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DUNMAN HIGH SCHOOL Preliminary Examination Year 6

H2 CHEMISTRY

Paper 1 Multiple Choice

9729/01

27 September 2021

1 hour

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

READ THESE INSTRUCTIONS FIRST

Write your centre number, index number, name and class at the top of this page.

Write in soft pencil.

Do not use staples, paper clips, glue or correction fluid.

There are **thirty** questions on this paper. Answer **all** questions. For each question there are four possible answers **A, B, C** and **D**.

Choose the one you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

Read the instructions on the Answer Sheet very carefully.

Each correct answer will score one mark. A mark will not be deducted for a wrong answer.

Any rough working should be done in this booklet.

The use of an approved scientific calculator is expected, where appropriate.

This document consists of **15** printed pages and **1** blank page.

1 Which ion has the same number of electrons and neutrons as $^{187}_{75}\text{Re}^{3+}$?

- A $^{182}_{74}\text{W}^{2+}$
 B $^{186}_{74}\text{W}^{+}$
 C $^{188}_{76}\text{Os}^{4+}$
 D $^{189}_{76}\text{Os}^{3+}$

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

The table shows the fifth, sixth, seventh, eighth, ninth and tenth ionisation energies of an element ($Z \leq 20$) in the Periodic Table.

	5th	6th	7th	8th	9th	10th
ionisation energy / kJ mol^{-1}	7975	9590	11343	14944	16964	48610

What can be inferred about the element from the above data?

- A It is in Group 2 of the Periodic Table.
 B It is in the third period of the Periodic Table.
 C Its 6th and 7th electrons are removed from different subshells.
 D It is likely to form an ionic compound when reacted with oxygen.

3 Which pair has the same shape?

- A BeCl_2 and SO_2
 B CO_2 and I_3^-
 C NO_3^- and PH_3
 D PO_4^{3-} and SF_4

4 Which lattice structure is correctly described?

	lattice structure	description
A	giant molecular	lattice of molecules held together by strong covalent bonds
B	giant ionic	each cation is only bonded to the anion to which electrons are transferred
C	giant metallic	all electrons are delocalised within the metal cation lattice
D	simple molecular	molecules held together by weak intermolecular forces

5 A gaseous sample containing $x \text{ dm}^3$ of gaseous methanol was burnt in $4x \text{ dm}^3$ of oxygen to produce carbon dioxide and water vapour. The total pressure in the system after combustion was P .

Which statement(s) is/are correct?

- 1 Methanol reacts with oxygen in a 2 : 3 mole ratio.
- 2 The partial pressure of carbon dioxide in the system is $0.18P$.
- 3 Assuming these gases behave ideally, they occupy an insignificant volume.

- | | |
|-----------------------|-----------------------|
| A 1, 2 and 3 | B 1 and 2 only |
| C 2 and 3 only | D 1 only |

6 The s- and p-block elements in Period 4 show a similar pattern of properties to the elements in Period 3.

On this basis, which prediction can be made about element 33, arsenic?

- A** Arsenic has a higher electronegativity than selenium.
- B** Arsenic has a highest oxidation state of +6.
- C** Chlorides of arsenic react with water to form acidic solutions.
- D** Oxides of arsenic react with water readily to form hydroxides.

- 7 **J**, **K** and **L** are Group 2 elements. The table below shows the observations when dilute sulfuric acid is added separately to carbonates of **J**, **K** and **L**.

metal carbonate	addition of sulfuric acid
J	White precipitate
K	White precipitate
L	Colourless solution

Carbonate of **K** decomposes at a higher temperature than that of **J**.

Which could be the identities of **J**, **K** and **L**?

	J	K	L
A	Ba	Ca	Mg
B	Mg	Ba	Ca
C	Ca	Ba	Mg
D	Ba	Mg	Ca

- 8 Which property increases down Group 17 elements or their hydrides?

- A** acidity of the hydrides
- B** oxidising power of the elements
- C** colour intensity of the hydrides
- D** volatility of the elements

- 9 The enthalpy change of formation of cobalt(II) chloride can be calculated using a Born–Haber cycle.

The relevant enthalpy changes are shown in the table.

	enthalpy change/ kJ mol^{-1}
$\text{Cl}_2(\text{g}) \rightarrow 2\text{Cl}(\text{g})$	+244
$\text{Cl}(\text{g}) + \text{e}^- \rightarrow \text{Cl}^-(\text{g})$	–355
$\text{Co}(\text{s}) \rightarrow \text{Co}(\text{g})$	+427
$\text{Co}(\text{g}) \rightarrow \text{Co}^+(\text{g}) + \text{e}^-$	+757
$\text{Co}^+(\text{g}) \rightarrow \text{Co}^{2+}(\text{g}) + \text{e}^-$	+1640
$\text{Co}^{2+}(\text{g}) + 2\text{Cl}^-(\text{g}) \rightarrow \text{CoCl}_2(\text{s})$	–2671

What is the enthalpy change of formation of CoCl_2 ?

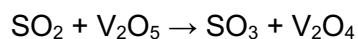
- A +42 kJ mol^{-1}
 B –69 kJ mol^{-1}
 C –202 kJ mol^{-1}
 D –313 kJ mol^{-1}
- 10 *Use of the Data Booklet is relevant to this question.*

The enthalpy change of solution for sodium bromide and magnesium bromide are -18 kJ mol^{-1} and -216 kJ mol^{-1} respectively.

Which statement(s) is/are correct?

- The enthalpy change of hydration of sodium ion is more exothermic than that of magnesium ion.
 - The lattice energy of sodium bromide is less exothermic than that of magnesium bromide.
 - Sodium bromide is likely to be less soluble than magnesium bromide.
- A 1 and 3 only B 1 and 2 only
 C 2 and 3 only D 3 only

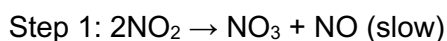
- 11 In the first step of the Contact Process, sulfur dioxide is converted to sulfur trioxide in the presence of a catalyst, vanadium(V) oxide, V_2O_5 .



In this reaction, how many moles of electrons were transferred per mole of V_2O_5 ?

- | | | | |
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| A | 1 | B | 2 |
| C | 2.5 | D | 3 |

- 12 The reaction between gaseous NO_2 and CO follows the mechanism shown below.



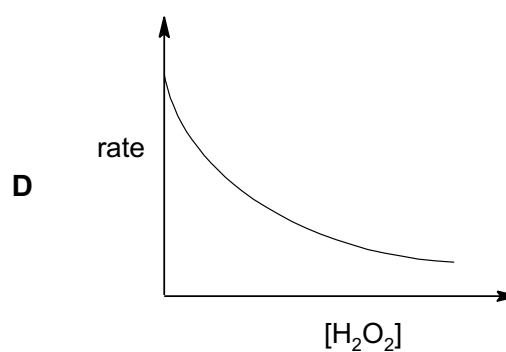
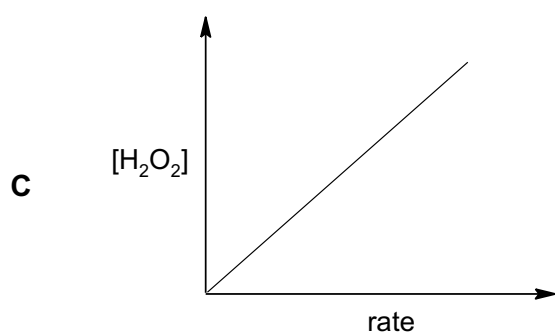
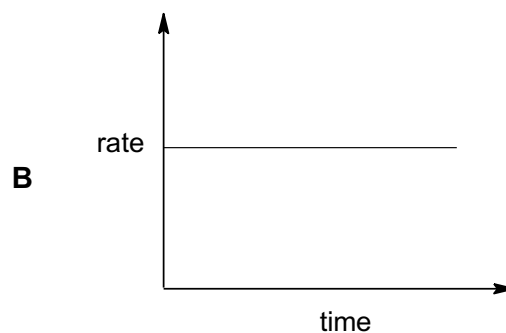
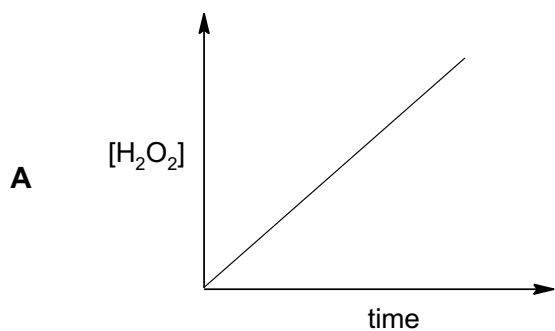
Which statement(s) is/are true about the kinetics of this reaction?

- 1 Increasing the partial pressure of CO in the reaction vessel has no effect on the rate.
- 2 Step 1 has a higher activation energy and a smaller rate constant than step 2.
- 3 The rate constant of the reaction has the units $\text{mol}^{-2} \text{dm}^6 \text{s}^{-1}$.

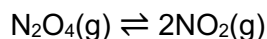
- | | | | |
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| A | 1 only | B | 1 and 2 only |
| C | 2 and 3 only | D | 1 and 3 only |

- 13 The decomposition of aqueous hydrogen peroxide is a first order reaction.

Which graph correctly describes the kinetics of this reaction?



- 14** 1 mol of N_2O_4 and 0.2 mol of NO_2 were added to a sealed vessel of fixed volume at 298 K. When the system reached equilibrium, 0.68 mol of NO_2 was present in the vessel.

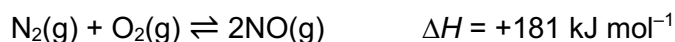


Which statement(s) is/are true about this equilibrium?

- 1 0.76 mol of N_2O_4 are present at equilibrium.
- 2 The value for the equilibrium constant, K_c , is 0.608.
- 3 The pressure in the vessel at equilibrium is lower than the pressure before the reaction started.

- | | |
|-----------------------|-----------------------|
| A 1 only | B 2 and 3 only |
| C 1 and 2 only | D 1 and 3 only |

- 15** Consider the reaction between nitrogen and oxygen to form nitrogen monoxide.



Which of the following changes will result in rightward shift in the equilibrium position but **not** a change in the rate constant of the forward reaction?

- A** Adding a heterogeneous catalyst
- B** Increasing the temperature of the reaction mixture
- C** Increasing the partial pressure of the nitrogen gas
- D** Reducing the volume of the reaction vessel

- 16 Methylamine, CH_3NH_2 , has a $\text{p}K_{\text{b}}$ of 3.3.

25.0 cm^3 of 0.1 mol dm^{-3} CH_3NH_2 was added to a conical flask. It was then titrated against 0.1 mol dm^{-3} HCl .

Which statement is true about the pH of the solution before the addition of HCl **and** after adding 13.00 cm^3 of HCl ?

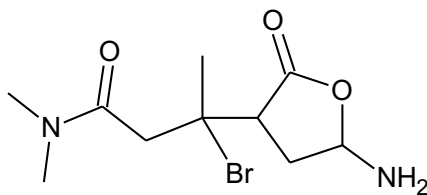
	Before addition of HCl	After adding 13.00 cm^3 of HCl
A	Less than 13	Slightly less than 10.7
B	Less than 13	Slightly more than 10.7
C	13	Slightly less than 10.7
D	13	Slightly more than 10.7

- 17 Magnesium hydroxide, $\text{Mg}(\text{OH})_2$, has a K_{sp} value of 1.8×10^{-11} at 25°C .

In which 0.1 mol dm^{-3} solution will $\text{Mg}(\text{OH})_2$ have the highest and lowest solubility?

	Highest solubility	Lowest solubility
A	$\text{KNO}_3(\text{aq})$	$\text{MgCl}_2(\text{aq})$
B	$\text{KNO}_3(\text{aq})$	$\text{NaOH}(\text{aq})$
C	$\text{CH}_3\text{COOH}(\text{aq})$	$\text{MgCl}_2(\text{aq})$
D	$\text{CH}_3\text{COOH}(\text{aq})$	$\text{NaOH}(\text{aq})$

18 Which statement(s) is/are true about the molecule below?



- 1 The molecule can act as a nucleophile, but not as an electrophile.
- 2 The molecule can undergo hydrolysis and condensation reactions with suitable reagents.
- 3 The molecule has 8 possible stereoisomers.

- | | |
|-----------------------|-----------------------|
| A 2 only | B 1 and 2 only |
| C 1 and 3 only | D 2 and 3 only |

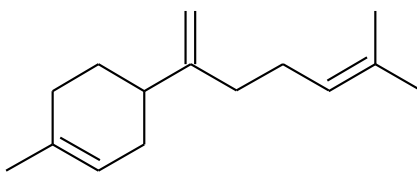
19 How many non-cyclic isomers (including stereoisomers) does C_5H_{10} have?

- | | |
|------------|------------|
| A 5 | B 6 |
| C 7 | D 8 |

20 Which statement best explains why alkanes and alkenes differ in their reactions towards halogens?

- A** Alkanes are non-polar molecules.
- B** The $2sp^3-1s$ C-H bond in alkanes is stronger than the $2sp^2-1s$ C-H bond in alkenes.
- C** Alkanes lack a region of high electron density to polarise the halogen molecule.
- D** The carbon atoms in the C=C double bond of alkenes have trigonal planar geometry.

- 21** Bisabolene is a terpene found in the essential oils of oregano.



bisabolene

When bisabolene reacts completely with bromine monochloride, BrCl , dissolved in an inert solvent, a mixture of different products are formed.

How many chiral alkyl **chlorides** are present in the **major** product?

- | | | | | | |
|----------|---|--|--|----------|---|
| A | 2 | | | B | 3 |
| C | 4 | | | D | 5 |

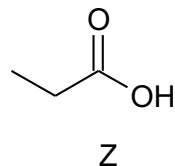
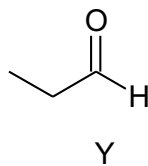
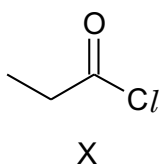
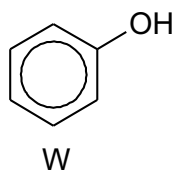
- 22** Separate samples of vinyl chloride, $\text{CH}_2=\text{CHCl}$, and iodoethane were warmed with ethanolic silver nitrate. A yellow precipitate quickly appears in one test-tube and no observable change was seen in the other test-tube.

Which statements account for the different observations?

- 1 Chlorine is more electronegative than iodine.
- 2 Iodine has a larger atomic radius than chlorine.
- 3 The p-orbital of chlorine overlaps with the p-orbitals of the C=C bond.
- 4 The π electrons in the C=C bond attracts the ethanol molecules.

- A** 1 and 4 only
B 2 and 3 only
C 1, 2 and 3 only
D 4 only

- 23 Equal amounts of compounds W, X, Y and Z are added separately to four test-tubes containing equal amounts of distilled water.



What is the order of increasing pH of the resultant solutions?

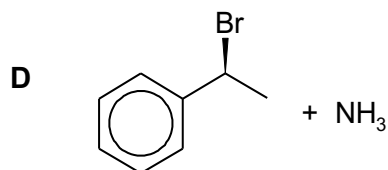
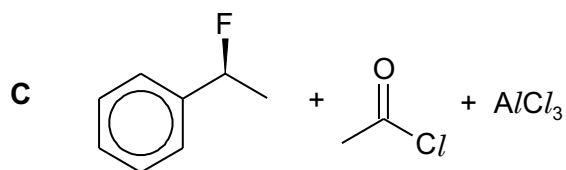
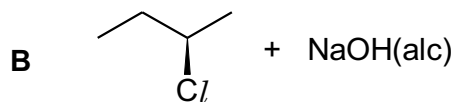
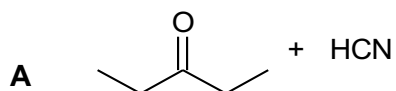
A X Z W Y

B Z X Y W

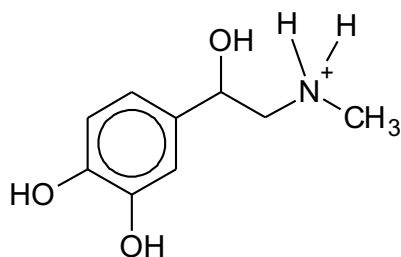
C X W Z Y

D Z W Y X

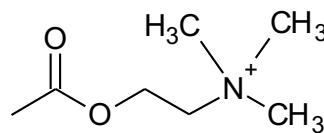
- 24 Which reaction forms a racemic mixture of two enantiomers?



- 25** Adrenaline and acetylcholine are neurotransmitters found in the human body. Their structures at physiological pH are shown below.
These structures are also relevant to question 26.



adrenaline



acetylcholine

How many moles of aqueous sodium hydroxide does one mole of each neurotransmitter react with at room temperature?

	moles of NaOH(aq) reacting with	
	adrenaline	acetylcholine
A	4	0
B	4	1
C	3	0
D	3	1

- 26** Which chemical test(s) can be used to distinguish adrenaline and acetylcholine?

- 1 neutral iron(III) chloride
- 2 2,4-dinitrophenylhydrazine
- 3 acidified potassium dichromate(VI)

- | | | | |
|----------|--------------|----------|--------------|
| A | 1 only | B | 2 only |
| C | 1 and 3 only | D | 2 and 3 only |

- 27 Bradykinin is a hypotensive vasodilator with the following amino acid sequence.

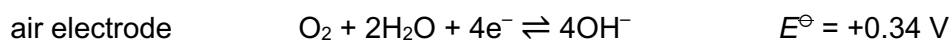
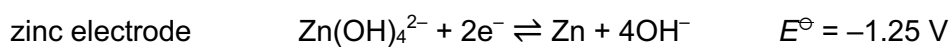


Carboxypeptidase P is an enzyme that cleaves peptide bonds on the carboxyl side of proline residues.

Which fragment is **not** formed when bradykinin is treated with carboxypeptidase P?

- | | | | |
|----------|---------|----------|-------------|
| A | Arg-Pro | B | Pro |
| C | Phe-Arg | D | Gly-Phe-Ser |

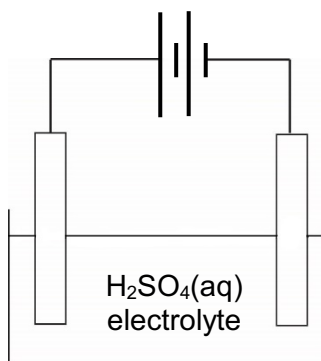
- 28 The half-equations for a zinc-air battery are given below.



In which direction do the electrons flow in the external circuit and what is the $\Delta G^\ominus$ per mol of zinc species?

	direction of electron flow	$\Delta G^\ominus$ per mol of zinc species / kJ mol^{-1}
A	zinc to air	-175
B	zinc to air	-307
C	air to zinc	-351
D	air to zinc	-614

- 29 The electrolysis setup below is used to coat aluminium objects with a protective oxide layer.



Which statements about the setup are correct?

- 1 Bubbles are formed on the right electrode.
- 2 The mass of the cathode increases with time.
- 3 The aluminium object is placed on the left electrode.
- 4 After some time, an anode sludge forms at the base of the cell.

- A** 1 and 3 only
C 2 and 4 only

- B** 2 and 3 only
D 1, 2 and 4 only

- 30 Going across the first row transition metals, which statement is correct?

- A** Melting point remains invariant.
- B** Formation of M^{2+} ions involves the removal of two 3d electrons.
- C** The maximum oxidation state increases then decreases.
- D** The increase in nuclear charge outweighs the increase in shielding effect.

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