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DUNMAN HIGH SCHOOL
Preliminary Examination
Year 6

H2 CHEMISTRY

9647/01

Paper 1 Multiple Choice

27 September 2013

60 minutes

Additional Materials: Optical Mark Sheet
 Data Booklet

INSTRUCTIONS TO CANDIDATES

- 1 Write your **name**, **index number** and **class** on this question paper.
- 2 There are **forty** 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 in **soft pencil** on the separate Optical Mark Sheet.
- 3 Each correct answer will score one mark. A mark will not be deducted for wrong answer.
- 4 Any rough working should be done in this booklet.
- 5 You may use a calculator.

Section A

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

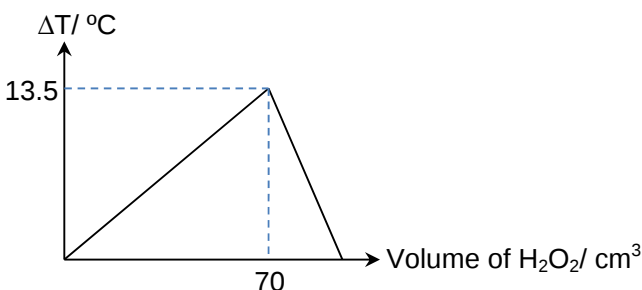
- 1** A 1.0 g sample containing 0.0065 mol of organoboron compound, with the formula $C_xH_yBO_z$, was burnt in an excess of oxygen. The carbon dioxide and steam produced were passed into solid NaOH and P_2O_5 , which increased in mass by 2.29 g and 0.877 g respectively. What is the molecular formula of the organoboron compound?

A CH_2BO_2 **B** $C_8H_7BO_2$ **C** $C_8H_{15}BO_2$ **D** $C_9H_{15}BO$

- 2** SO_2 gas is found in air near volcanoes. 218.4 cm^3 of SO_2 collected at s.t.p. near a volcano was reacted with 25.0 cm^3 of 0.130 mol dm^{-3} acidified potassium dichromate solution to turn the solution from orange to green. What is the oxidation state of sulfur at the end of the reaction?

A 0 **B** +2 **C** +4 **D** +6

- 3** Varying volumes of H_2O_2 of an unknown concentration was reacted with varying volumes of 0.50 mol dm^{-3} acidified potassium manganate(VII) in a series of experiments, to produce the graph below. The total volume of solutions used in each experiment was 100 cm^3 . In each experiment, the difference between the highest temperature reached and the initial temperature was calculated, and was plotted against the volume of H_2O_2 used.



What is the concentration of H_2O_2 and the enthalpy change of the reaction per mole of H_2O_2 ? Assume specific heat capacity of the solution is $4.2\text{ J g}^{-1}\text{ K}^{-1}$ and the density of the solution is 1 g cm^{-3} .

	$[H_2O_2]$	Enthalpy change of reaction
A	0.536 mol dm^{-3}	$+151\text{ kJ mol}^{-1}$
B	0.214 mol dm^{-3}	$+378\text{ kJ mol}^{-1}$
C	0.536 mol dm^{-3}	$+378\text{ kJ mol}^{-1}$
D	0.214 mol dm^{-3}	$+151\text{ kJ mol}^{-1}$

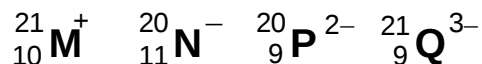
- 4 Elements **W**, **X**, **Y** and **Z** are four consecutive elements in the Periodic Table. The following table shows the first four ionisation energies of each element.

Element	1 st I.E	2 nd I.E	3 rd I.E	4 th I.E
W	1685	3374	6050	8408
X	2081	3952	6122	9371
Y	496	4562	6910	9543
Z	738	1451	7733	10543

Which Groups do elements **W** and **Z** belong to?

- | | W | Z |
|----------|-----------|----------|
| A | Group VII | Group II |
| B | Group V | Group I |
| C | Group III | Group VI |
| D | Group I | Group IV |

- 5 Four ions of unknown elements are given below.



Which of the following correctly shows a pair of isotopic and isoelectronic species?

- | | Isotopic | Isoelectronic |
|----------|--------------------------------|-------------------------------|
| A | $\text{P}^{2-}, \text{Q}^{3-}$ | $\text{N}^{-}, \text{Q}^{3-}$ |
| B | $\text{N}^{-}, \text{P}^{2-}$ | $\text{M}^{+}, \text{N}^{-}$ |
| C | $\text{N}^{-}, \text{P}^{2-}$ | $\text{N}^{-}, \text{Q}^{3-}$ |
| D | $\text{P}^{2-}, \text{Q}^{3-}$ | $\text{M}^{+}, \text{N}^{-}$ |

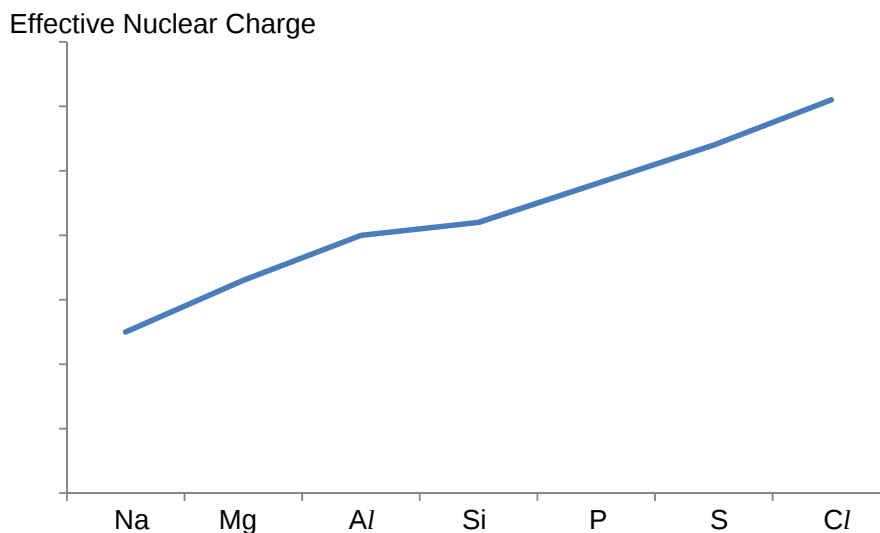
- 6 Given the following reaction:



An equimolar mixture of **A** and **B** is allowed to reach equilibrium at 700 K. Determine the total pressure at equilibrium if the partial pressure of **C** at equilibrium is found to be 2.00 atm.

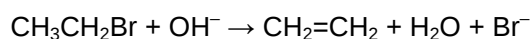
- A** 1.28 atm **B** 4 atm **C** 4.28 atm **D** 4.56 atm

- 7 The following shows a graph of effective nuclear charge against proton number for elements in Period 3 of the Periodic Table, from sodium to chlorine.



Which of the following trends **cannot** be inferred from the graph above?

- A Atomic radii decrease across the period.
 - B Electron affinity increase across the period.
 - C Electronegativity increase across the period.
 - D Electrical conductivity decrease across the period.
- 8 When bromoethane reacts with alcoholic potassium hydroxide to produce ethene, the overall equation and rate equation are given as follows.



$$\text{rate} = k[\text{CH}_3\text{CH}_2\text{Br}][\text{OH}^-]$$

Which of the following statement is consistent with the rate equation?

- A The units of the rate constant k are $\text{mol}^{-2} \text{dm}^{-6} \text{s}^{-1}$.
- B This is an elementary reaction as intermediates are formed.
- C When bromoethane reacts with excess KOH, the half life of bromoethane is halved if $[\text{KOH}]$ is doubled.
- D The graph of $[\text{CH}_3\text{CH}_2\text{Br}]$ against time shows a constant half life, indicating first order of reaction with respect to KOH.

- 9 Which of the following reactions of first row transition metal ions is correct?
- A Addition of $\text{Na}_2\text{CO}_3(\text{aq})$ to $\text{FeCl}_3(\text{aq})$ produces a brown precipitate of $\text{Fe}_2(\text{CO}_3)_3$.
- B Addition of $\text{KI}(\text{aq})$ to $\text{CuSO}_4(\text{aq})$ produces a blue precipitate of CuI_2 .
- C Addition of KOH to $\text{K}_2\text{CrO}_4(\text{aq})$ produces an orange solution of $\text{K}_2\text{Cr}_2\text{O}_7$.
- D Addition of concentrated HCl to $\text{CuSO}_4(\text{aq})$ produces a yellow solution of $\text{H}_2[\text{CuCl}_4]$.

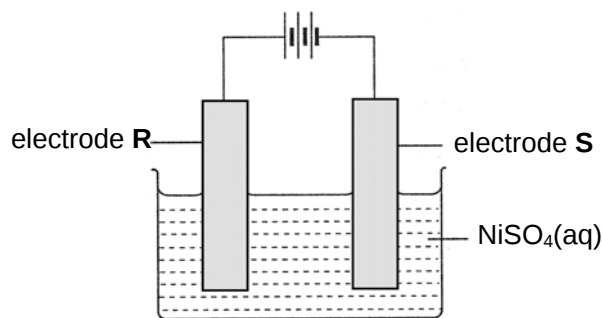
- 10 The table below describes the solubilities of magnesium and barium sulfates and hydroxides in water.

	Solubility of sulfates in water	Solubility of hydroxides in water
Mg^{2+}	Soluble	Sparingly soluble
Ba^{2+}	Sparingly soluble	Soluble

Which of the following is **not** true?

- A Enthalpy change of solution is likely to be exothermic for magnesium sulfate but endothermic for barium sulfate.
- B The enthalpy change of hydration for barium cations is more exothermic than for magnesium cations.
- C Magnesium sulfate is more soluble than barium sulfate as enthalpy change of hydration becomes less exothermic down the group.
- D Barium hydroxide is more soluble than magnesium hydroxide as lattice energy of the ionic solid is less exothermic down the group.
- 11 Which of the following statements about strontium and palladium is true?
- A The atomic radius of palladium is smaller than strontium as the d electrons in palladium provide effective shielding against the nuclear charge.
- B Palladium, with a larger number of valence electrons, has stronger electrostatic forces of attraction between its cations and electrons.
- C Strontium has a maximum oxidation state of +2 while palladium has a maximum oxidation state of +5.
- D There are more atoms per unit volume of strontium, compared to palladium.

- 12** In an experiment, a cell is set up to obtain pure nickel from a nickel-silver alloy as shown below.



When a current of 40.0 A flows through the electrolyte for 26.8 minutes, the mass of the anode changes by 50 g.

Which of the statement is correct?

- A** Electrode **R** is pure nickel and electrode **S** is the nickel-silver alloy.
- B** The concentration of $\text{NiSO}_4(\text{aq})$ decreases during the experiment.
- C** The mass of the cathode changes by 50 g during the experiment.
- D** The nickel-silver alloy contains 39% of nickel by mass.
- 13** Which of the following does **not** show a possible reaction between a halide and concentrated H_2SO_4 ?
- A** $6\text{HI} + \text{H}_2\text{SO}_4 \rightarrow 3\text{I}_2 + \text{S} + 4\text{H}_2\text{O}$
- B** $2\text{HI} + \text{H}_2\text{SO}_4 \rightarrow \text{I}_2 + \text{SO}_2 + 2\text{H}_2\text{O}$
- C** $\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{NaHSO}_4 + \text{HCl}$
- D** $8\text{HBr} + \text{H}_2\text{SO}_4 \rightarrow 4\text{Br}_2 + \text{H}_2\text{S} + 4\text{H}_2\text{O}$

- 14 The table below shows the reactions of some halogens with sodium thiosulfate and hydrogen.

Halogen	Reaction with $\text{Na}_2\text{S}_2\text{O}_3$	Reaction with H_2
Chlorine	$4\text{Cl}_2 + \text{S}_2\text{O}_3^{2-} + 5\text{H}_2\text{O} \rightarrow 8\text{Cl}^- + 2\text{SO}_4^{2-} + 10\text{H}^+$	$\text{Cl}_2 + \text{H}_2 \rightarrow 2\text{HCl}$
Iodine	$\text{I}_2 + 2\text{S}_2\text{O}_3^{2-} \rightarrow 2\text{I}^- + \text{S}_4\text{O}_6^{2-}$	$\text{I}_2 + \text{H}_2 \rightleftharpoons 2\text{HI}$

Which statement can be deduced from the above equations?

- A The decomposition temperature of HCl is lower than that of HI .
- B Iodine is a more powerful oxidising agent than chlorine.
- C Astatine cannot oxidise thiosulfate to sulfate anions.
- D Bromine does not oxidise $\text{S}_2\text{O}_3^{2-}$ to $\text{S}_4\text{O}_6^{2-}$.
- 15 2-Aminobenzoic acid and 4-aminobenzoic acid, as shown below, are commonly used in organic synthesis.

2 – Aminobenzoic acid

I

4 – Aminobenzoic acid

II

Which of the following shows the correct trend in acidity, melting point, and solubility?

	K_a	Melting point	Relative solubility in water
A	$\text{I} > \text{II}$	$\text{I} < \text{II}$	$\text{I} < \text{II}$
B	$\text{I} < \text{II}$	$\text{I} > \text{II}$	$\text{I} < \text{II}$
C	$\text{I} > \text{II}$	$\text{I} > \text{II}$	$\text{I} > \text{II}$
D	$\text{I} < \text{II}$	$\text{I} < \text{II}$	$\text{I} > \text{II}$

- 16 Which of the following conversions show the correct product obtained with LiAlD_4 in dry ether, followed by D_2O ? ($\text{D} = {}^2\text{H}$)

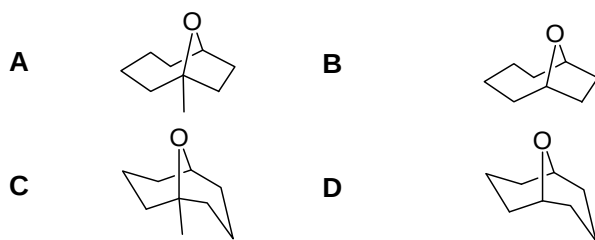
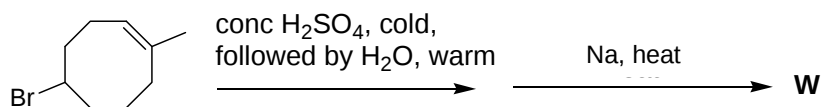
	Reactant	Product with LiAlD_4
A	CH_3CN	$\text{CH}_3\text{CD}_2\text{NH}_2$
B	$\text{CH}_3\text{CH}=\text{CH}_2$	$\text{CH}_3\text{CHDCH}_2\text{D}$
C		
D	CH_3COOH	$\text{CH}_3\text{CD}_2\text{OD}$

- 17 **F**, **G** and **H** are consecutive elements in Period 3. Element **H** has an oxide that reacts with hot concentrated NaOH, and the first ionisation energy of element **G** is lower than **F**.

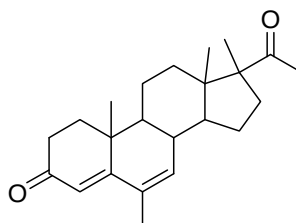
Which of the following shows the identities of elements **F**, **G** and **H**?

	F	G	H
A	Mg	Al	Si
B	Na	Mg	Al
C	Al	Si	P
D	Si	P	S

- 18 The major product from the reaction scheme below is molecule **W**. Which of the following shows the most likely structure of **W**?



- 19 Medrogestrone, which has the structure shown below, is a drug used in the treatment of cancer.

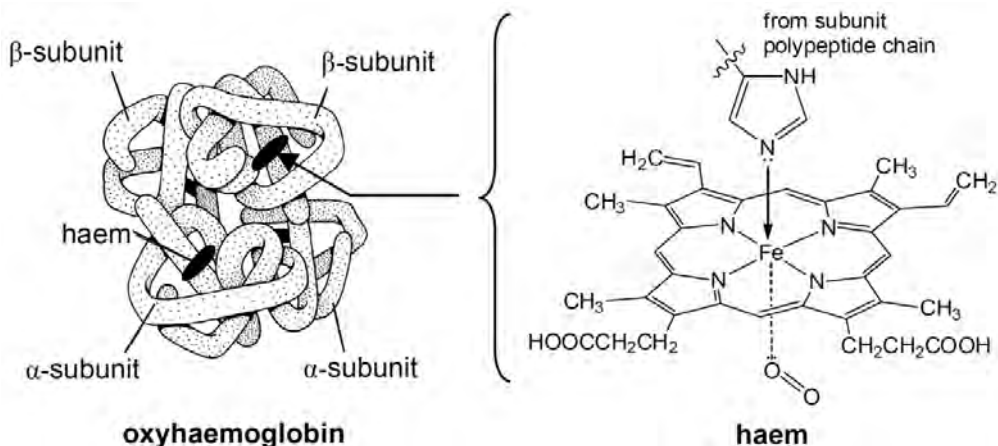


Medrogestrone

Upon treatment with cold KMnO_4 and cold HCN, with catalytic NaCN, how many stereoisomers will be formed?

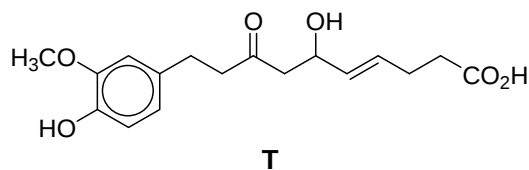
- A** 2^8
B 2^{10}
C 2^{12}
D 2^{14}

- 20 The following diagram shows the structural components of oxyhaemoglobin and the oxygenated form of haemoglobin. Each subunit is a polypeptide chain. It is known that molecules with multiple bonds form very strong bonds with Fe^{2+} , and prevents dioxygen from binding.



Which of the following statements about oxyhaemoglobin is **not** correct?

- A The four subunits make up a tertiary structure.
 B The Fe^{2+} in haem is octahedral.
 C The molecules CO , CN^- , SO_2 and NO are toxic to the body.
 D The Fe in haem undergoes ligand exchange and replaces a water molecule with O_2 in order to form oxyhaemoglobin.
- 21 Gingerol is a natural product found in fresh ginger. It can be derivatised to form **T**, as shown below.



Which of the following shows the correct number of moles of Na(s) , NaOH(aq) and $\text{Br}_2\text{(aq)}$ that can react with **T**? (Assume $-\text{OCH}_3$ is inert)

	Na(s)	NaOH(aq)	$\text{Br}_2\text{(aq)}$
A	3	2	1
B	3	2	2
C	3	3	1
D	2	2	1

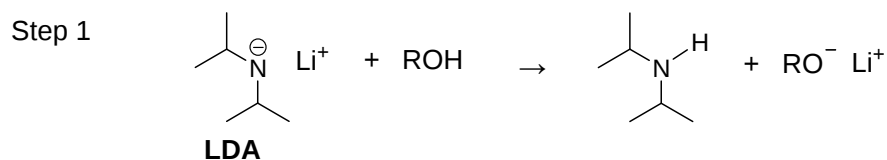
- 22 The following shows the R – groups of some amino acids.

Amino acid	Glu	Lys	Phe	Ser	Val
R – group	$\begin{array}{c} \text{---} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{COOH} \end{array}$	$\begin{array}{c} \text{---} \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{CH}_2 \\ \\ \text{NH}_2 \end{array}$	$\begin{array}{c} \text{---} \\ \\ \text{CH}_2 \\ \\ \text{C}_6\text{H}_5 \end{array}$	$\begin{array}{c} \text{---} \\ \\ \text{CH}_2 \\ \\ \text{OH} \end{array}$	$\begin{array}{c} \text{---} \\ \\ \text{HC}-\text{CH}_3 \\ \\ \text{CH}_3 \end{array}$

Which of the following shows the correct R–group interactions between the stated pairs of amino acids at pH 1?

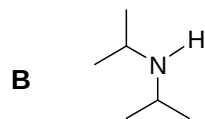
- | | Amino acids | R–group interactions |
|---|-------------|----------------------|
| A | Ser, Ser | Disulfide bridge |
| B | Glu, Val | Hydrogen bonding |
| C | Phe, Lys | Ionic interactions |
| D | Val, Phe | Hydrophobic |

- 23 Lithium diisopropyl amine (LDA) is a strong base that is commonly used to deprotonate alcohols. The alkoxides formed can be used in organic synthesis as shown below.



Which of the following statements is **not** true?

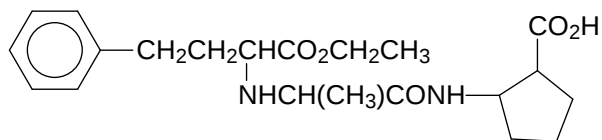
- A This reaction cannot be carried out in an acidic medium.



- C Step 2 is an electrophilic substitution.

- D Step 1 is an acid–base reaction.

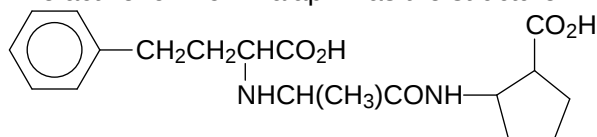
- 24 A prodrug is a molecule that can be converted into its active form in the body. An example is *Enalapril*, as shown below. The active form of *Enalapril* can be formed when enzymes in the body hydrolyse esters found on the molecule.



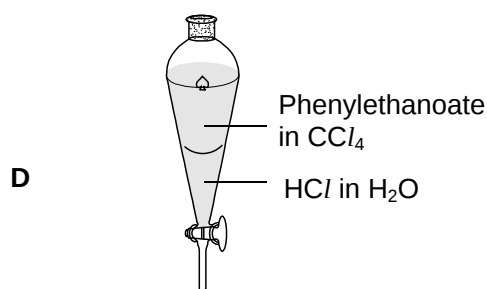
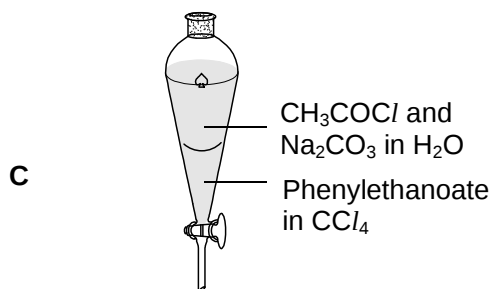
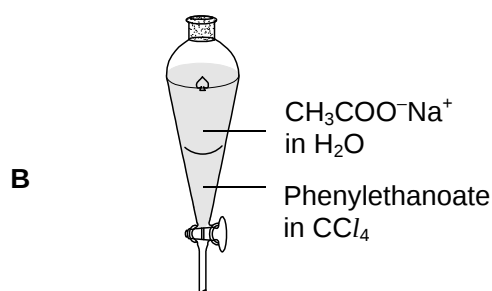
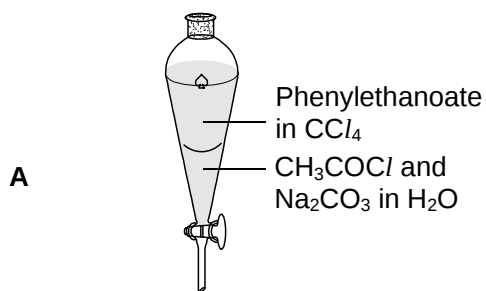
Enalapril

Which of the following is **not** true of Enalapril?

- A Enalapril decolourises aqueous KMnO_4 when heated in an acidic medium.
- B Enalapril does not react with 2,4-dinitrophenylhydrazine.
- C Enalapril reacts with two moles ethanoyl chloride.
- D The active form of Enalapril has the structure



- 25 A student prepared phenyl ethanoate by reacting phenol with excess ethanoyl chloride, using CCl_4 as solvent. After the reaction, the student poured the reaction mixture into a separating funnel containing aqueous sodium carbonate, and carefully shook the separating funnel. Which of the following shows the correct identification of the layers observed, and the compounds dissolved?



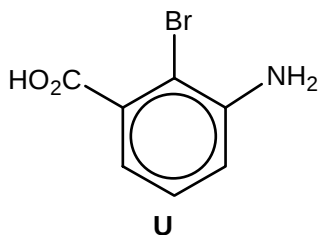
- 26 Unknowns **J**, **K** and **L** are halogen containing organic compounds. The following chemical tests are conducted with each unknown separately and the observations are recorded.

	J	K	L
<u>Test 1</u> Addition of each unknown separately to water.	No visible change	White fumes	No visible change
<u>Test 2</u> Warm each unknown separately with aqueous NaOH, followed by the addition of dilute nitric acid and aqueous silver nitrate	No visible change	White precipitate formed	Yellow precipitate formed after 15 minutes

Which of the following shows possible identities of **J**, **K** and **L**?

	J	K	L
A	Chlorobenzene	Benzoyl chloride	Iodomethane
B	1,2 –dichlorobenzene	Ethanoyl chloride	Iodoethene
C	Bromomethylbenzene	Ethanoyl chloride	Iodobenzene
D	Bromomethylbenzene	Benzoyl chloride	Iodoethane

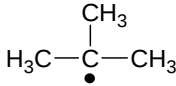
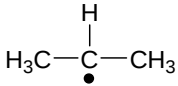
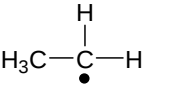
- 27 The following molecule, **U**, can be synthesized from benzene.



Which of the following synthetic route would give the highest yield for **U**?

- A** bromination → alkylation → reduction → nitration → oxidation
B alkylation → oxidation → bromination → nitration → reduction
C nitration → reduction → bromination → alkylation → oxidation
D nitration → alkylation → reduction → bromination → oxidation

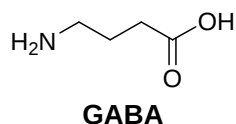
- 28 Radicals are sp^2 hybridised, with the lone electron occupying the unhybridised p orbital. Their relative rates of formation are tabulated below.

Radical			
Relative rate of formation	5	4	1

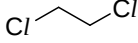
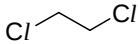
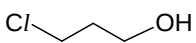
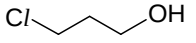
What is the ratio of 1-chloro-2-methylpropane to 2-chloro-2-methylpropane formed when 2-methylpropane reacts with chlorine gas in the presence of UV light?

- A 9:5 B 9:4 C 9:1 D 1:1
- 29 Which of the following alcohols produce the largest number of products, including stereoisomers, when reacted with excess concentrated H_2SO_4 at $170^\circ C$?
- A $CH_3CH_2CH_2CH_2CH_2OH$
 B $CH_3CH_2CH_2CH(OH)CH_3$
 C $CH_3CH_2CH(OH)CH_2CH_3$
 D $CH_3CH(CH_3)CH(OH)CH_3$

- 30 GABA is a neurotransmitter in the mammalian central nervous system.



Which of the following conversions shows the best method to synthesize GABA?

- A  $\xrightarrow[\text{reflux}]{\text{alcoholic KCN}}$ $\xrightarrow{\text{LiAlH}_4 \text{ in dry ether}}$ $\xrightarrow{\text{H}^+(\text{aq}), \text{ reflux}}$
- B  $\xrightarrow[\text{cold}]{\text{HCN, catalytic NaCN}}$ $\xrightarrow{\text{H}^+(\text{aq}), \text{ reflux}}$ $\xrightarrow{\text{LiAlH}_4 \text{ in dry ether}}$
- C  $\xrightarrow[\text{reflux}]{\text{alcoholic KCN}}$ $\xrightarrow[\text{reflux}]{K_2Cr_2O_7/H^+(\text{aq})}$ $\xrightarrow{H_2/Pd}$
- D  $\xrightarrow[\text{reflux}]{K_2Cr_2O_7/H^+(\text{aq})}$ $\xrightarrow[\text{reflux}]{\text{alcoholic KCN}}$ $\xrightarrow{H_2/Pd}$

Section B

For each question 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** Carbon exists as a number of allotropes, for example graphite, fullerenes and acetylenic carbon, which have the following description.

Allotrope	Description
Graphite	Each carbon atom is covalently bonded to three other carbon atoms.
Fullerene	Each carbon atom has an unhybridised p orbital with one electron, which can be delocalised over the whole molecule.
Acetylenic carbon	Chains of atoms with alternating triple and single bonds, with bond lengths at either 1.21×10^{-10} m or 1.38×10^{-10} m.

Which of the following deductions on the shape of the carbon atom, hybridisation, and electrical conductivity of the allotrope are correct?

	Allotrope	Shape	Hybridisation	Electrical conductivity
1	Fullerene	Trigonal planar	sp^2	Conductor
2	Acetylenic carbon	Linear	sp	Non-conductor
3	Graphite	Trigonal pyramidal	sp^3	Conductor

- 32** Which of the following explains why real gas deviate from ideal gas behaviour?

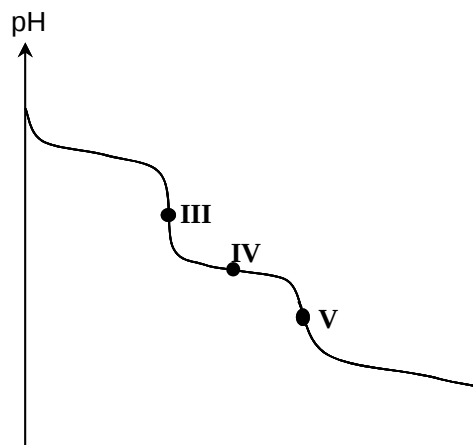
- Gas particles are simple molecules with weak intermolecular van der Waals' forces of attraction.
- Gas particles can be compressed to a certain minimum volume, beyond which cannot decrease further even if pressure increases.
- Gas particles move at higher speeds when temperature increases.

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

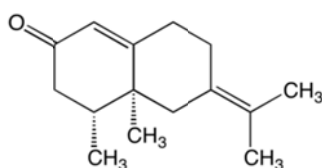
No other combination of statements is used as a correct response.

- 33** The following shows the titration curve obtained when N-methylethylene diamine, $\text{CH}_3\text{NHCH}_2\text{CH}_2\text{NH}_2$, is titrated with hydrochloric acid.

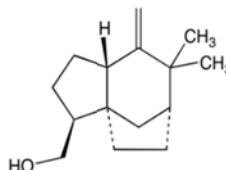


Which of the following statements are true of the

- 1** Point **IV** represents a solution that resists pH
 - 2** At point **III**, the solution consists of only $\text{CH}_3\text{NHCH}_2\text{CH}_2\text{NH}_3^+\text{Cl}^-$
 - 3** Point **V** can be determined using litmus as an indicator.
- 34** The molecules α -Vetivone and Khusimol are isolated from the vetiver grass native to India.



α -Vetivone



Khusimol

Which of the following reactions can distinguish α -vetivone and Khusimol?

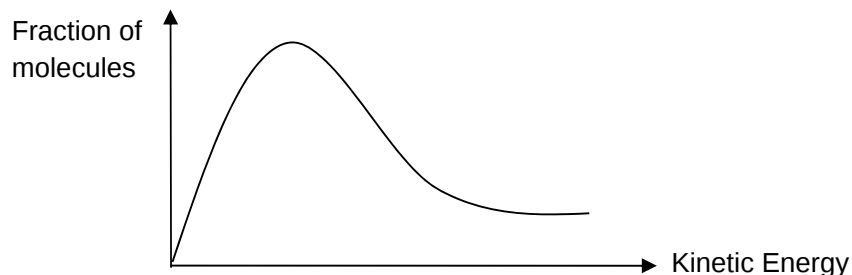
- 1** Acidified KMnO_4 , reflux, followed by the addition of aqueous sodium carbonate.
- 2** Addition of 2,4-dinitrophenylhydrazine.
- 3** Addition of PCl_5 .

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.

- 35** The diagram represents the distribution of molecular kinetic energies within a gas at temperature T_1 .



Which of the following statements is correct?

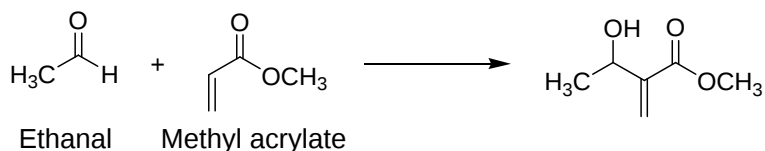
- 1** As the gas is cooled, the maximum of the curve will be displaced to the left.
 - 2** Raising the temperature increases the proportion of molecules at any given energy.
 - 3** The total number of molecules varies at different temperature.
- 36** Which of the following will liberate a pungent gas that turns damp red litmus blue, upon warming with dilute aqueous sodium hydroxide?
- 1** CH_3CN
 - 2** CH_3CONH_2
 - 3** $\text{CH}_3\text{CO}_2^-\text{NH}_4^+$
- 37** Which of the following statements describe the reaction of butanone with HCN, in a catalytic amount of NaOH?
- 1** The slow step involves the breaking of a π bond.
 - 2** Two products that rotate plane polarised light in opposite directions are formed.
 - 3** The rate equation is $\text{rate} = k[\text{butanone}]$.

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

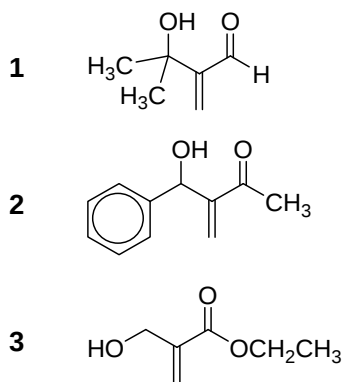
A	B	C	D
1, 2 and 3 are correct	1 and 2 only are correct	2 and 3 only are correct	1 only is correct

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

- 38** The Bayllis–Hillman reaction is a base catalysed C–C bond forming reaction, which converts aldehydes to alcohols. For example, ethanal and methyl acrylate reacts as shown below.

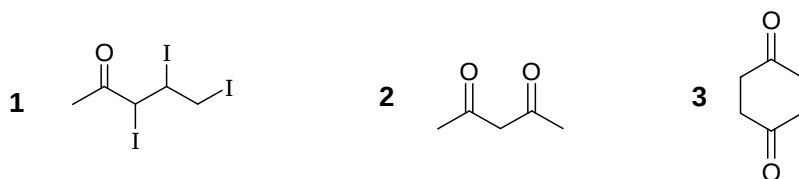


Which of the following is a product of the Bayllis–Hillman reaction?



- 39** A teacher reacted 0.001 mol of compound **V** with aqueous iodine in aqueous sodium hydroxide. After filtration of the yellow precipitate, she added dilute nitric acid, followed by excess silver nitrate to the filtrate, and obtained 0.006 mol of another yellow precipitate.

Which of the following is a possible structure of compound **V**?



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.

- 40** Methylbenzene reacted with bromine in FeBr_3 , in the presence of UV light. Which of the following pairs of compounds consist of one likely and one unlikely product of this reaction?

