

Section A

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

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

Which of the following has the same number of atoms as 14.0 g of ethene?

- A 11.5 g of sodium metal
- B 14.0 g of methane gas
- C 44.0 g of carbon dioxide gas
- D 96.0 g of oxygen gas

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

Chlorine exists as 2 isotopes, ^{35}Cl and ^{37}Cl .

Which of the following statements is true about the isotopes of chlorine?

- A Both isotopes have the same number of protons but different number of electrons.
- B The most abundant isotope of chlorine is ^{35}Cl .
- C The isotopes of chlorine exhibit different chemical properties.
- D The number of neutrons in ^{37}Cl is 18.

- 3 30 cm³ of a hydrocarbon was allowed to burn in excess oxygen. On cooling to room temperature, the volume of the residual gas was found to have decreased by 90 cm³. On adding concentrated base, the volume of the residual gas decreased by another 120 cm³. What is the minimum volume of oxygen required for complete combustion of this hydrocarbon?

- A 90 cm³
- B 145 cm³
- C 165 cm³
- D 180 cm³

- 4 Potassium dichromate(VI), $\text{K}_2\text{Cr}_2\text{O}_7$, is a common oxidising agent that is used to determine the concentration of a compound via redox titration. In one such titration, 0.05 mol dm^{-3} of acidified $\text{K}_2\text{Cr}_2\text{O}_7$ was used to titrate against 25.0 cm^3 of a solution containing 0.20 mol dm^{-3} of a metal ion M^{2+} .

Given that the metal ion is oxidised to M^{4+} , what is the volume of $\text{K}_2\text{Cr}_2\text{O}_7$ needed to reach the end point of this titration?

- A 33.35 cm^3
- B 27.80 cm^3
- C 16.85 cm^3
- D 12.20 cm^3

- 5 The first eight ionisation energy of an element, **E**, are given in the table below.

Ionisation energy / kJ mol^{-1}	1 st	2 nd	3 rd	4 th	5 th	6 th	7 th	8 th
E	735	1588	2467	3590	5211	7400	18545	22887

Given that the relative atomic mass of **E** is less than 130, which of the following statements about **E cannot** be determined from the given data above?

- A It has a valence electronic configuration of $ns^2 np^4$.
 - B It is a simple covalent compound with weak intermolecular forces of attraction.
 - C It usually forms an ionic compound with a charge of -2.
 - D It is from Period 4.
- 6 Which of the following statements is explained by co-ordinate bonding?
- A The dimerisation of carboxylic acids.
 - B The dimerisation of AlCl_3 .
 - C The formation of N_2O_4 from NO_2 .
 - D The formation of a salt from an acid base reaction.

- 7 Distillation is a process of separating miscible liquids based on their boiling points. Liquids with low boiling points will be distilled off first while those with higher boiling points are collected later.

Assuming that the following compounds were miscible in a solution, which of them would be collected first when this solution is subjected to distillation?

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

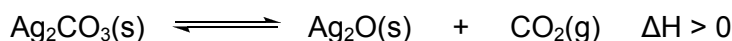
- 8 Which of the following equation represents the standard enthalpy change of neutralisation?

- A $2\text{HCl} + \text{Ba}(\text{OH})_2 \longrightarrow \text{BaCl}_2 + 2\text{H}_2\text{O}$
- B $\frac{1}{2}\text{HCl} + \frac{1}{2}\text{NaOH} \longrightarrow \frac{1}{2}\text{NaCl} + \frac{1}{2}\text{H}_2\text{O}$
- C $\text{H}_2\text{SO}_4 + \text{Ba}(\text{OH})_2 \longrightarrow \text{BaSO}_4 + 2\text{H}_2\text{O}$
- D $\frac{1}{2}\text{H}_2\text{SO}_4 + \text{NaOH} \longrightarrow \frac{1}{2}\text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$

- 9 Which of the following statements describes a system in dynamic equilibrium?

- A It is when the amount of reactants is equal to the amount of products.
- B It is when the equilibrium constant has a value of 1.
- C It is when the equilibrium constant has no units.
- D The rates of the forward and reverse reactions are equal.

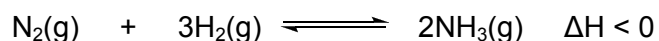
- 10 The decomposition of silver carbonate can be represented by the following equation.



Which of the following statements about decomposition of silver carbonate is correct?

- A Increasing the pressure of the system would produce more CO_2 .
- B Increasing the temperature of the system will cause less CO_2 to be produced.
- C Removing CO_2 from the system will not change the K_c value of this equilibrium.
- D The unit for the K_c of this equilibrium is $\text{mol}^{-1} \text{dm}^3$.

- 11 The Haber process is the formation of ammonia and it can be represented by the following equation.



When the Haber process was done at two different temperatures, T_1 and T_2 , the following data was obtained.

Temperature	% of NH_3
T_1	0.324
T_2	0.571

When the Haber process was done at two different pressures, P_1 and P_2 , the following data was obtained.

Pressure	% of NH_3
P_1	0.771
P_2	0.433

Which of the following statements about the various conditions is true?

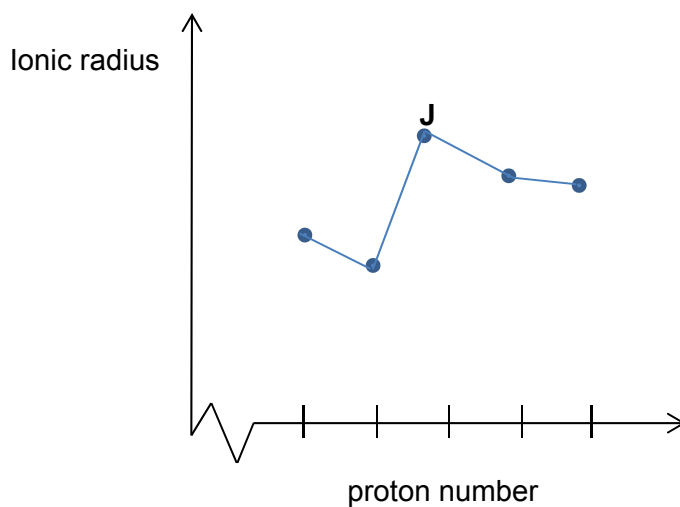
- A $T_1 > T_2$ and $P_1 > P_2$
 - B $T_1 > T_2$ and $P_1 < P_2$
 - C $T_1 < T_2$ and $P_1 > P_2$
 - D $T_1 < T_2$ and $P_1 < P_2$
- 12 What volume of water needs to be added to 1 dm^3 of $0.100 \text{ mol dm}^{-3} \text{ H}_2\text{SO}_4$ to obtain a solution with a pH of 2?
- A 9 dm^3
 - B 19 dm^3
 - C 20 dm^3
 - D 25 dm^3

- 13 The rate of a reaction between compounds **G** and **H** is investigated by altering their initial concentrations and measuring their rates. The following results were obtained.

Experiment No.	[G] / mol dm ⁻³	[H] / mol dm ⁻³	Initial rate / mol dm ⁻³ s ⁻¹
1	1	2	1
2	2	2	2
3	1	4	4
4	3	1	x

What is the value of x ?

- A 0.5
 B 0.75
 C 1
 D 1.25
- 14 The following diagram shows the ionic radius of consecutive elements in Period 3.



What is the element that corresponds to **J**?

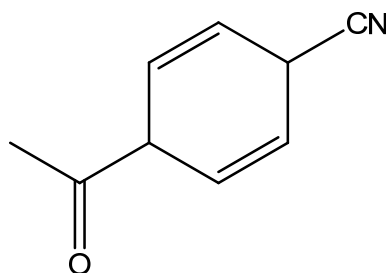
- A Na
 B Al
 C P
 D S

- 15 Which of the following properties across the elements of Period 3 do **not** show a general increasing followed by a decreasing trend?
- A Electrical conductivity of the elements
 - B Melting point of the elements
 - C Melting point of the oxides
 - D pH of the chlorides in water

- 16 Aluminium has an ionisation energy that is lower than both the element before and after it in Period 3.

Which of the following accounts for this observation?

- A Aluminium has a giant metallic lattice structure
 - B Effective shielding provided by the electrons in the 3s orbital
 - C Effective nuclear charge increases across a period
 - D Inter-electronic repulsion in the 3p orbital
- 17 Compound **K** has the following structure.



Compound **K**

Which of the following shows the distributions of the hybridisation states of all the carbon atoms in compound **K**?

	sp	sp²	sp³
A	1	5	3
B	1	4	4
C	2	5	2
D	2	4	3

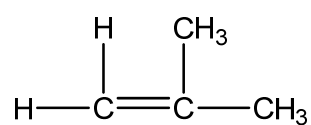
18 A molecule has the following criteria:

- Molecular formula of C_5H_{10}
- Contains a double bond
- Contains either 4 or 5 carbon chain long

How many structural isomers will fit the criteria of this molecule?

- A 4
B 5
C 6
D 7

19 2-methylpropene has the following structure.



2-methylpropene

What is the major product when 2-methylpropene is allowed to react with aqueous bromine in a solution of concentrated sodium bromide?

- A $\begin{array}{c} \text{H} \quad \text{CH}_3 \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ | \quad | \\ \text{Br} \quad \text{Br} \end{array}$
- B $\begin{array}{c} \text{H} \quad \text{CH}_3 \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ | \quad | \\ \text{Br} \quad \text{OH} \end{array}$
- C $\begin{array}{c} \text{H} \quad \text{CH}_3 \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ | \quad | \\ \text{Br} \quad \text{Na} \end{array}$
- D $\begin{array}{c} \text{H} \quad \text{CH}_3 \\ | \quad | \\ \text{H}-\text{C}-\text{C}-\text{CH}_3 \\ | \quad | \\ \text{OH} \quad \text{Br} \end{array}$

20. Which of the following statements about benzene is **false**?

- A It has two times more sigma bonds than pi bonds.
- B The C and the H atoms in benzene are all on the same plane.
- C It has 6 pi electrons in its ring of delocalised electrons.
- D It is less reactive compared to alkenes.

21. To test for the presence of halogen derivatives, the following steps are carried out.

Step 1: NaOH(aq) and heat

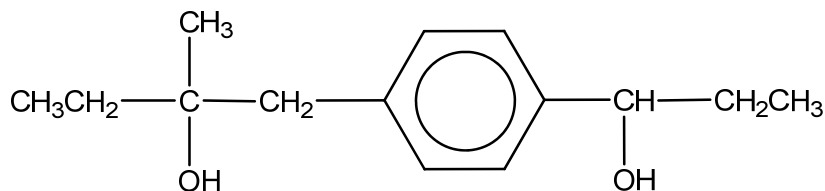
Step 2: Add acidified AgNO₃(aq)

The type of halogen derivative can not only be determined by the colour of the precipitate after the reaction but also by the rate at which the precipitate appears.

Which of the following halogen derivatives will have the slowest appearance of its precipitate when subjected to the two steps described above?

- A CH₃CH₂Br
- B CH₃CH₂Cl
- C CH₃CH₂I
- D C₆H₅I

22. The compound shown below is a derivative of ibuprofen, which is a painkiller.



Which of the following reagents will react with only one alcohol group in the derivative of ibuprofen?

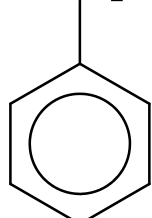
- A Concentrated H₂SO₄, 170°C
- B Cr₂O₇²⁻, H₂SO₄ (aq), heat
- C I₂ dissolved in NaOH (aq), warm
- D PCl₅ at r.t.p

23 Compound **L** has the following observations:

- Gives an orange precipitate with 2,4-dinitrophenylhydrazine
- Yields 1,4-dibenzoic acid when reacted with acidified KMnO_4
- Unable to react with Fehling's solution but able to react with Tollen's reagent

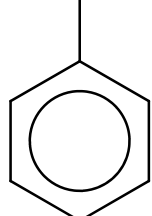
What could compound **L** be?

A CH_2CH_3



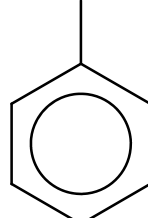
CH_2COCH_3

B CH_2CH_3



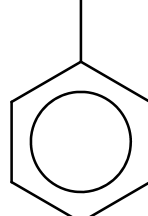
$\text{CH}_2\text{CH}_2\text{CHO}$

C CHO



$\text{CH}_2\text{CH}_2\text{CH}_2\text{CH}_3$

D CHO



$\text{C}(\text{CH}_3)_3$

24 Which of the following molecules would have the smallest pK_a value?

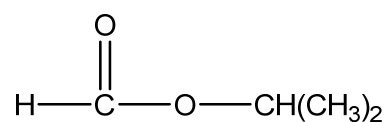
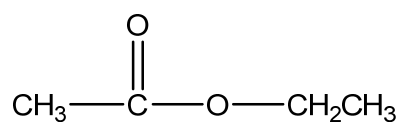
A $\text{CH}_3\text{CH}(\text{NH}_2)\text{CH}_2\text{COOH}$

B $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{COOH}$

C $\text{CH}_3\text{CH}_2\text{CH}(\text{NH}_2)\text{COOH}$

D $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{COOH}$

- 25 Below are the structures of two ester isomers with the molecular formula $C_4H_8O_2$.



Which of the following reagents can be used to distinguish these 2 ester isomers?

- A $\text{Cr}_2\text{O}_7^{2-}$, H_2SO_4 (aq), heat
- B MnO_4^- , H_2SO_4 (aq), heat
- C LiAlH_4 in dry ether
- D 2,4 dinitrophenylhydrazine

Section B

For each of the questions in this section, one or more of the three numbered statements 1 to 3 may 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 is used as a correct response.

26 Which of the following pair have the same number of unpaired electrons?

- 1 Cr, Co^{3+}
- 2 Fe^{2+} , Mn^{3+}
- 3 Cu^+ , V^{5+}

27 Which of the following information can be determined from a reaction pathway diagram?

- 1 The activation energy of the reaction.
- 2 The enthalpy change of the reaction.
- 3 The number of steps in the mechanism of the reaction.

28 Which of the following, when mixed, would result in a buffer solution?

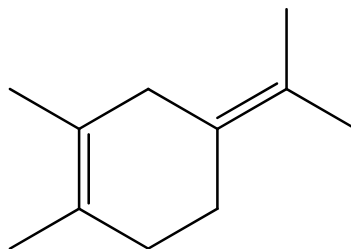
- 1 25 cm³ of 0.100 mol dm⁻³ HCl and 15 cm³ of 0.100 mol dm⁻³ NH₃
- 2 25 cm³ of 0.100 mol dm⁻³ NH₃ and 10 cm³ of 0.100 mol dm⁻³ H₂SO₄
- 3 25 cm³ of 0.100 mol dm⁻³ CH₃COOH and 15 cm³ of 0.100 mol dm⁻³ NaOH

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 is used as a correct response.

29 Compound **M** has the following structure.



Compound **M**

Which of the following statements are correct when compound **M** is treated with hot acidified KMnO_4 ?

- 1** The products contain at least one carbonyl compound.
- 2** The products contain at least one carboxylic acid.
- 3** The products contain carbon dioxide.

30 Which of the following reactions are considered to be a condensation reaction?

- 1** The reaction between an acid chloride and alcohol forms an ester and water.
- 2** The reaction between a carbonyl compound and 2,4-dinitrophenylhydrazine forms an orange precipitate and water.
- 3** The reaction between an alcohol and concentrated sulfuric acid at 170°C forms an alkene and water.

END OF PAPER

Answers:

1	C	6	B	11	A	16	B	21	D	26	C
2	B	7	A	12	B	17	A	22	B	27	A
3	C	8	D	13	B	18	C	23	C	28	C
4	A	9	D	14	C	19	A	24	D	29	D
5	D	10	C	15	D	20	A	25	B	30	B