6H_5CO_2H$ reacting with 0.5 mol of KOH. The resulting solution will contain 0.5 mol of $C_6H_5CO_2H$ and 0.5 mol of $C_6H_5CO_2^-$, an acidic buffer.

16 A student isolated an organic compound with the molecular formula C_4H_8. How many possible isomers (including structural and geometrical isomers) can be deduced from the molecular formula?

A 3
B 4
C 5
D 6

Answer is **D**

There are 6 possible isomers that can be formed for C_4H_8

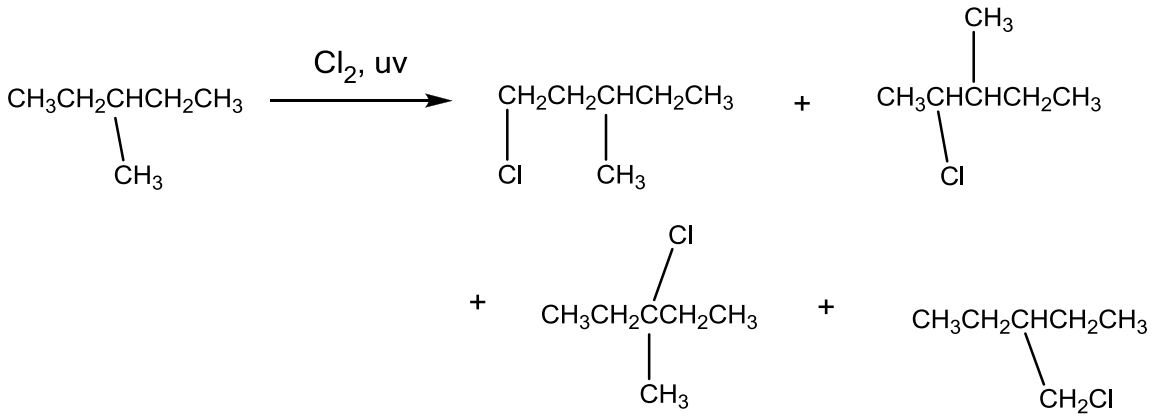


17 3-methylpentane was reacted with chlorine gas in the presence of ultraviolet light. What is the total number of possible structural isomers formed, assuming only mono-substitution took place?

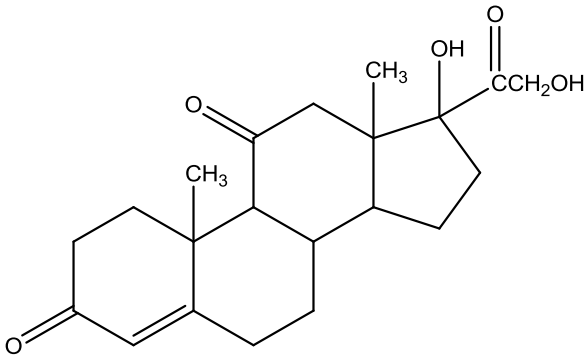
A 4
B 5
C 6
D 14

Answer is **A**

The four possible structural isomers formed are:



18 Cortisone is an anti-inflammatory hormone.



cortisone

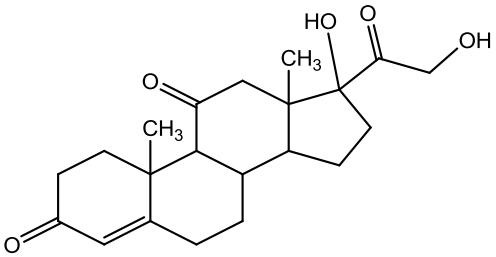
Cortisone is first reacted with hydrogen in the presence of a platinum catalyst, and the product is then oxidised by warming with acidified $KMnO_4$.

Given that no carbon-carbon σ bond is broken in this process, how many C=O double bonds will there be in the structure of the final product?

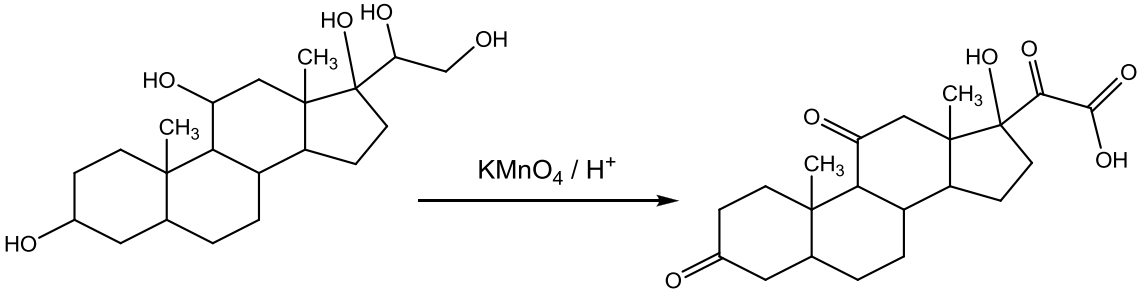
A 3 **C** 5

B 4 **D** 6

Answer is **B**

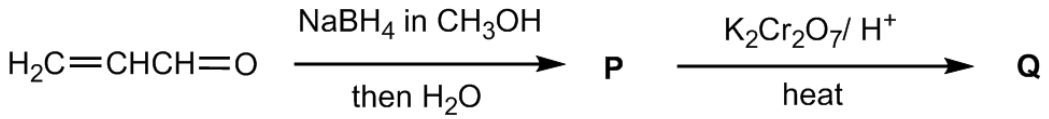


cortisone



No. of double bonds = 4

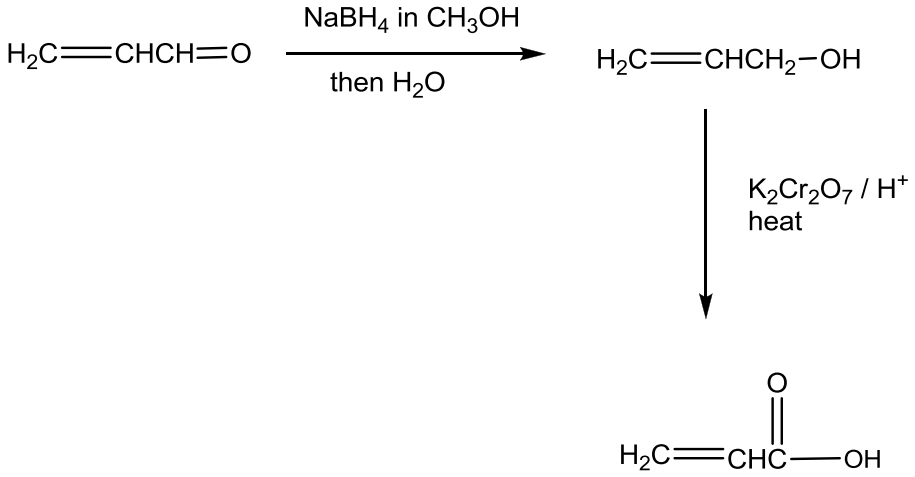
19 What will be the final product **Q** in this sequence of reactions?



A $CH_2CHCOOH$
B CH_3CH_2COOH
C $HOCH_2CH(OH)CH_2OH$
D HO_2CCOCO_2H

Answer is **A**

$NaBH_4$ can also reduce carbonyl group but it cannot reduce alkene. $K_2Cr_2O_7$ will only oxidise alcohol in P but it cannot oxidise alkene.



20 The table shows the results of simple chemical tests on a compound **U**.

Reagents	Observations
2,4-dinitrophenylhydrazine	Orange ppt
Fehling's reagent	Brick red ppt
Alkaline aqueous iodine	Yellow ppt

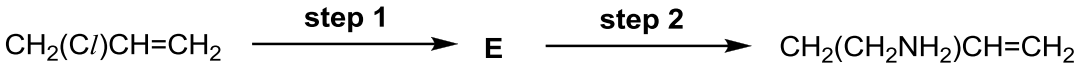
What could compound **U** be?

A CH_3CHO
B CH_3CH_2CHO
C $CH_3CH(OH)CH_3$
D CH_3COCH_3

Answer is **A**

Based on the three tests, compound U should be a carbonyl compound as it gives an orange ppt. with 2,4-DNPH. It is also an aldehyde as it gives a brick red ppt. with Fehling's reagent and it has a CH_3CO group as it forms a yellow ppt. with alkaline aqueous iodine.

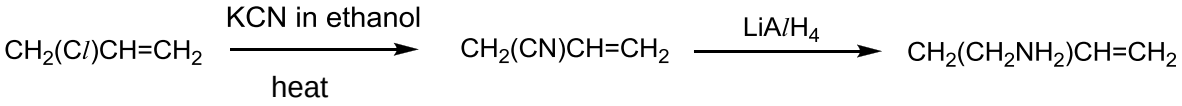
21 Which of the following options shows the correct reagents and conditions for step 1 and 2?



	Step 1	Step 2
A	KCN in ethanol, heat	H_2, Pt
B	KCN in ethanol, heat	$LiAlH_4$
C	HCN, trace NaOH(aq), cold	$LiAlH_4$
D	NH_3 in ethanol, heat	H_2, Pt

Answer is **B**

The reaction will proceed in this manner:



22 Which alcohol is used to manufacture the ester, $CH_3CH_2CH(OH)CO_2CH(CH_3)_2$?

A	CH_3CO_2H	**C**	$CH_3CH_2CH_2OH$
B	$CH_3CH(OH)CH_3$	**D**	CH_3OH

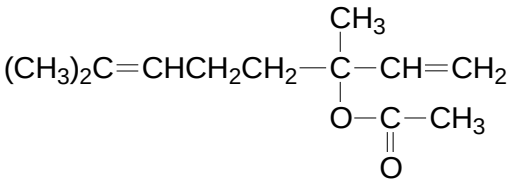
Answer is **B**

$CH_3CH_2CH(OH)CO_2CH(CH_3)_2$ is made from:

$CH_3CH_2CH(OH)COOH$ and $HOCH(CH_3)_2$

$HOCH(CH_3)_2$ can be rewritten as $CH_3CH(OH)CH_3$ (Option B).

23 Linalyl acetate is a naturally-occurring compound and it is a principal component of the essential oils of lavender.



Linalyl acetate

Which of the following statements about linalyl acetate is not true?

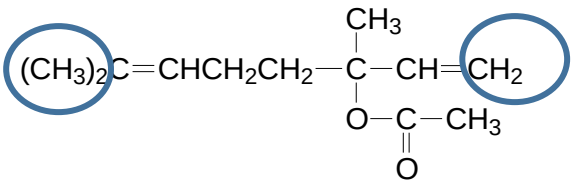
A It exhibits *cis-trans* isomerism.

B It does not react with 2,4-dinitrophenylhydrazine.

C It decolourises bromine water.

D It reacts with hot acidified potassium dichromate(VI) to give CH_3COOH as one of the products.

Answer is **A**



Answer **A** is correct as the groups attached to one side of each C=C bond are identical (circled in the diagram). So there are no cis-trans isomers.

24 Which of the following forms an oxide that is soluble in both water and aqueous sodium hydroxide?

A magnesium

B silicon

C aluminium

D phosphorus

Answer is **D**

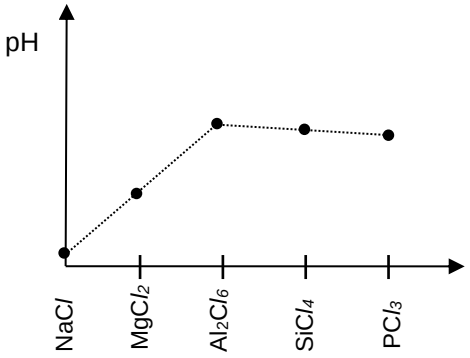
Phosphorus trioxide P_4O_6 is a non-metallic acidic oxide that reacts with water an aqueous sodium hydroxide in the following manner:

$P_4O_6(s) + 6H_2O(l) \longrightarrow 4H_3PO_3(aq)$

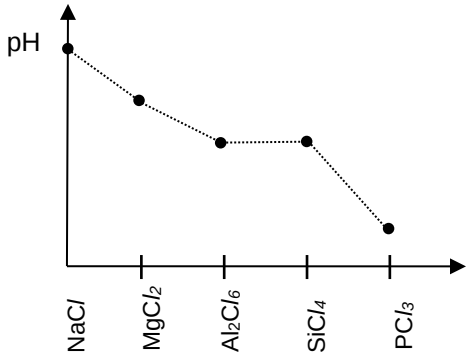
$P_4O_6(s) + 8NaOH(aq) \longrightarrow 4Na_2HPO_3(aq) + 2H_2O(l)$

25 The chlorides of the elements sodium to phosphorous are separately added to water. Which of the following diagrams best represents the pH of the solutions produced?

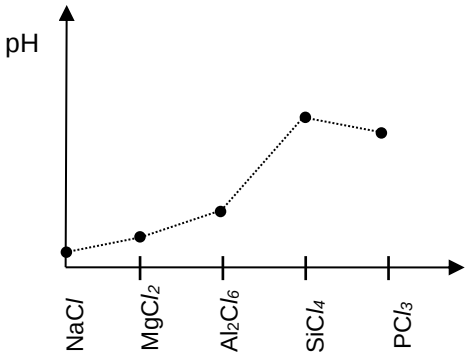
A



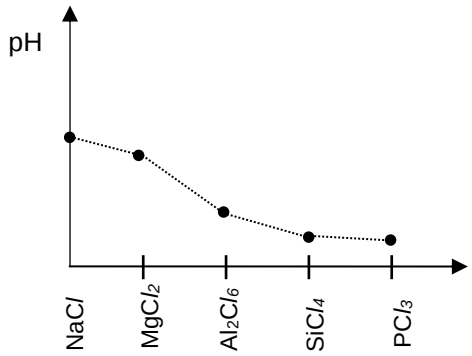
B



C



D



Answer is **D**

Across the Period 3, when the chlorides become more covalent, its tendency to undergo hydrolysis increases. Hence the pH of the resulting solution drops steadily across the period.

Section B

For each of the questions in this section, one or more of the three numbered statements **1** to **3** may be correct.

Decide whether each of the statements is or is not correct (you may find it helpful to put a tick against the statements that you consider to be 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** are correct	**2** and **3** are correct	**1** only is correct.

26 In flooded soils, like those used for rice cultivation, the oxygen content is low. In such soils, anaerobic bacteria cause the loss of nitrogen from the soil as shown in the following sequence.

$$NO_3^-(aq) \xrightarrow{\textbf{W}} NO_2^-(aq) \xrightarrow{\textbf{X}} NO(g) \xrightarrow{\textbf{Y}} N_2O(g) \xrightarrow{\textbf{Z}} N_2(g)$$

Which of the following steps involve a reduction in the oxidation number of nitrogen by 1?

1 **X**, **Y** and **Z**

2 **W** and **Y**

3 **W** and **X**

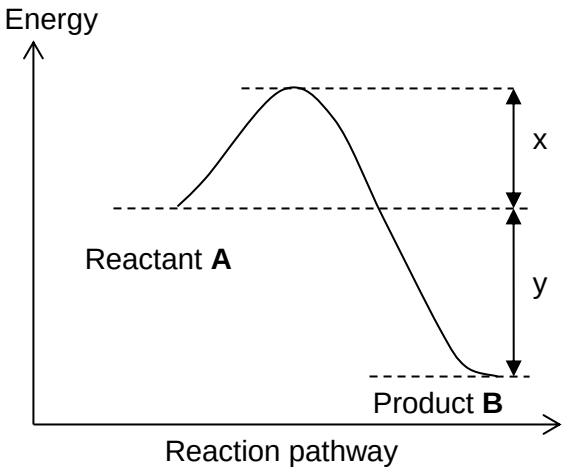
Answer is **D**

Oxidation number (oxidation state) of nitrogen:
+5 in NO_3^-
+3 in NO_2^-
+2 in NO
+1 in N_2O
0 in N_2

In **W** change in oxidation number = +2
In **X** change in oxidation number = +1
In **Y** change in oxidation number = +1
In **Z** change in oxidation number = +1

So option **1** is the correct.

27 The energy profile for a reversible reaction is shown below.



Which of the following statements are correct?

1 The reaction from **B** to **A** is endothermic.

2 The activation energy of the reaction **A** to **B** is *x*.

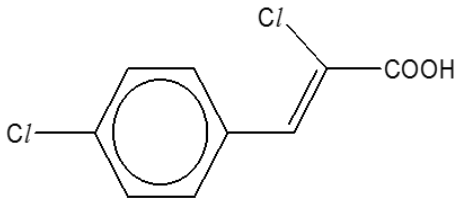
3 The activation energy of the reaction **B** to **A** is *x* + *y*.

Answer is **A**

Reactant **B** has lower energy than the product **A**, hence reaction is endothermic

Activation energy, E_a is the minimum amount of energy that molecular collisions must possess in order for a chemical reaction to occur. It is measured from the reactant to the transition state.

28 Compound **A** is used as a starting material for a class of anti-bacterial drugs known as quinolones. Which of the following statements about compound **A** are correct?



compound **A**

1 1 mole of **A** reacts with CH_3OH to give 1 mole of H_2O.

2 1 mole of **A** reacts with Na metal to give 0.5 mole of H_2.

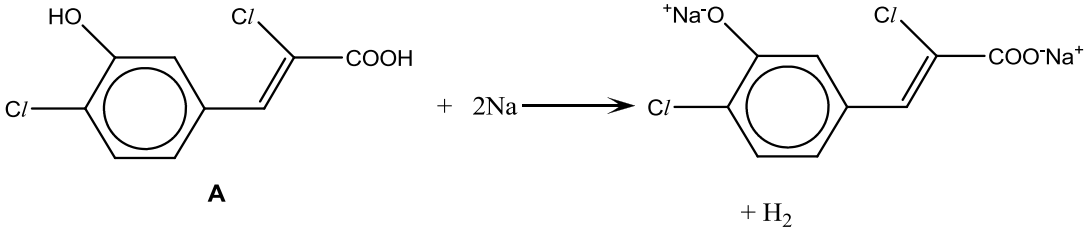
3 1 mole of **A** reacts with $CaCO_3$ to give 1 mole of CO_2.

Answer is **B**

Option **1** is correct as only carboxylic acid group in A reacts with PCl_5:

$$RCOOH + PCl_5 \longrightarrow RCOCl + POCl_3 + HCl$$

Option **2** is correct as both phenol and carboxylic acid group in A reacts with Na metal:



Option **3** is wrong as **2** moles of A reacts with $CaCO_3$ to form 1 mole of CO_2

$$2ROOH + CaCO_3 \longrightarrow Ca(RCOO^-)_2 + CO_2 + H_2O$$

29 For which types of compound are **all** of the following statements correct?

- They are unreactive towards mild oxidising agents.
- They form esters.
- They react with sodium.

1 aldehydes

2 carboxylic acids

3 tertiary alcohols

Answer is **C**

Option **1** is wrong because aldehydes can be oxidised but it cannot react with sodium and cannot form esters.

Option **2** and **3** are correct as both carboxylic acid and tertiary alcohols cannot be oxidised, they both react with sodium and they both can form esters.

30 Which of the following trends concerning Period 3 elements from Na to C*l* are true?

1 There is a change from metallic behaviour to non-metallic behaviour.

2 Their compounds show an increase in the maximum oxidation number across the period.

3 The melting points of the elements decrease across the period.

Answer is **B**

Option **1** is correct as the covalent character of the elements increase from Na to C*l*.

Option **2** is correct as the number of valence electrons increase Na to C*l* hence the maximum oxidation state of the element increases.

Option **3** is wrong as the melting point of the elements increase across the period and reaches a maximum at Si before decreasing across the period.