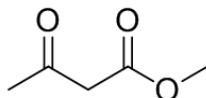


Section A

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

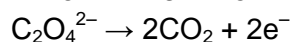
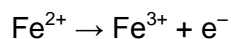
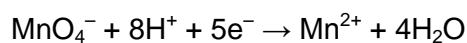
- 1 A compound has the following structure.



How many moles of oxygen gas are needed to completely burn 1 mole of this compound?

- A** 5.0 **B** 5.5 **C** 6.0 **D** 6.5

- 2 Consider the following half-equations.



What volume of 0.01 mol dm^{-3} KMnO_4 is required to oxidise 15 cm^3 of an acidified solution of 0.01 mol dm^{-3} FeC_2O_4 ?

- A** 3 cm^3 **B** 6 cm^3 **C** 9 cm^3 **D** 15 cm^3

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

Which particle would, on losing an electron, have a half-filled set of p orbitals?

- A** C^- **B** N^{2-} **C** Si^{3-} **D** P^-

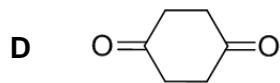
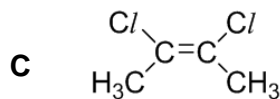
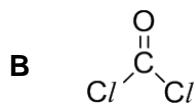
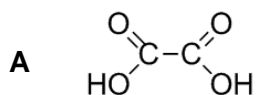
- 4 The first six successive ionisation energies, in kJ mol^{-1} of an element **Z** are as follows:

947 1798 2735 4837 6043 12310

What is a possible formula of the oxide of element **Z**, in its highest possible oxidation state?

- A** ZO_2 **B** ZO_3 **C** Z_2O **D** Z_2O_5

- 5 Which one of the molecular structures below will have the **smallest** overall dipole?



- 6 Which one of the following sets of solid elements includes a giant metallic structure, a macromolecular structure and a simple molecular structure?

A	Al	Si	S
B	C	Si	Sn
C	Mg	Al	Si
D	Na	Mg	Al

- 7 In which one of the following sets is the bond angle in species **I** bigger than in species **II**?

	I	II
A	NCI_3	PCl_3
B	OCl_2	NCI_3
C	SOCl_2	SO_2
D	H_2S	H_2O

- 8 The lattice energies of the caesium chloride, caesium fluoride, sodium chloride and sodium fluoride are given below in the options, not necessarily in this order.

Which value corresponds to the lattice energy of caesium chloride?

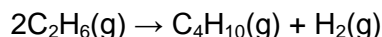
- A** -661 kJ mol^{-1} **B** -747 kJ mol^{-1} **C** -780 kJ mol^{-1} **D** -918 kJ mol^{-1}

- 9 Which one of the following processes is endothermic?

- A** the freezing of water
B the reaction of Zn with HCl
C the reaction of Ba(OH)_2 with H_2SO_4
D the decomposition of H_2O into its elements

- 10 Use of the Data Booklet is relevant for this question.

What is the enthalpy change for the following reaction?



- A** -112 kJ mol^{-1} **B** -34 kJ mol^{-1} **C** $+34 \text{ kJ mol}^{-1}$ **D** $+112 \text{ kJ mol}^{-1}$
- 11 A radioactive element has two isotopes, **X** and **Y**, with half-lives of 2 min and 6 min respectively.
- An experiment starts with x times as many atoms of **X** as of **Y**. After 6 min, the number of atoms of **X** and **Y** are both equal.
- Given that radioactive decay is a first order reaction, what is the value of x ?
- A** 0.5 **B** 2 **C** 4 **D** 8
- 12 For a reaction $2\text{U}(\text{aq}) + 3\text{V}(\text{aq}) \rightarrow 2\text{W}(\text{aq})$, the rate equation is $\text{rate} = k[\text{U}]^2[\text{V}]$.
- It is given that at 25°C , at a particular initial **[U]** and initial **[V]**, initial rate = r . It is also given that the rate doubles for every 10°C rise in temperature.
- What is the initial rate of the above reaction, given that initial **[U]** and initial **[V]** are both halved at 55°C ?
- A** $0.5r$ **B** r **C** $2r$ **D** $4r$
- 13 Each of the following equilibria is subjected to two changes carried out separately:
- (i) the pressure is reduced at constant temperature;
- (ii) the temperature is increased at constant pressure.

For which equilibrium will both of these changes result in an increase in the proportion of products?

- A** $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g})$ $\Delta H = +53 \text{ kJ mol}^{-1}$
- B** $\text{N}_2\text{O}_4(\text{g}) \rightleftharpoons 2\text{NO}_2(\text{g})$ $\Delta H = +57 \text{ kJ mol}^{-1}$
- C** $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{SO}_3(\text{g})$ $\Delta H = -197 \text{ kJ mol}^{-1}$
- D** $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g})$ $\Delta H = -950 \text{ kJ mol}^{-1}$

- 14 10 cm^3 of a 0.01 mol dm^{-3} solution of H_2SO_4 is diluted with 90 cm^3 of water.

What is the pH of the resulting solution?

- A 1.7 B 2.0 C 2.7 D 3.0

- 15 The value of the ionic product of water, K_w , varies with temperature as shown:

temperature / °C	$K_w / \text{mol}^2 \text{ dm}^{-6}$
25	1.0×10^{-14}
62	1.0×10^{-13}

Based on the above information, which one of the following statements is **incorrect**?

- A Water is a neutral liquid at 62°C .
 B The pH of water increases with increasing temperature.
 C The ionic dissociation of water is an endothermic process.
 D The ionic dissociation of water increases by a factor of 3.16 from 25°C to 62°C .
- 16 In what order do the radii of the following ions increase?
- A $\text{Mg}^{2+} < \text{Na}^+ < \text{Si}^{4+}$ B $\text{Si}^{4+} < \text{Mg}^{2+} < \text{Na}^+$
 C $\text{P}^{3-} < \text{S}^{2-} < \text{Cl}^-$ D $\text{Al}^{3+} < \text{Si}^{4-} < \text{P}^{3-}$
- 17 An element in the second period of the Periodic Table often shows similar properties to the element a group higher in the third period. This is known as a diagonal relationship between the elements.

An example of a diagonal relationship is between beryllium and aluminium.

Which one of the following statements about BeO and BeCl_2 is **incorrect**?

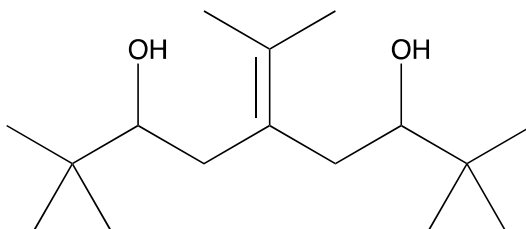
- A BeO is amphoteric in nature but BeCl_2 is acidic in nature.
 B BeO is predominantly covalent but BeCl_2 is predominantly ionic.
 C BeO is insoluble in water but BeCl_2 partially hydrolyses in water.
 D BeO has a giant lattice structure but BeCl_2 has a simple lattice structure.

- 18 When alkane **N**, C_7H_{16} , was reacted with bromine under ultraviolet light, it produced only three isomeric monobromo compounds, with the formula $C_7H_{15}Br$.

What is the likely identity of alkane **N**?

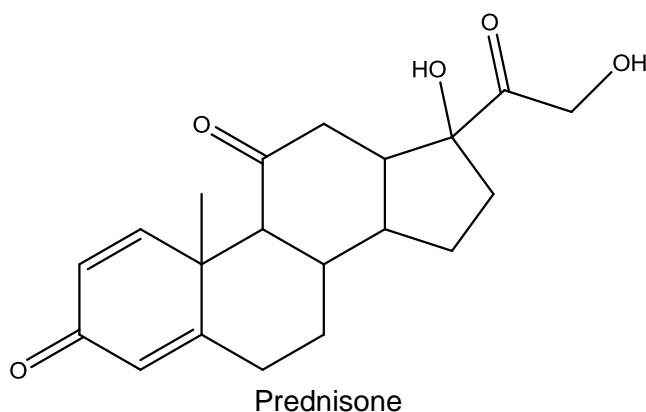
- A $CH_3(CH_2)_5CH_3$
 B $(CH_3)_2CH(CH_2)_3CH_3$
 C $(CH_3)_3CCH_2CH_2CH_3$
 D $(CH_3)_3CCH(CH_3)_2$

- 19 Compound **M** has the following structure.



What is the total number of geometric isomers that can be formed from the product of the reaction of compound **M** with excess concentrated sulfuric acid at $170^\circ C$?

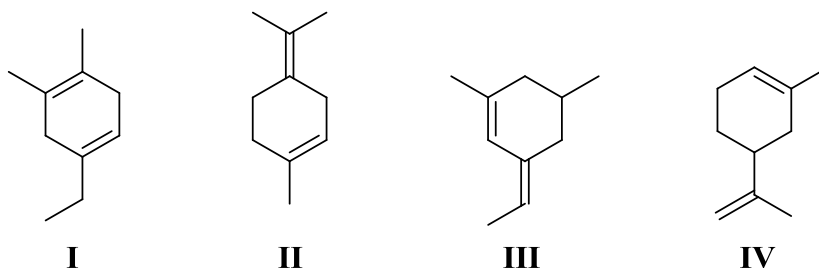
- A 0 B 2 C 4 D 8
- 20 Prednisone is a synthetic corticosteroid drug used for the treatment of inflammatory diseases and allergies such as asthma and multiple myeloma.



Which reaction occurs with Prednisone?

- A It gives steamy white fumes on reaction with PCl_5 .
 B One mole of Prednisone reacts with Na metal to give two moles of H_2 gas.
 C It reacts with $LiAlH_4$ to form carboxylic acids.
 D It reduces Tollen's reagent.

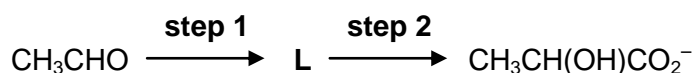
- 21 The following compounds are isomers of $C_{10}H_{16}$.



1 mol of each of the above compounds was separately heated under reflux with acidified $KMnO_4$. The resulting solutions were then treated with $NaOH$ to remove excess acid followed by treatment with aqueous alkaline I_2 . A pale yellow precipitate was observed for each compound.

Which one of the above compounds produced the same amount of pale yellow precipitate?

- A** I and III **B** I and IV **C** I, II, and IV **D** I, III and IV
- 22 Lactic acid is produced in muscle cells during intense exercise. Under physiological pH, the majority of lactic acid is dissociated and present in the form of lactate, $CH_3CH(OH)CO_2^-$. Lactate can be synthesised in the following two-step process.



What are the identities of the reagents for **step 1** and **2** and the organic intermediate **L**?

	step 1	L	step 2
A	$NaBH_4$	CH_3CH_2OH	ethanolic KCN
B	acidified $K_2Cr_2O_7$	CH_3CO_2H	$NaOH(aq)$
C	HCN , trace amount of KCN	$CH_3CH(OH)CN$	$NaOH(aq)$
D	HCN , trace amount of KCN	$CH_3CH(OH)CN$	acidified $K_2Cr_2O_7$

- 23 For the following compounds $H_3CC(CH_3)_2OH$, $CH(CH_3)_2CO_2H$ and $CCl(CH_3)_2CO_2H$, which sequence shows the correct order of increasing pK_a in an aqueous solution of equal concentration?
- A** $CH(CH_3)_2CO_2H$, $CCl(CH_3)_2CO_2H$, $H_3CC(CH_3)_2OH$
- B** $CCl(CH_3)_2CO_2H$, $CH(CH_3)_2CO_2H$, $H_3CC(CH_3)_2OH$
- C** $H_3CC(CH_3)_2OH$, $CH(CH_3)_2CO_2H$, $CCl(CH_3)_2CO_2H$
- D** $H_3CC(CH_3)_2OH$, $CCl(CH_3)_2CO_2H$, $CH(CH_3)_2CO_2H$

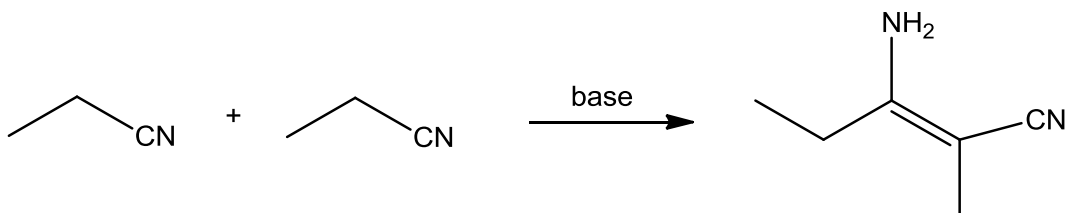
- 24 Acidified potassium dichromate(VI) of concentration 1 mol dm^{-3} was added in parts to three separate test-tubes containing 10 cm^3 of 1 mol dm^{-3} of unknown solutions **H**, **J** and **K** respectively. Each mixture was warmed and the observations are recorded below.

solution	colour observed upon warming when	
	1 st part of 3.3 cm^3 of $\text{K}_2\text{Cr}_2\text{O}_7$ was added	2 nd part of 3.3 cm^3 of $\text{K}_2\text{Cr}_2\text{O}_7$ was added
H	orange	orange
J	green	orange
K	green	green

Which one of the following could be the identities of **H**, **J** and **K**?

	H	J	K
A	$\text{C}_6\text{H}_5\text{CH}_2\text{OH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$
B	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}_2\text{COCH}_3$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
C	$\text{CH}_3\text{CH}_2\text{CH}_2\text{COOH}$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{CHO}$	$\text{CH}_3\text{CH}_2\text{COCH}_3$
D	$(\text{CH}_3)_2\text{C}(\text{OH})\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$

- 25 The Thorpe reaction is a self-condensation of aliphatic nitriles in the presence of a base catalyst. The self-condensation between two molecules of propanenitrile is shown below.



Which one of the following can be synthesised by the Thorpe reaction?

- A** $\text{CH}_3\text{C}(\text{NH}_2)=\text{C}(\text{CH}_3)\text{CN}$
B $\text{CH}_3\text{CH}_2\text{C}(\text{NH}_2)=\text{C}(\text{CH}_2\text{CH}_3)\text{CN}$
C $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{NH}_2)=\text{C}(\text{CH}_2\text{CH}_3)\text{CN}$
D $\text{CH}_3\text{CH}_2\text{CH}_2\text{C}(\text{NH}_2)=\text{C}(\text{CH}_2\text{CH}_2\text{CH}_3)\text{CN}$

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 only are correct	2 and 3 only are correct	1 only is correct

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

26 Which pair of solutions on mixing would result in an acidic buffer?

- 1** 25 cm³ of 0.1 mol dm⁻³ CH₃CO₂H(aq) and 10 cm³ of 0.2 mol dm⁻³ NaOH(aq)
- 2** 50 cm³ of 0.2 mol dm⁻³ CH₃CO₂H(aq) and 25 cm³ of 0.2 mol dm⁻³ Ba(OH)₂(aq)
- 3** 15 cm³ of 0.1 mol dm⁻³ HNO₃(aq) and 10 cm³ of 0.1 mol dm⁻³ NH₃(aq)

27 Hydrogen peroxide reacts with acidified iodide ions, liberating iodine.

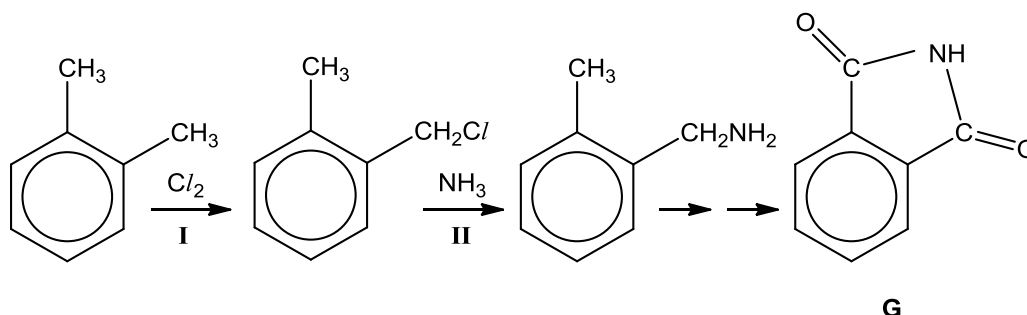
In investigation of this reaction, the following results were obtained.

Expt	Initial concentrations of reactants / mol dm ⁻³			Initial rate of formation of iodine / mol dm ⁻³ s ⁻¹
	[H ₂ O ₂]	[I ⁻]	[H ⁺]	
1	0.010	0.010	0.10	2.0 x 10 ⁻⁶
2	0.030	0.010	0.10	6.0 x 10 ⁻⁶
3	0.030	0.020	0.10	1.2 x 10 ⁻⁵
4	0.040	0.040	0.20	3.2 x 10 ⁻⁵

Which of the following statements are correct?

- 1** The rate equation for the rate reaction can be written as rate = $k[\text{H}_2\text{O}_2][\text{I}^-]$.
- 2** The rate constant is 0.02 mol⁻¹ dm³ s⁻¹.
- 3** H₂O₂ is oxidised in this reaction.

- 28 Which of the following **incorrectly** describes the reactivity of Period 3 elements?
- 1 P burns with a bright flame in air to form solid P_4O_6 only.
 - 2 Al reacts rapidly in the presence of steam to give solid $Al(OH)_3$ and H_2 gas.
 - 3 P reacts slowly in the presence of excess Cl_2 to give a mixture of PCl_3 and PCl_5 .
- 29 Which reagents could be used to distinguish between $CH_3CH(Cl)CH_2CHO$ and $CH_3CH=CHCH_2OH$?
- 1 sodium metal
 - 2 warm alkaline iodine solution
 - 3 sodium borohydride followed by aqueous bromine in the dark
- 30 The following reaction scheme shows the synthesis of compound **G** from 1,2-dimethylbenzene through a series of reactions.



Which of the following statements about this scheme are **incorrect**?

- 1 The carbon atoms in **G** are sp^2 and sp^3 hybridised.
- 2 Step **I** involves substitution while step **II** involves addition.
- 3 **G** can be oxidised by acidified $KMnO_4$ to give a dicarboxylic acid.

