



CHEMISTRY

9647/01

Paper 1 Multiple Choice

18th September 2015
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.

1. Enter your NAME (as in NRIC). _____
2. Enter the SUBJECT TITLE. _____
3. Enter the TEST NAME. _____
4. Enter the CLASS. _____

Write your **name**
and **Civics Group**

5. Enter your CLASS NUMBER or INDEX NUMBER.
6. Now SHADE the corresponding lozenge in the grid for EACH DIGIT or LETTER

WRITE		SHADE APPROPRIATE BOXES									
I N D E X		0	1	2	3	4	5	6	7	8	9
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		0	1	2	3	4	5	6	7	8	9
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		0	1	2	3	4	5	6	7	8	9
N U M B E R		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		0	1	2	3	4	5	6	7	8	9
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
		0	1	2	3	4	5	6	7	8	9
		☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
	A	B	C	D	E	F	G	H	I		
	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	

Write and
shade
your index
number

There are **forty** 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 **21** printed pages.

Section A

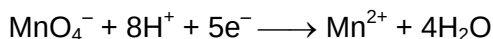
For each question, there are four possible answers, **A, B, C and D**. Choose the **one** you consider to be correct.

- 1** Incomplete combustion of $y \text{ dm}^3$ of butane, C_4H_{10} , yielded a mixture of carbon dioxide and carbon monoxide in the ratio of 3:1, together with water vapour.

What is the volume of oxygen consumed?

- | | |
|----------------------------|-----------------------------|
| A $5y \text{ dm}^3$ | C $9y \text{ dm}^3$ |
| B $6y \text{ dm}^3$ | D $12y \text{ dm}^3$ |

- 2** 0.005 mol of a metal oxide, Y_2O_x , reacted exactly with 0.006 mol of acidified potassium manganate(VII) solution. The half-equation for the reduction of MnO_4^- is shown below.



Given that the oxidation state of **Y** in the product is +6, what is the value of x ?

- | | |
|------------|------------|
| A 1 | C 3 |
| B 2 | D 4 |

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

Significant contributions to carbon dioxide levels in the atmosphere comes from the thermal decomposition of limestone (calcium carbonate) and the manufacture of cement and lime (calcium oxide).

Cement works roast 1000 million tonnes of limestone per year and a further 200 million tonnes is roasted in kilns to make lime.

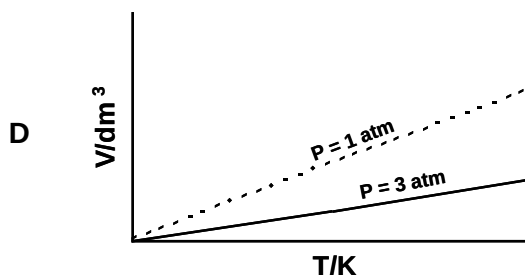
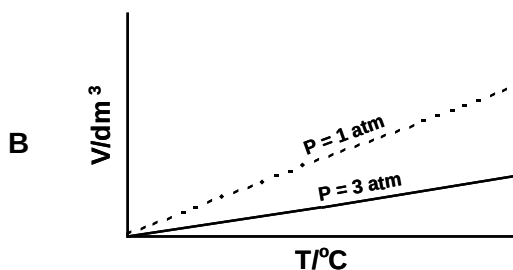
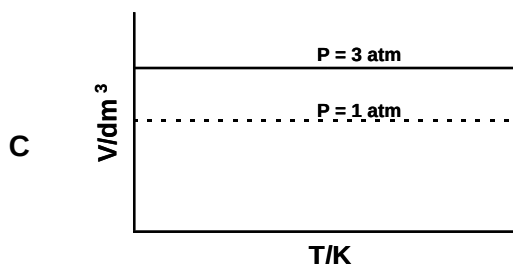
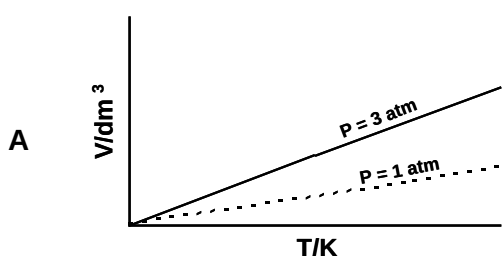
What is the total annual mass output of carbon dioxide (in million tonnes) from these two processes?

- A** 440
- B** 528
- C** 660
- D** 880

- 4** Which of the following species has three unpaired electrons?

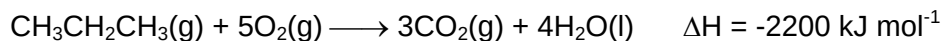
- | | | | |
|-------------|---------------------------|---------------------------|---------------------------|
| A Al | B Ti^{3+} | C Zn^{2+} | D Cr^{3+} |
|-------------|---------------------------|---------------------------|---------------------------|

- 5 Which of the following describes a phenomenon which **cannot** be explained by hydrogen bonding?
- A Ethanoic acid molecules form a dimer when dissolved in benzene.
 - B Ice has a lower density than water at 0 °C.
 - C The boiling point of alcohol increases with increasing molecular mass.
 - D 2-nitrophenol has a lower boiling point than 4-nitrophenol.
- 6 Which plot clearly exhibits ideal gas behavior?



- 7 *Use of Data Booklet is relevant to this question.*

Propane burns exothermically in air as follows.

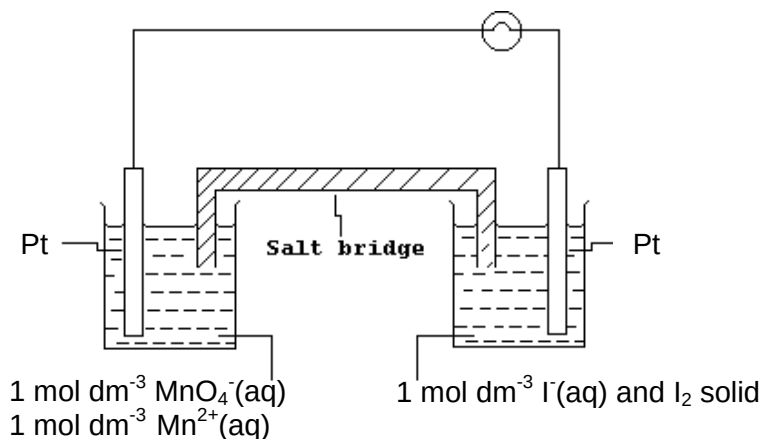


0.05 moles of propane from the burner was used to heat 0.9 dm^3 of water. It was found that the temperature of the water increased to 40°C after three minutes at room conditions.

What is the rate of heat loss to the surroundings in kJ min^{-1} ?

- A 17.9 kJ min^{-1}
 B 36.7 kJ min^{-1}
 C 53.6 kJ min^{-1}
 D 103 kJ min^{-1}
- 8 *Use of Data Booklet is relevant to this question.*

A cell involving aqueous potassium iodide and acidified sodium manganate(VII) is shown.



Which of the following statements is true?

- A The e.m.f of the cell is -0.98 V .
 B The purple colour of iodine will become more intense over time.
 C The light bulb will be brighter when the concentration of $\text{MnO}_4^-(\text{aq})$ increases.
 D The direction of electron flow will reverse when the $\text{MnO}_4^-/\text{Mn}^{2+}$ half-cell is replaced with a Cl_2/Cl^- half cell.

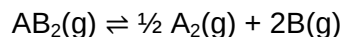
- 9 *Use of Data Booklet is relevant to this question.*

In the commercial electrolysis of concentrated sodium chloride, the products are chlorine, hydrogen and sodium hydroxide.

What is the maximum yield of each of these products when 58.5 kg of sodium chloride was electrolysed?

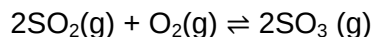
	Yield of chlorine /kg	Yield of hydrogen /kg	Yield of sodium hydroxide /kg
A	35.5	1	40
B	35.5	2	80
C	71	1	40
D	71	2	80

- 10 The equilibrium, $A_2(g) + 4B(g) \rightleftharpoons 2AB_2(g)$, has an equilibrium constant K_c of 3.60. What will be the numerical value of the equilibrium constant for the following reaction at the same temperature?



- | | |
|---------------|---------------|
| A 0.14 | C 0.28 |
| B 0.53 | D 3.60 |

- 11** Sulfur dioxide is converted to sulfur trioxide in the Contact process as shown by the equation below.

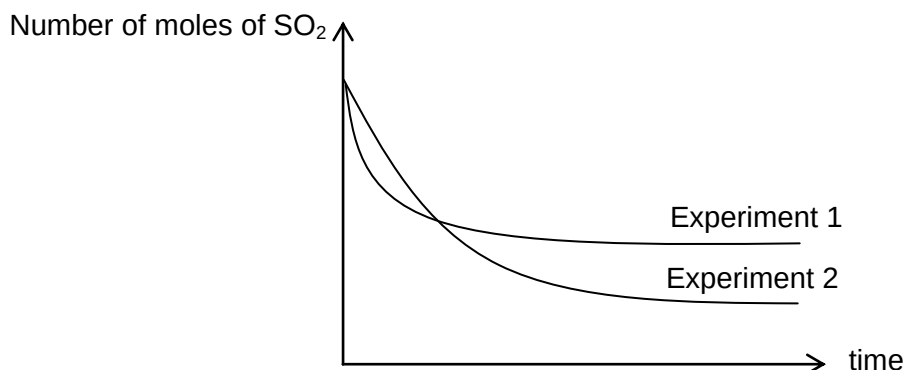


To investigate the reaction, two experiments were conducted.

Experiment 1: Quantities of SO_2 and O_2 were placed in a sealed vessel and the reaction was allowed to proceed at a constant temperature.

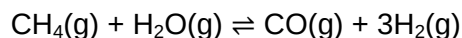
Experiment 2: The experiment was repeated at a different temperature using quantities of reactants same as experiment 1.

The graph below shows the amount of SO_2 present in the mixture.



These results show that experiment 2 was conducted at a

- A** higher temperature and the forward reaction is endothermic.
 - B** lower temperature and the forward reaction is endothermic.
 - C** higher temperature and the forward reaction is exothermic.
 - D** lower temperature and the forward reaction is exothermic.
- 12** Steam reforming process is the most common method for industrial production of hydrogen.



The value of K_c is found to be 5.27 for this reaction when 0.65 mol of methane is mixed with 0.30 mol of steam in a 1 dm^3 vessel.

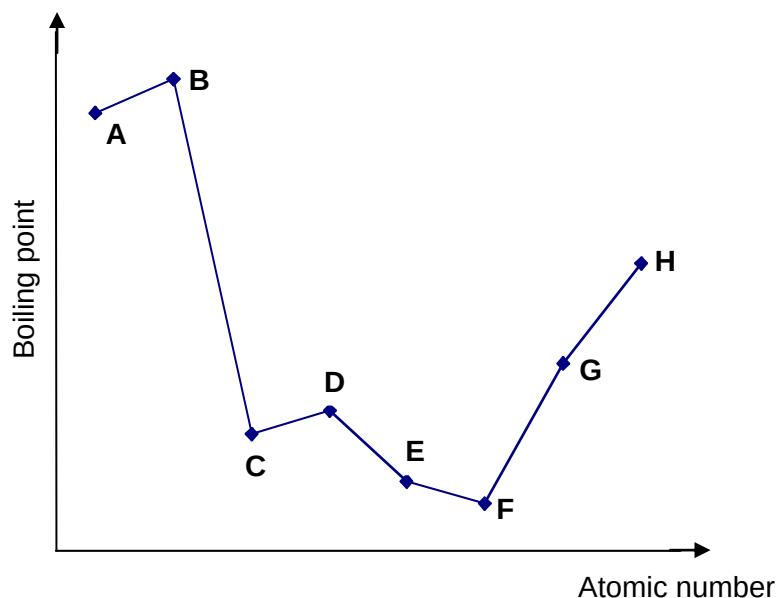
How many moles of steam must be added to the mixture to raise the equilibrium amount of hydrogen gas to 0.84 mol at the same temperature?

- | | |
|----------------|----------------|
| A 0.030 | C 0.085 |
| B 0.065 | D 0.090 |

- 13** The numerical value of solubility product of magnesium hydroxide is 1.8×10^{-12} . What is the solubility of magnesium hydroxide in a solution of sodium hydroxide at pH 12.5 and 25 °C?

- | | | | |
|----------|------------------------|----------|-----------------------|
| A | 5.69×10^{-11} | C | 1.80×10^{-9} |
| B | 4.50×10^{-10} | D | 7.66×10^{-5} |

- 14** The graph below shows the variation in the boiling points for eight consecutive elements in the Periodic Table, all with atomic number between 10 and 20.



Which of the following statements is true?

- A** Element **A** and barium are in the same group.
- B** Element **G** has a smaller atomic radius than element **H**.
- C** Element **D** has a lower first ionisation energy than element **C**.
- D** The oxide of **G** dissolves in water to give an acidic solution.

- 15** X, Y and Z are elements in Period 3 of the Periodic Table.

A mixture containing the oxides of X, Y and Z was dissolved in excess dilute sulfuric acid and filtered. The oxide of Z was collected as a residue. When excess dilute sodium hydroxide was added to the filtrate, only a white precipitate of the hydroxide of Y was formed.

What are the possible identities of X, Y and Z?

	X	Y	Z
A	Mg	Al	P
B	Al	Mg	P
C	Mg	Al	Si
D	Al	Mg	Si

- 16** Which property of Group II elements (magnesium to barium) decreases with increasing atomic number?

- A reactivity with water
- B solubility of hydroxides in water
- C second ionisation energy
- D reducing power

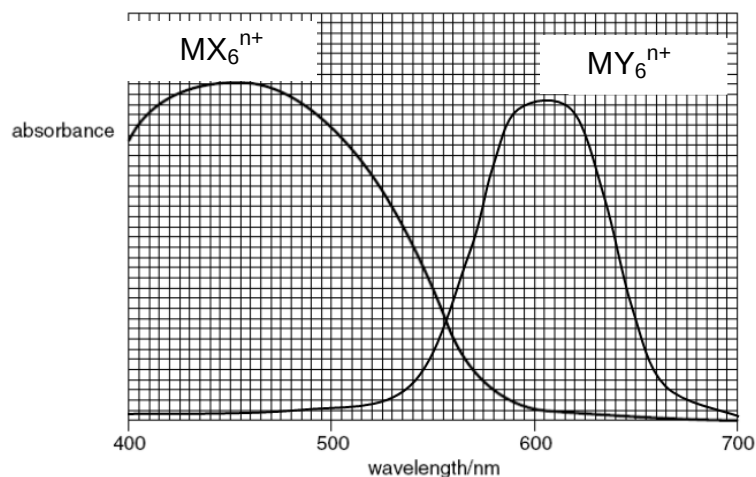
- 17** Two experiments were conducted to prepare pure hydrogen iodide from solid potassium iodide.

Experiment	Reagent used
1	concentrated H_2SO_4
2	concentrated H_3PO_4

Which of the following describes the outcome of each experiment correctly?

- A Experiment 1 was successful, as hydrogen iodide can be quickly isolated due to its low boiling point.
- B Experiment 1 was unsuccessful, as hydrogen iodide formed will further react to give iodine and hydrogen sulfide.
- C Experiment 2 was unsuccessful, as H_3PO_4 is a weaker acid than H_2SO_4 , thus hydrogen iodide cannot be formed.
- D Experiment 2 was successful, as H_3PO_4 is a weaker reducing agent than H_2SO_4 .

- 18 The graph below shows the visible spectra of two complexes of transition metal M, MX_6^{n+} and MY_6^{n+} .



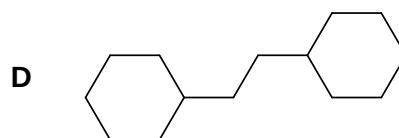
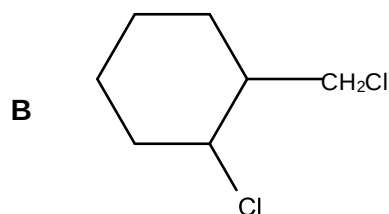
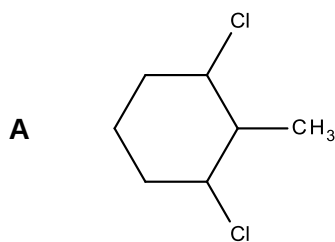
The colours corresponding to the wavelengths in the visible light region are shown below.

colour	wavelength / nm
violet	400 – 430
blue	430 – 490
green	490 – 570
yellow	570 – 590
orange	590 – 620
red	620 – 750

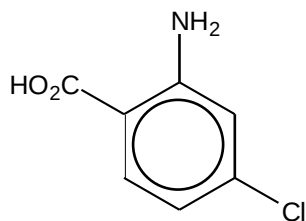
What is the colour of each complex and which ligand causes a larger d-orbital splitting?

	Colour of MX_6^{n+}	Colour of MY_6^{n+}	ligand which causes a larger d-orbital splitting
A	Violet	Orange-red	X
B	Red	Green-blue	X
C	Violet	Orange-red	Y
D	Red	Green-blue	Y

- 19 Methylcyclohexane and Cl_2 are mixed together and irradiated with light. Which of the following compound is **not** formed?



- 20 A student wishes to synthesise compound **Q** from benzene.



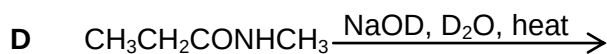
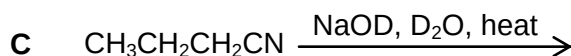
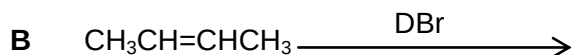
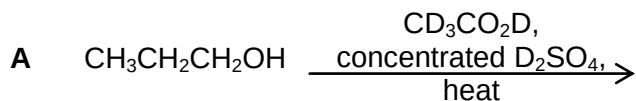
Compound **Q**

Which of the following routes would give the maximum yield of **Q**?

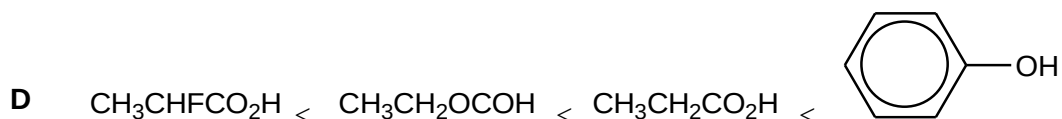
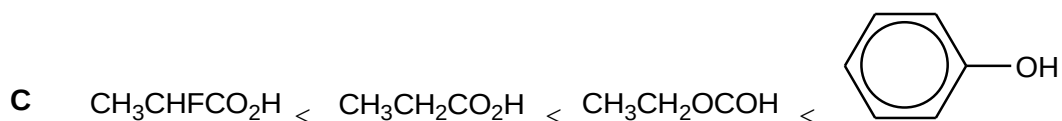
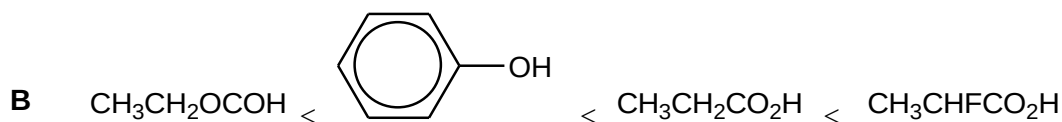
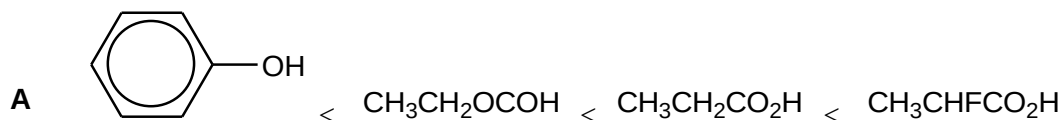
- A** Nitration → alkylation → reduction → chlorination → oxidation
- B** Chlorination → nitration → reduction → alkylation → oxidation
- C** Alkylation → nitration → oxidation → chlorination → reduction
- D** Alkylation → nitration → chlorination → reduction → oxidation

21 Deuterium, D, is an isotope of hydrogen.

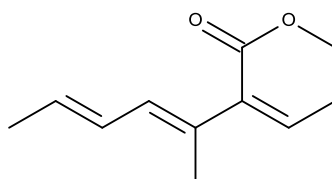
Which reaction will **not** yield organic product(s) containing deuterium?



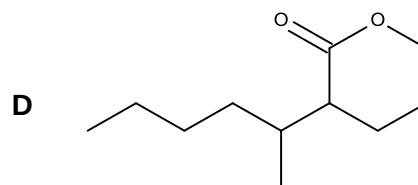
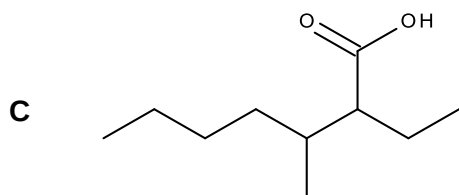
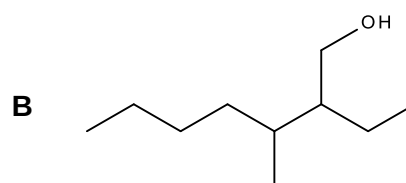
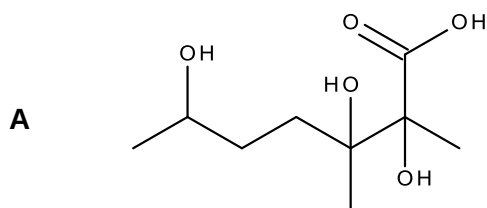
22 Which of the following shows the correct order of increasing acidity?



23 Part of the structure of a fungicide, strobilurin, is shown.



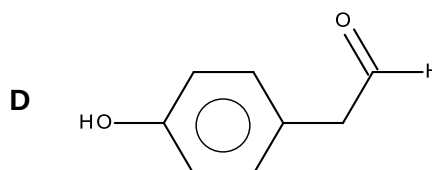
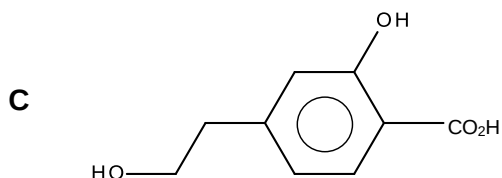
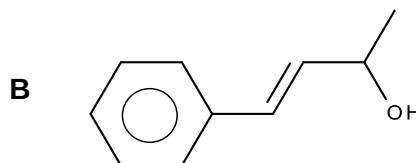
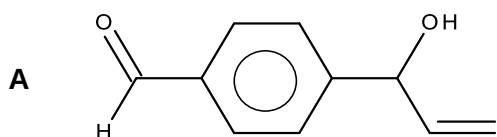
If strobilurin is first warmed with aqueous sulfuric acid, and its product then treated with hydrogen in the presence of a palladium catalyst, what could be the structure of the final product?



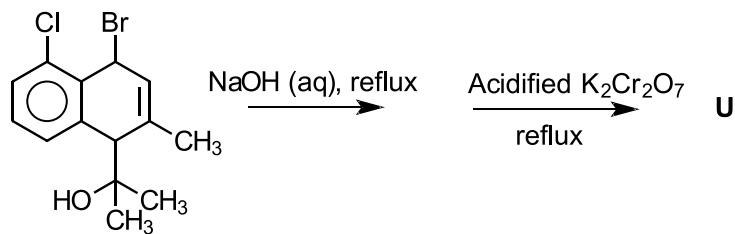
24 An organic compound **R** has the following properties:

- It decolourises $\text{Br}_2(\text{aq})$.
- It reacts with $\text{PCl}_5(\text{s})$.
- Upon heating with acidified $\text{Na}_2\text{Cr}_2\text{O}_7$, it forms a product that gives a brick-red precipitate with an alkaline solution of complexed $\text{Cu}^{2+}(\text{aq})$.

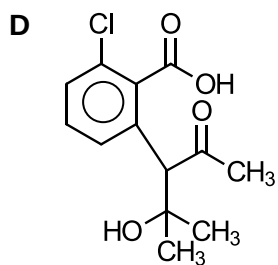
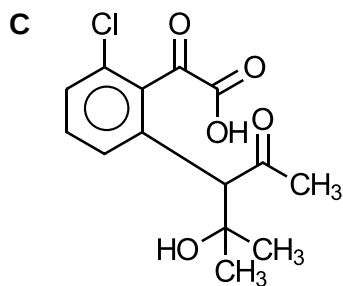
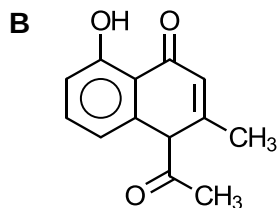
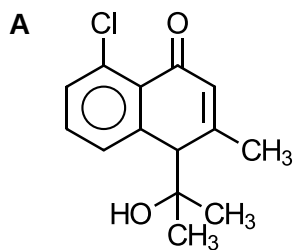
Which of the following is likely to be compound **R**?



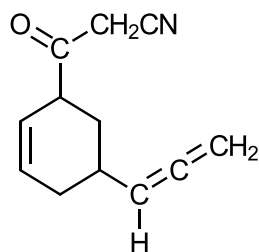
25 The reaction scheme below shows the synthesis of compound **U**.



Which of the following can be **U**?

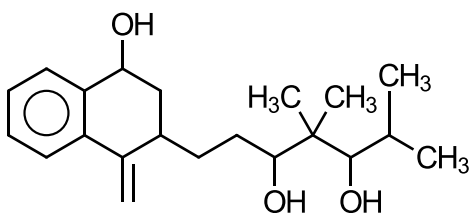


- 26 Which of the following statements is true regarding compound **Z**?



Compound **Z**

- A** There is only one sp hybridised carbon atom in a molecule of **Z**.
- B** A molecule of **Z** contains six π bonds.
- C** After **Z** reacts with LiAlH_4 , all the carbon atoms in the product formed are sp^3 hybridised.
- D** **Z** is a planar molecule.
- 27 Compound **P** reacts with concentrated H_2SO_4 at 180°C to form Compound **Q**. Compound **P** has the following structure.

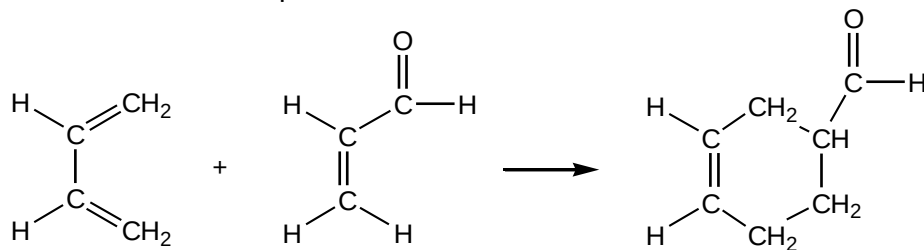


Compound **P**

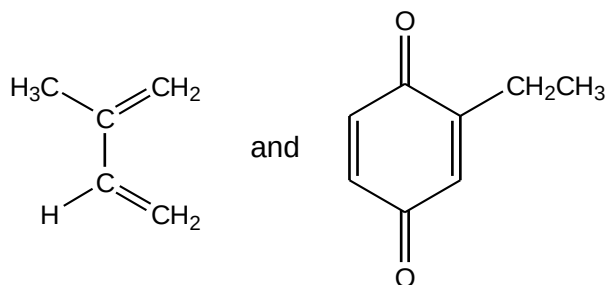
What is the total number of stereoisomers of Compound **Q**?

- A** 2 **B** 4 **C** 8 **D** 16

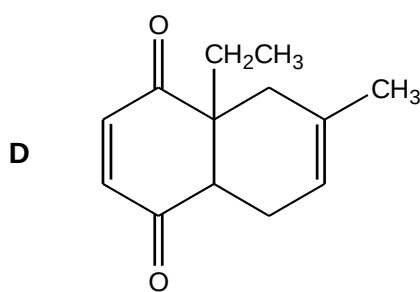
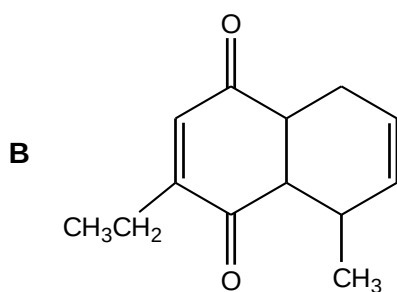
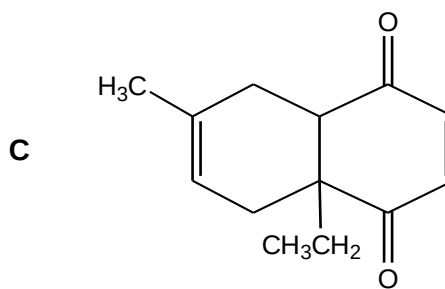
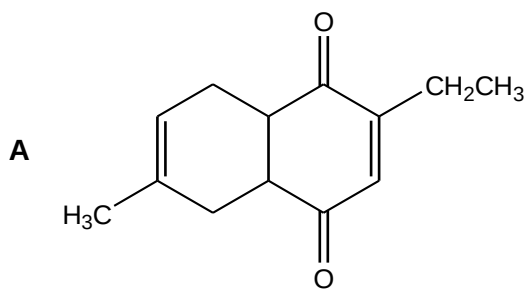
- 28 Unsaturated carbonyl compounds can undergo a useful reaction known as the Diels-Alder reaction with a diene. An example is shown below.



A student reacted the following diene and carbonyl compound together in a Diels-Alder reaction.



Which of the following would **not** be formed as a product?



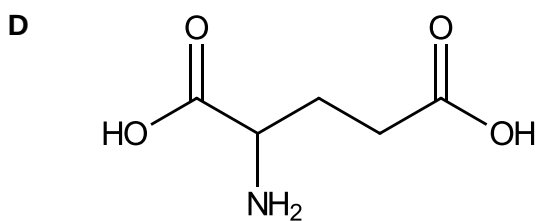
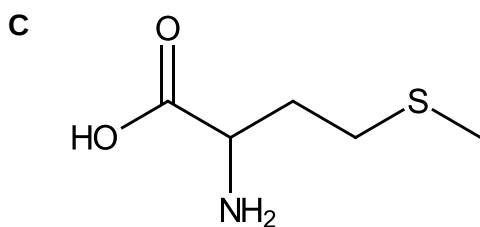
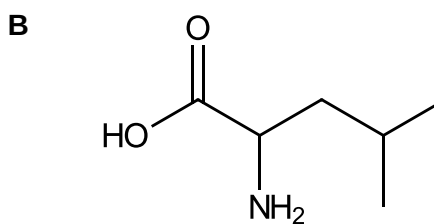
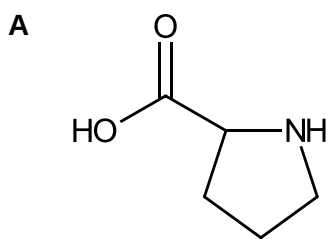
- 29 Partial hydrolysis of a tetrapeptide (containing four amino acid residues) produces the following three dipeptides.



Which of the following is the structure of the tetrapeptide?

- A $\text{NH}_2\text{CH}(\text{CH}(\text{CH}_3)_2)\text{CONHCH}(\text{CH}_3)\text{CONHCH}(\text{CH}(\text{CH}_3)_2)\text{CONHCH}(\text{CH}_3)\text{CO}_2\text{H}$
 B $\text{NH}_2\text{CH}(\text{CH}(\text{CH}_3)_2)\text{CONHCH}(\text{CH}(\text{CH}_3)_2)\text{CONHCH}(\text{CH}_3)\text{CONHCH}(\text{CH}_3)\text{CO}_2\text{H}$
 C $\text{NH}_2\text{CH}(\text{CH}_3)\text{CONHCH}(\text{CH}(\text{CH}_3)_2)\text{CONHCH}(\text{CH}_3)\text{CONHCH}(\text{CH}(\text{CH}_3)_2)\text{COOH}$
 D $\text{NH}_2\text{CH}(\text{CH}_3)\text{CONHCH}(\text{CH}_3)\text{CONHCH}(\text{CH}_3)\text{CONHCH}(\text{CH}_3)\text{CO}_2\text{H}$
- 30 "Helix breakers" are amino acids that disrupt the regularity of the α -helical backbone conformation in a protein. These amino acids also cause breakages or deformations in β -pleated sheets.

Which of the following amino acids is likely to be a "helix breaker"?



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 which you consider to be correct).

The responses **A** to **D** should be selected on the basis of

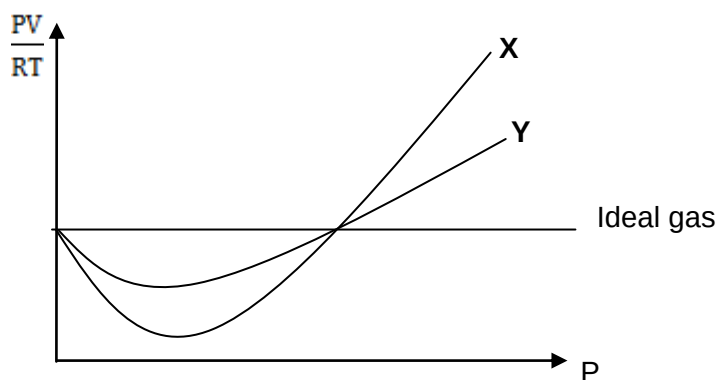
A	B	C	D
1,2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

31 Which of following statements are **incorrect**?

- 1** A covalent compound that contains both hydrogen and oxygen can form hydrogen bonds between its molecules.
- 2** Ionic compounds can be distinguished from metals by their electrical conductivity in the liquid states.
- 3** All substances with covalent bonding have poor electrical conductivity.

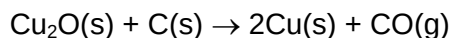
32 The graph below shows the behaviour of two gases **X** and **Y**.



What could be the identities of **X** and **Y**?

	X	Y
1	NH ₃	N ₂
2	CO ₂	O ₂
3	N ₂ at 270K	N ₂ at 370K

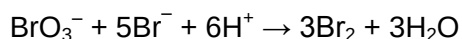
- 33 The reduction of copper(I) oxide with carbon is shown below.



Enthalpy change of formation of $\text{Cu}_2\text{O(s)}$ and CO(g) are -167 kJ mol^{-1} and -111 kJ mol^{-1} respectively. The numerical value of the ΔS is $165 \text{ J K}^{-1} \text{ mol}^{-1}$.

Which of the following statements are true?

- 1 The entropy change for the reaction is positive.
 - 2 The enthalpy change for the reaction is $+56 \text{ kJ mol}^{-1}$.
 - 3 Reaction is spontaneous at 340 K.
- 34 The table below shows the experimental results for the reaction of bromate(V) and bromide in the presence of acid.

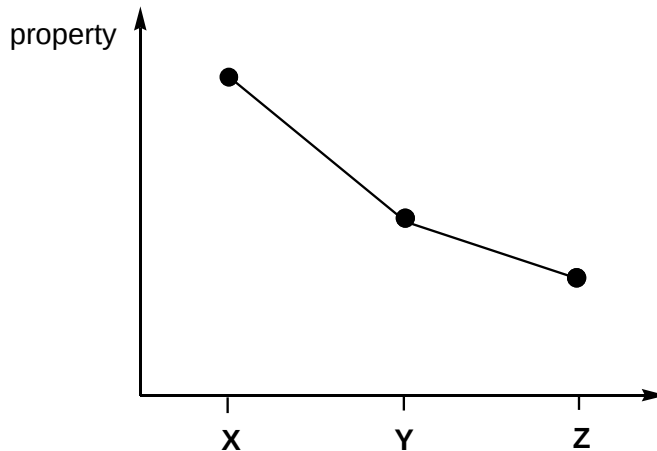


Expt	$[\text{BrO}_3^-]$	$[\text{Br}^-]$	$[\text{H}^+]$	relative rate
1	0.10	0.15	0.40	1
2	0.20	0.15	0.40	2
3	0.10	0.30	0.40	2
4	0.30	0.10	0.20	0.5
5	0.01	0.60	0.80	x

Which of the following statements are correct for this reaction?

- 1 The value of x is 1.6.
- 2 The overall order of reaction is 4.
- 3 A plot of rate against $[\text{BrO}_3^-]$ will be a straight line graph with positive gradient for experiment 5.

35 Which property about X, Y and Z will give the trend shown below?



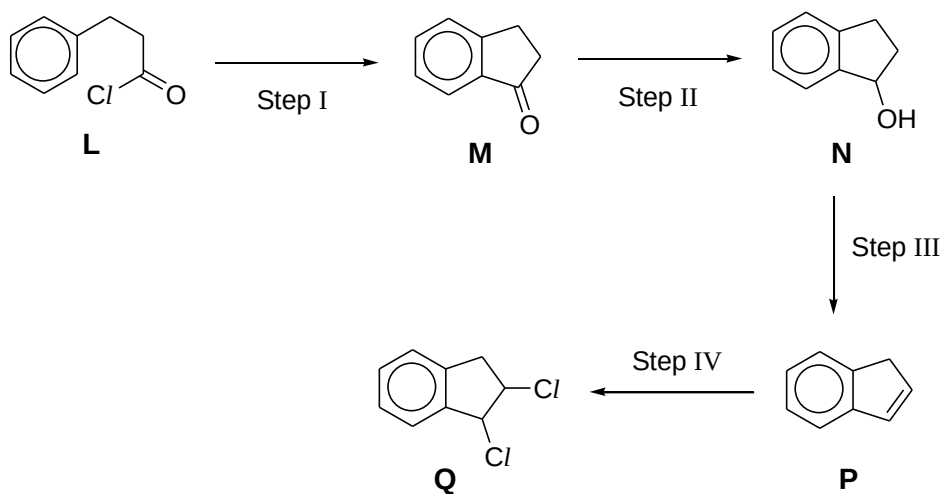
	Property	X	Y	Z
1	pH of the resultant solution when added to water	MgCl_2	AlCl_3	SiCl_4
2	atomic radius	S	Cl	Ar
3	boiling point	HCl	HBr	HI

36 Vanadium occurs naturally in minerals and fossil fuel deposits.

Which of the following statements are **not** correct for vanadium and its compounds?

- 1 The maximum oxidation state of vanadium is found in VO^{2+} .
- 2 V_2O_5 is used as a catalyst in the manufacture of ammonia.
- 3 Vanadium is less dense than calcium.

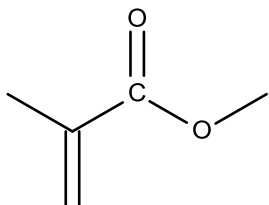
37 Consider the following reaction scheme.



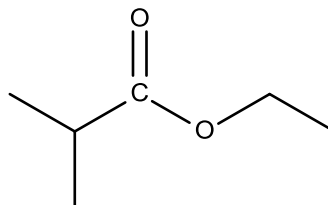
Which of the following statements about the above reaction scheme is correct?

- 1 Step I requires a catalyst.
- 2 Compound **M** is a planar molecule.
- 3 Step IV is a substitution reaction.

38 Perspex is a clear, colourless polymer used for optical applications. It is made of the monomer, methyl methacrylate.



Methyl methacrylate



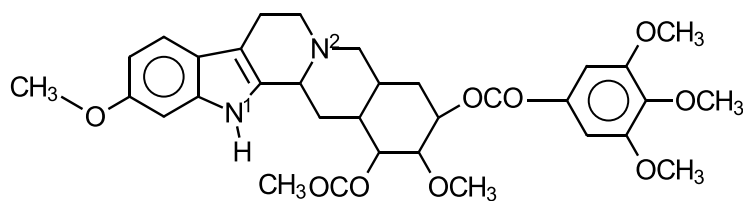
Compound **Z**

Which of the following reagents and conditions can be used to distinguish methyl methacrylate and compound **Z**?

- 1 Aqueous alkaline iodine, heat
- 2 2,4-DNPH, room temperature
- 3 NaOH(aq), heat

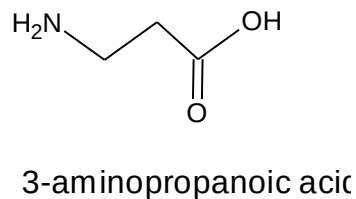
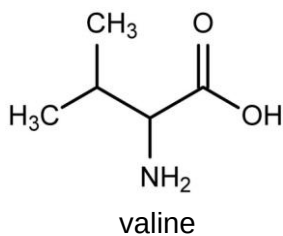
- 39 *Reserpine* is an antipsychotic and antihypertensive drug used for the control of high blood pressure and relief of psychotic behaviours.

[The ether $-\text{OCH}_3$ group is inert]



Which statements are correct?

- 1 The *reserpine* molecule does not give an orange precipitate with 2,4-DPNH.
 - 2 The *reserpine* molecule has 6 chiral centres
 - 3 The N atom labeled N^1 has a lower pK_b than the N atom labeled N^2 .
- 40 Valine is a naturally occurring amino acid. Which of the following statements about valine and 3-aminopropanoic acid is correct?



- 1 Valine and 3-aminopropanoic acid are not structural isomers.
- 2 Both valine and 3-aminopropanoic acids are soluble in water due to formation of hydrogen bonding.
- 3 Both compounds are able to react with ethanoic acid to give amide.