



SERANGOON JUNIOR COLLEGE
General Certificate of Education Advanced Level
Higher 1

Candidate Name

Class

CHEMISTRY

JC2 Preliminary Examination

Paper 1 Multiple Choice

Additional Materials: Data Booklet
 Optical Mark Sheet (OMS)

8872/01

28 Aug 2015

50 min

READ THESE INSTRUCTIONS FIRST

On the separate multiple choice OMS given, write your name, subject title and class in the spaces provided.

Shade correctly your FIN/NRIC number.

There are **30** questions in 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 using a **soft pencil** on the separate OMS.

Each correct answer will score one mark.

A mark will not be deducted for a wrong answer.

You are advised to fill in the OMS as you go along; no additional time will be given for the transfer of answers once the examination has ended.

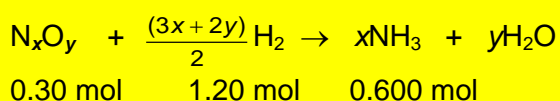
Any rough working should be done in this question paper.

This document consists of ____ printed pages and ____ blank page.

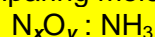
Turn Over]

Answer all questions

1	Oxides of nitrogen, N_xO_y , are air pollutants. In a reaction, 0.30 mol of N_xO_y is reacted with 30 dm ³ of hydrogen gas at room temperature and pressure and passed over a heated catalyst to produce ammonia and water as the only products. At the end of the reaction, 1.20 dm ³ of hydrogen gas remains. The ammonia produced required 0.300 mol of sulfuric acid for complete neutralisation. What is the molecular formula of the oxide?	
	A	NO
	B	NO ₂
	C	N ₂ O
	D	N ₂ O ₄

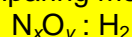
Answer: **C**No. of moles of $H_2 = (30-1.2)/24 = 1.20$ No. of moles of $NH_3 = 0.300 \times 2 = 0.600$

Comparing mole ratio,



$$1 : 2 \Rightarrow x = 2$$

Comparing mole ratio,



$$1 : 4$$

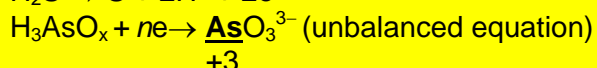
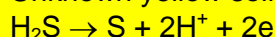
$$\frac{(3x+2y)}{2} = 4 \Rightarrow y = 1$$

 \Rightarrow Molecular formula is **N₂O**.

2	In an experiment, H_2S was reacted with 28.00 cm ³ of 0.250 mol dm ⁻³ of an unknown arsenate species, H_3AsO_x , in a strongly acidic medium to form a yellow solid of mass 0.225 g and ortho-arsenite, AsO_3^{3-} . Determine the oxidation state of As in H_3AsO_x .	
	A	+2
	B	+3
	C	+4
	D	+5

Answer: **D**

Unknown yellow solid is S (Deduction).



$$\text{Mole ratio: } 0.250 \times \frac{28}{1000} H_3AsO_x \equiv \frac{0.225}{32.1} S$$

$$0.007 H_3AsO_x \equiv 0.007 S$$

$$H_3AsO_x \equiv S$$

$$\therefore n = 2$$

Since final oxidation state of $AsO_3^{3-} = +3$, initial oxidation state must be **+5**.

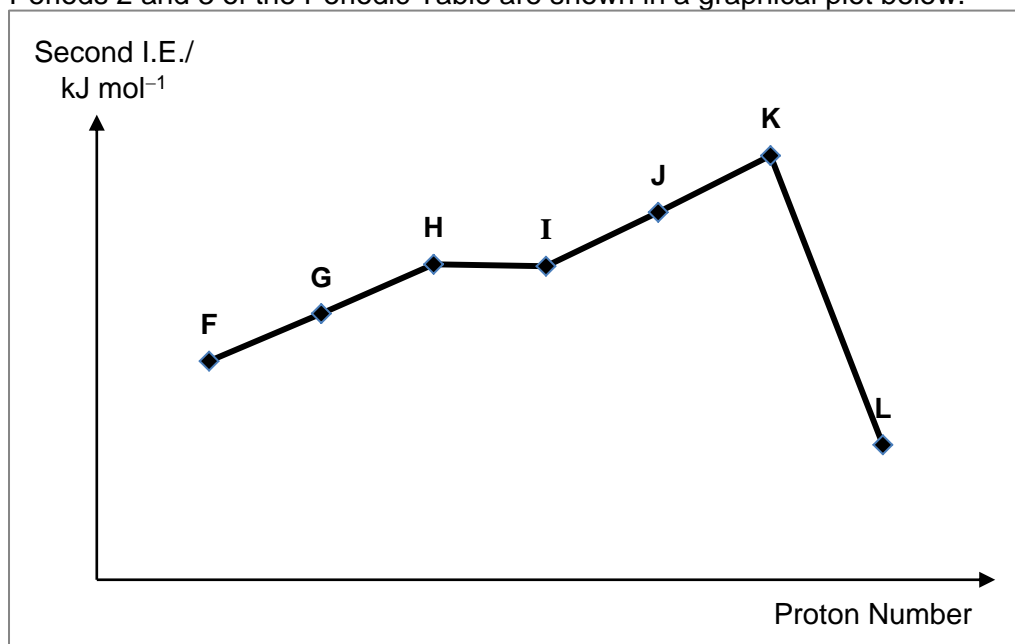
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3	The ion E^{2+} has 86 electrons and 138 neutrons. Which of the following statements is true?
A	Element E is isoelectronic with radon.
B	The first ionisation energy of element E is higher than that of Sr.
C	The oxide of E formed is expected to have a higher melting point than SrO.
D	In an electric field, the ion E^{2+} will be deflected at a smaller angle than that of Sr^{2+} .

Answer: **D**

- A ☐ Element **E** has $86 + 2 = 88$ electrons. (\rightarrow Ra)
 B ☐ First ionisation energy decreases down the group.
 C ☐ E^{2+} has the same charge as Sr^{2+} but a larger cationic radius
 \rightarrow smaller lattice energy
 D ☒ E^{2+} has a larger mass than Sr^{2+} and hence deflected at a smaller angle since
 extent of deflection $\propto \frac{e}{m}$

- 4** The second ionisation energies (I.E.) of seven consecutive unknown elements **F** to **L** in Periods 2 and 3 of the Periodic Table are shown in a graphical plot below.



Which unknown letter (**F** to **L**) is likely to represent the element nitrogen?

A	Element F
B	Element G
C	Element H
D	Element I

Answer: **B**

Look for the highest 2nd I.E. in the graph and that will most likely correspond to a Group I element. In this case, **G** is most likely deduced to be Na. Hence, **G** is nitrogen.

5	<p>Lithium peroxide, Li_2O_2, is synthesised by reacting lithium hydroxide with hydrogen peroxide. Which diagram correctly shows the bonding of the peroxide anion in Li_2O_2?</p> <p>Key: ● electron from the first oxygen atom ○ electron from the second oxygen atom × electron from lithium atom</p>
A	
B	
C	
D	
Answer: <u>D</u>	

6	Which pair of compounds satisfies the following conditions?			
	(i) The first compound has a larger bond angle than the second compound.			
	(ii) The first compound is more polar than the second compound.			
		First compound	Second compound	
	A	ClO_2	HCN	
	B	NF_3	SeF_6	
	C	IF_3	PH_3	
	D	BeCl_2	N_2H_4	
Answer: B				
A	ClO_2	(105° , polar)	HCN	(180° , polar)
B	NF_3	(107° , polar)	SeF_6	(90° , non-polar)
C	IF_3	(90° , polar)	PH_3	(107° , polar)
D	BeCl_2	(180° , non-polar)	N_2H_4	(107° , polar)

7	Which of the following has a positive ΔH value?
A	$\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$
B	$\text{NaOH}(\text{aq}) + \text{CH}_3\text{COOH}(\text{aq}) \rightarrow \text{CH}_3\text{COO}^-\text{Na}^+(\text{aq}) + \text{H}_2\text{O}(\text{l})$
C	$2\text{O}(\text{g}) \rightarrow \text{O}_2(\text{g})$
D	$\text{Na}(\text{s}) \rightarrow \text{Na}(\text{g})$

Answer: **D**

- A enthalpy of combustion has negative ΔH
 B enthalpy of neutralisation has negative ΔH
 C bond formation has negative ΔH
 D enthalpy of atomisation has positive ΔH

8

The table shows the enthalpy change of neutralisation per mole of water formed, ΔH , for the following acids and bases.

acid	base	$\Delta H / \text{kJ mol}^{-1}$
hydrochloric acid	sodium hydroxide	-57.0
P	Sodium hydroxide	-54.0
hydrochloric acid	Q	-52.0
nitric acid	R	-57.0

What are **P**, **Q** and **R**?

	P	Q	R
A	propanoic acid	ammonia	sodium hydroxide
B	propanoic acid	potassium hydroxide	ammonia
C	sulfuric acid	ammonia	potassium hydroxide
D	sulfuric acid	sodium hydroxide	ammonia

Answer: **A**

$\Delta H = -57 \text{ kJ mol}^{-1}$ indicates neutralisation between strong acid and strong base.
 Any numerical value lesser than 57 indicates reaction between either strong acid and weak base or weak acid and strong base.

As such,

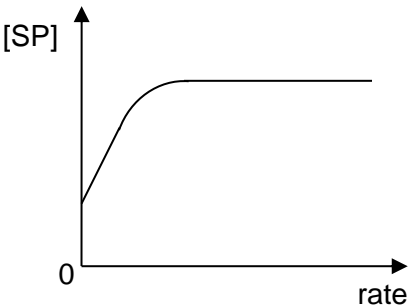
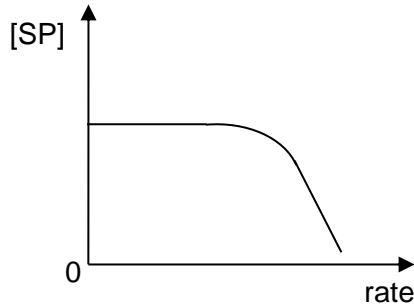
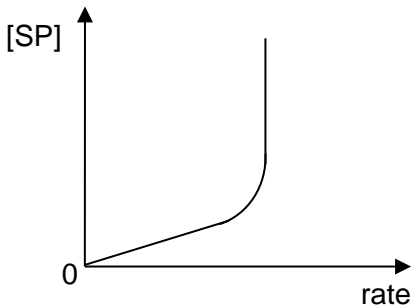
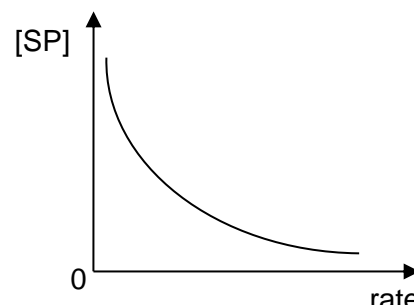
P is weak acid: propanoic acid

Q is weak base: ammonia

R is strong base: sodium hydroxide/ potassium hydroxide

9	The table shows some data on two acid-base indicators.		
	Indicator	pH range of colour change	Colour change
			acid alkali
	thymolphthalein	9-10	colourless blue
	chlorphenol red	6-7	yellow red
	Which conclusion can be drawn about a solution in which thymolphthalein is colourless and chlorphenol red is red?		
	A	It is weakly acidic.	
	B	It is neutral.	
	C	It is weakly alkaline.	
	D	It is strongly alkaline.	
Answer: C When thymolphthalein is colourless, $\text{pH} < 9$ When chlorphenol red is red, $\text{pH} > 7$ pH range of solution 7-9 -> Solution is weakly alkaline.			

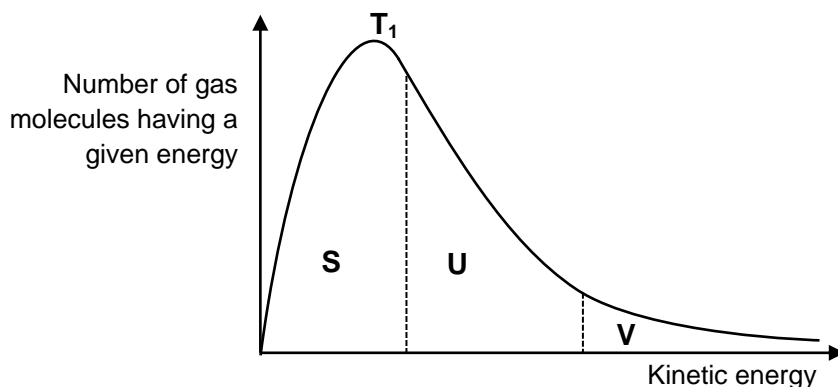
10	Equal volumes of $0.050 \text{ mol dm}^{-3}$ of hydrochloric acid was mixed with $0.050 \text{ mol dm}^{-3}$ of calcium hydroxide. Calculate the pH of the resulting solution.		
	A	13.1	
	B	12.4	
	C	7.0	
	D	1.6	
Answer: B Ca(OH)_2 is diacidic and hence is in excess. $[\text{OH}^-]_{\text{remaining}} = [\text{OH}^-]_{\text{int}} - [\text{OH}^-]_{\text{reacted}}$ $\quad\quad\quad = (0.10 - 0.05) / 2$ $\quad\quad\quad = 0.0250 \text{ mol dm}^{-3}$ $\text{pOH} = -\lg(0.25) = 1.6$ $\text{pH} = 14 - \text{pOH} = 12.4$			

11	Serine protease (SP) is a biological catalyst which increases the rate of hydrolysis of amide bonds in proteins. Which graph represents the [serine proteases] to rate of reaction	
	A 	B 
	C 	D 

Answer: C

When concentration of enzyme is low, the order of reaction with respect to it is 1. A straight line seen as a straight line. As concentration of enzyme increases, order of reactions wrt enzyme is zero. Rate becomes independent of [SP] and is constant regardless of the increase in [SP].

- 12** The Boltzman distribution curve shows the number of gas molecules have a particular kinetic energy at constant temperature, T_1 .



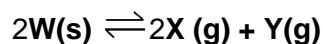
What happens to the size of the areas labelled **S**, **U** and **V** if a higher temperature, T_2 was used?

	S	U	V	
A	increase	increase	decrease	
B	increase	decrease	decrease	
C	decrease	increase	increase	
D	decrease	decrease	increase	

Answer: C

As temperature increase, the peak of the graph would shift to the right, resulting in an increase in areas **U** and **V** but a decrease in area **S**.

- 13** Compound **W** decomposes upon heating according to the following equation:



When 3.9 mol of **W** were put into a 1.0 dm^3 container and heated, the equilibrium mixture contained 0.8 mol of **Y**.

What is the approximate numerical value of the equilibrium constant K_c ?

A	0.387		
B	0.640		
C	1.28		
D	2.05		

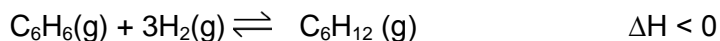
Answer: D



I	-	0	0
C	-	+1.6	+0.8
E	-	1.6	0.8

$$K_c = (0.8/1)(1.6/1)^2 = 2.05 \text{ mol}^3\text{dm}^{-9}$$

- 14** Under which following sets of condition may result in the highest yield of C_6H_{12} at equilibrium for the following reaction



		Temperature	Pressure
	A	High	High
	B	High	Low
	C	Low	High
	D	Low	Low

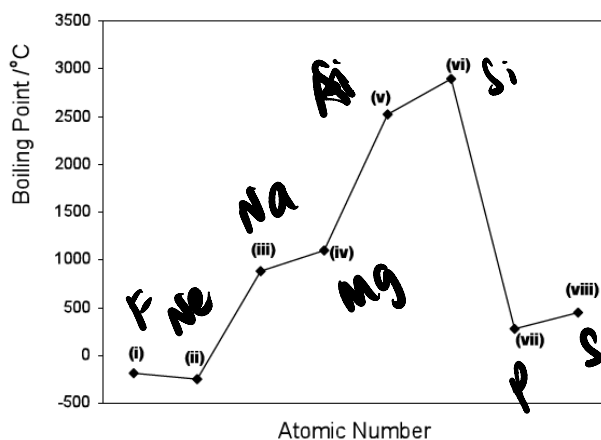
Answer: C

The forward reaction is exothermic. By LCP, the position of equilibrium will shift right to release heat, favouring the exothermic reaction at low temperatures.

By LCP, the position of equilibrium will shift right to decrease the no of moles of gas at lower pressures at high pressures.

- 15** Please use the following data for Question 15 and 16.

The following graph shows the boiling points of eight consecutive elements from Periods 2 and 3 of the Periodic Table.



Which of the following statement about the oxides of the elements is **incorrect**?

- A** The oxide of (vi) is a giant molecule.
- B** The oxide of (i) has a melting point of 1286°C.
- C** (viii) can form an oxide with variable oxidation states.
- D** The oxide of (vii) dissolves in water to give an acidic solution.

Answer : B

Big jump from (ii) to (iii).

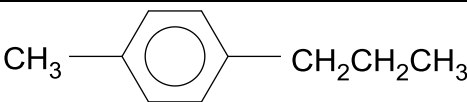
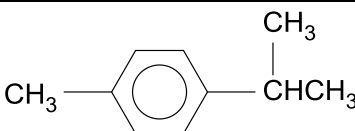
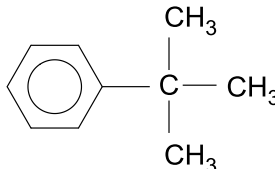
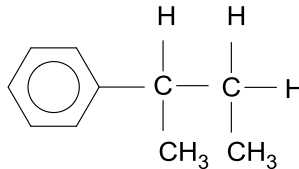
From simple molecular structure to Giant metallic lattice structure → (iii) is Na

The elements from (i) to (viii) are F, Ne, Na, Mg, Al, Si, P, S respectively.

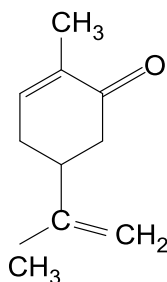
Fluorine forms a covalent oxide with simple molecular structure, and should not have such high melting point. **B** is incorrect.

16	Which of the following statement about the chlorides of the elements is correct ?
A	(iii) and (vi) form chlorides with high melting points.
B	The chloride of (vii) hydrolyses in water to give a basic solution.
C	The chloride of (iv) dissolves in water to give a slightly acidic solution.
D	(v) forms a chloride that is a good electrical conductor in the aqueous and molten state.
Ans: C MgCl_2 first dissolves to form Mg^{2+} and Cl^- aqueous ions: $\text{MgCl}_2 (\text{s}) + 6 \text{H}_2\text{O} (\text{l}) \rightarrow [\text{Mg}(\text{H}_2\text{O})_6]^{2+} (\text{aq}) + 2 \text{Cl}^- (\text{aq})$ The Mg^{2+} ions undergo slight hydrolysis with water molecules: $[\text{Mg}(\text{H}_2\text{O})_6]^{2+} (\text{aq}) \rightleftharpoons [\text{Mg}(\text{H}_2\text{O})_5(\text{OH})]^+ (\text{aq}) + \text{H}^+ (\text{aq})$	

17	Element Z has a melting point of 97.7°C . The oxide of element Z reacts with water to give an alkaline solution. However, its chloride dissolves in water to give a neutral solution. What is element Z ?
A	sodium
B	aluminium
C	silicon
D	phosphorus
Ans: A Sodium oxide reacts vigorously with water to form basic solution. Its chloride undergoes hydration to form a neutral solution.	

18	Compound K reacts with bromine gas in the presence of UV light to form 3 mono-brominated products. Which of the following is a possible structure of K ?			
	A		B	
	C		D	
Ans: B Compound A will form 4 different mono-brominated products. Compound B will form 3 different mono-brominated products. Compound C will form 1 mono-brominated product. Compound D will form 4 different mono-brominated products.				

- 19 Carvone is responsible for the odour of spearmint.

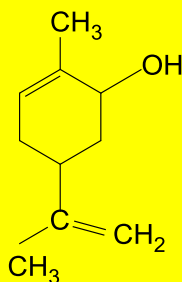


How many σ and π bonds are found in the product formed when carvone reacts with sodium boron hydride?

	σ	π	
A	27	0	
B	31	0	
C	27	2	
D	31	2	

Answer: C

Only the carbonyl group can be reduced to alcohol and the alkenes will not be reduced. Hence the following product is formed.



- 20 A series of experiments were conducted with four organic halogeno compounds. They were treated separately with boiling aqueous sodium hydroxide. The products from each compound were then acidified with dilute nitric acid followed by aqueous silver nitrate.

Experiment	Halogeno compounds	Time for ppt to appear after addition AgNO_3 (aq)
1	chloropropane	15 seconds
2	bromopropane	10 seconds
3	iodopropane	2 seconds

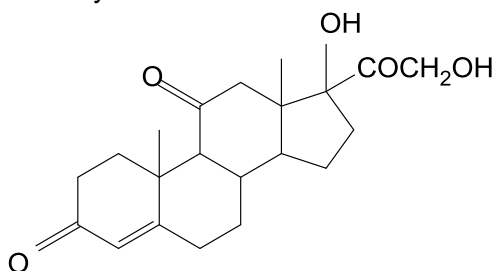
Why was the shortest time taken for the precipitate to appear for iodopropane?

- A Iodopropane has the weakest carbon-halogen bond.
 B Iodopropane has the shortest carbon-halogen bond.
 C Iodopropane has the least polar carbon-halogen bond.
 D Iodopropane has the most extensive intermolecular van der Waals' forces of attraction.

Ans: A

Strength of C-X bond: $\text{C-Cl} > \text{C-Br} > \text{C-I}$
 Ease of cleavage of C-X bond: $\text{C-Cl} < \text{C-Br} < \text{C-I}$
 Order of reactivity of R-X: $\text{R-Cl} < \text{R-Br} < \text{R-I}$
 Rate of reaction: $\text{R-Cl} < \text{R-Br} < \text{R-I}$
 time for ppt to form from R-X:
 2-chloropropane > 2-bromopropane > 2-iodopropane

21 Cortisone is an anti-inflammatory hormone.



Which reagent would react with this compound?

- | | |
|----------|------------------------------|
| A | Tollen's reagent |
| B | sodium carbonate |
| C | aqueous alkaline iodine |
| D | aqueous potassium dichromate |

Ans: **D**

22 Compound **M** found in the urine of patients suffering from diabetes, gives the following experimental observations.

- With acidified potassium dichromate, it gives a green-blue solution.
- On warming with **M**, Fehling's solution retains its blue colour.
- With hydrogen cyanide and aqueous sodium cyanide, **M**, produces $\text{C}_4\text{H}_7\text{NO}_2$.

What could be the structural formula of **M**?

- | | |
|----------|--|
| A | CH_3COCHO |
| B | $\text{CH}_3\text{COCH}_2\text{OH}$ |
| C | $\text{CH}_3\text{CH}(\text{OH})\text{CHO}$ |
| D | $\text{CH}_3\text{CH}(\text{OH})\text{COCH}_3$ |

Ans: **B**

M does not contain an aldehyde. It contains a primary or secondary alcohol. Only $\text{CH}_3\text{COCH}_2\text{OH}$ produces $\text{C}_4\text{H}_7\text{NO}_2$.

23 The following shows the synthesis of the compound, $\text{CH}_2=\text{CHCH}_2\text{NH}(\text{CH}_3)$.

$$\text{CH}_2=\text{CHCOOH} \xrightarrow[\text{LiAlH}_4 \text{ in dry ether}]{\text{Step 1}} \text{P} \xrightarrow{\text{Step 2}} \text{Q} \xrightarrow{\text{Step 3}} \text{CH}_2=\text{CHCH}_2\text{NH}(\text{CH}_3)$$

What are the identities of the organic intermediates **P** and **Q** and the reagents for step 3?

		P	Q	Step 3	
	A	$\text{CH}_2=\text{CHCH}_2\text{OH}$	$\text{CH}_2=\text{CHCH}_2\text{Br}$	NH_3	
	B	$\text{CH}_2=\text{CHCH}_2\text{Br}$	$\text{CH}_2=\text{CHCH}_2\text{OH}$	NH_3	
	C	$\text{CH}_2=\text{CHCH}_2\text{OH}$	$\text{CH}_2=\text{CHCH}_2\text{Br}$	CH_3NH_2	
	D	$\text{CH}_2=\text{CHCH}_2\text{Br}$	$\text{CH}_2=\text{CHCH}_2\text{OH}$	CH_3NH_2	

Ans: **C**



24 When an ester is formed between benzoic acid and methanol enriched with ^{18}O , the water produced is not enriched with ^{18}O . Which of the following conclusions cannot be drawn from this observation?

A The O–H bond in the methanol breaks during the reaction.

B The oxygen in the water must be derived from the benzoic acid

C The ^{18}O has been effectively reduced to ^{16}O during the process.

D The carbon–to–oxygen single bond of the $-\text{COOH}$ group in the acid breaks during the reaction.

Answer: **C**

25 The Russian composer Borodin, was also a research chemist. He discovered a reaction in which two ethanal molecules combine to form a compound commonly known as aldol (reaction I). Aldol forms another compound on heating (reaction II).

I $2\text{CH}_3\text{CHO} \rightarrow \text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO}$

II $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CHO} \rightarrow \text{CH}_3\text{CH}=\text{CHCHO} + \text{H}_2\text{O}$

Which of the following best describes reactions **I** and **II**?

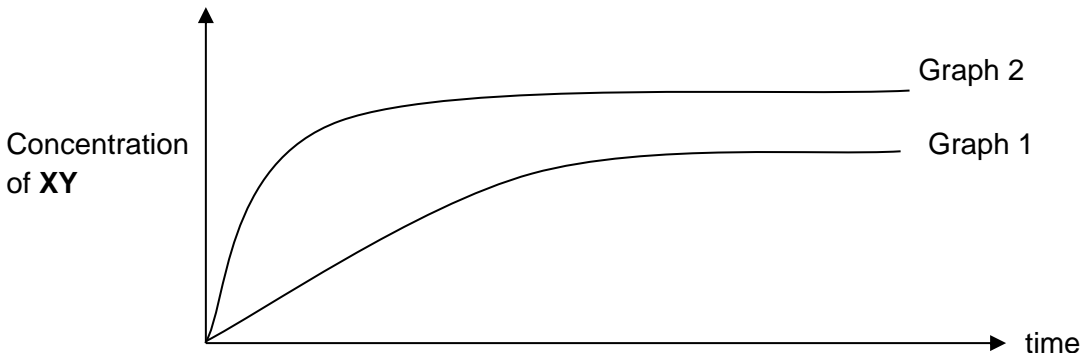
		I	II	
	A	Addition	Elimination	
	B	Addition	Reduction	
	C	Elimination	Reduction	
	D	Substitution	Elimination	

Answer: **A**

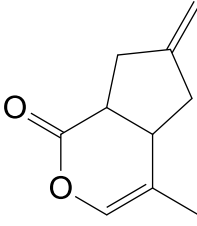
For **questions 26 – 30**, one or more of the numbered statements **1** to **3** may be correct. Decide whether each of the statements is or is not correct. The responses **A** to **D** should be selected on the basis of

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

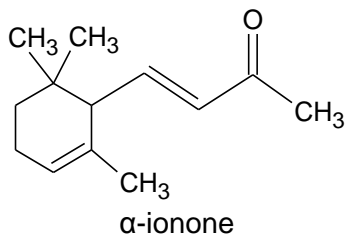
No other combination of statements is to be used as correct response.

26	<p>Two diatomic gases, X_2 and Y_2, react as follows:</p> $X_2(g) + Y_2(g) \rightleftharpoons 2XY(g) \quad \Delta H < 0$ <p>The graph shows how the percentage yield of the product, XY, varies with time.</p>  <p>Which of the following changes could account for the change from Graph 1 to Graph 2?</p>
1	Addition of Y_2
2	Increase in pressure
3	Decrease in temperature
	<p>Answer: D (1 only)</p> <p>Since the amount of gaseous reactant and amount of gaseous products are equal, change in pressure will not affect the equilibrium position.</p> <p>Decrease in temperature will cause the rate to slow down but in Graph 2, the gradient was steeper than in Graph 1.</p>

27	Among the elements of Group IV, those towards the top, carbon to germanium, have very different properties from those at the bottom, tin and lead					
	The melting point of the elements are shown below.					
	Element	C	Si	Ge	Sn	Pb
	mp/ ^o C	>3550	1410	937	232	327
	Which of the following statement is incorrect?					
	1	The decrease in melting point from carbon to germanium is due to an increase in atomic radius.				
	2	The chloride of all the elements can react with water.				
	3	Down the group there is an increase in covalent character.				
	<p>Answer: C (2 and 3 only)</p> <p>Option 1 is correct. The trends reflect the increasing weakness of covalent bonds as the atoms get bigger and the bonds get longer.</p> <p>Option 2 is wrong as CCl₄ has no reaction with water. SiCl₄ reacts violently with water. GeCl₄, SnCl₄ and PbCl₄ hydrolyses in water</p> <p>Option 3 is wrong as Sn and Pb has giant metallic structure.</p>					

28	<i>Neptalactone</i> is the active ingredient found in the plant, Catnip. A derivative <i>Neptalactone</i> has the following structure:	
		
	Which of the following statements is true of the derivative of <i>Neptalactone</i> ?	
	1	It exhibits geometric isomerism.
2	It contains an ester and an alkene functional group.	
3	It contains five sp ³ hybridised and five sp ² hybridised carbon atoms.	
Answer: C (2 and 3 only)		

- 29** Ionones are a significant contributor to the aroma of roses. They are found in a variety of essential oils and are important chemicals in perfumery. One such ionone is the α -ionone as shown below.

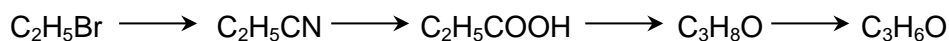


Which statements about these reactions are correct?

- | | |
|----------|--|
| 1 | One mole α -ionone could react with one mole of sodium metal. |
| 2 | One mole α -ionone could react with two moles of liquid bromine. |
| 3 | One mole α -ionone could react with one mole of 2,4-dinitrophenylhydrazine. |

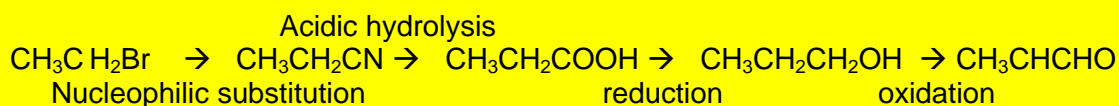
Answer: **C** (2 and 3 are correct)

- 30** Which type of reaction(s) is **not** shown in the synthesis below?



- | | |
|----------|--------------|
| 1 | Addition |
| 2 | Reduction |
| 3 | Substitution |

Answer: **D (1 only)**



There are no addition reaction in this synthesis.

END OF PAPER 1

Turn Over]