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CLASS _____



JURONG PIONEER JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATION 2025

CHEMISTRY

8873/01

Higher 1

18 September 2025

Paper 1 Multiple Choice Questions

1 hour

Candidates answer on the Question paper.

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.

Write your name, class and exam index number on the Answer Sheet in the spaces provided unless this has been done for you.

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

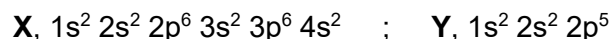
Any rough working should be done in this booklet.

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

This document consists of **14** printed pages and **0** blank page.

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

The atoms **X** and **Y** have the electronic configurations shown below.



Which compound are they likely to form?

- A** X_2Y **B** XY **C** XY_2 **D** XY_4

- 1 **Answer C**



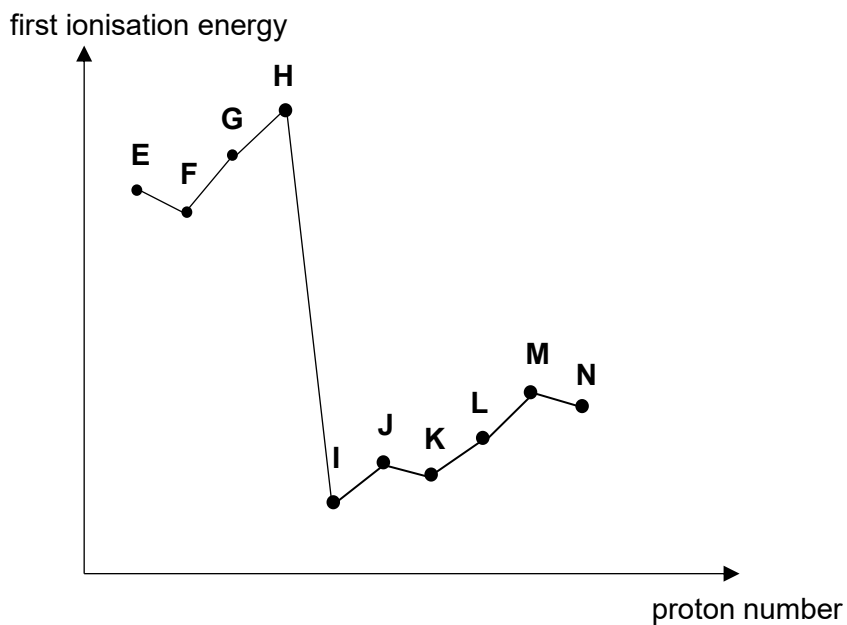
$\Rightarrow$ has 2 valence electrons, Group 2 element (Ca); tendency to lose 2 electrons to give Ca^{2+}



$\Rightarrow$ has 7 valence electrons, group 17 element (F); tendency to accept 1 electron to form F^-

Hence will form CaF_2 which is XY_2

- 2 The trend of first ionisation energy for 10 consecutive elements, in Period 2 and 3, is given below.



Which of the following statement is correct?

- A** Element **E** and **N** belong to the same group.
B **L** has a giant covalent structure.
C The oxide of **J** is amphoteric.
D The chloride of **I** is insoluble in water.

2 Answer B

The largest drop in first ionisation energy is between H and I. This indicates H is from 2 period 2 and I is from period 3. H is in group 18 and I is in group 1.

Hence, E, nitrogen, and M, phosphorous, belong to the same group, group 15.

L is in group 14, silicon, and has a giant covalent structure.

The oxide of J, magnesium oxide, is a basic oxide.

The chloride of I, sodium chloride, is soluble in water.

3 In which pair of molecules are both non-polar?

- 1 BeH₂ and SO₃
- 2 AlCl₃ and CH₄
- 3 PCl₅ And SCl₆

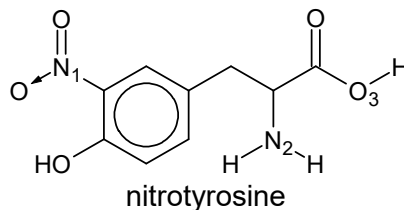
- A** 1, 2 and 3
B 1 and 2 only
C 2 and 3 only
D 1 only

3 Answer A

- | | |
|---|---|
| 1 BeH ₂ is linear. SO ₃ is trigonal planar. Both are non-polar. | ✓ |
| 2 AlCl ₃ is trigonal planar. CH ₄ is tetrahedral. Both are non-polar. | ✓ |
| 3 PCl ₅ is trigonal bipyramidal. SCl ₆ is octahedral. Both are non-polar. | ✓ |

The following information is for Questions 4 and 5.

Nitrotyrosine has been identified as an indicator for cell damage in the human body.



4 What are the bond angles around N_1 , N_2 and O_3 of nitrotyrosine?

Bond angle / °			
	N_1	N_2	O_3
A	105	107	120
B	105	120	105
C	120	120	120
D	120	107	105

4 **Answer D**

N_1 is trigonal planar $\Rightarrow 120^\circ$

N_2 is trigonal pyramidal $\Rightarrow 107^\circ$

O_3 is bent $\Rightarrow 104.5 \approx 105^\circ$

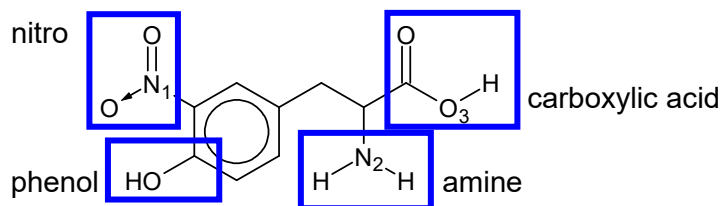
5 Which of the following functional groups can be found in nitrotyrosine?

You may refer to the structure above.

- 1 Amide
- 2 Amine
- 3 Carboxylic acid

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

5 **Answer C**



1 Amide

✗

2 Amine

✓

3 Carboxylic acid

✓

- 6 Which row correctly describes the structure and bonding present in the solid lattice of the given substance?

	substance	structure	bonding
A	iodine	simple covalent	instantaneous dipole–induced dipole only
B	iron	giant metallic	ionic bonding only
C	sodium carbonate	giant ionic	ionic and covalent bonding
D	graphite	giant molecular	covalent bonding only

6 Answer: C

- *A Iodine has both covalent bonding between I atoms and instantaneous dipole–induced dipole forces of attraction between I₂ molecules.
- *B Iron has metallic bonding.
- ✓C Sodium carbonate has ionic bonding between Na⁺ and CO₃²⁻ ions. There are covalent bonds between the atoms of CO₃²⁻.
- *D There are covalent bonds between the carbon atoms of graphite instantaneous dipole–induced dipole forces of attraction between individual layers.

- 7 Arrange the following compounds in **ascending** order of boiling point.

Compound	Formula	<i>M_r</i>
P	CH ₃ CH ₂ CH ₂ CH ₃	58
Q	CH ₃ COCH ₃	58
R	CH ₃ CH(CH ₃) ₂	58
S	CH ₃ CH ₂ CH ₂ OH	60

- A P → Q → R → S
- B Q → S → P → R
- C R → P → Q → S
- D S → P → R → Q

7 Answer C

Since P, Q, R and S all have the same M_r , they would have similar number of electrons to polarise. Hence, in this case hydrogen bonding > permanent dipole–permanent dipole > instantaneous dipole–induced dipole.

P and Q have the lowest boiling point as both only have instantaneous dipole–induced dipole forces of attractions between their molecules. R has a lower boiling point than P as it has branching which makes the molecule more spherical and thus reducing the extensiveness of instantaneous dipole–induced dipole forces of attraction.

Q is a polar molecule with permanent dipole–permanent dipole forces of attraction between molecules. This attraction is stronger than instantaneous dipole–induced dipole forces of attractions, thus boiling point of Q > P.

S has the highest boiling point as it is able to form hydrogen bonding between molecules. Hydrogen bonding is stronger than both permanent dipole–permanent dipole and instantaneous dipole–induced dipole forces of attractions.

8 Which of the following statements can be explained by the presence of intermolecular hydrogen bonding only.

- 1 Ice is less dense than water.
- 2 Dimerisation of ethanoic acid in hexane.
- 3 Dissolution of sodium chloride in water.

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

8 Answer: A

- ✓1 Ice is less dense as upon freezing, water molecules form a rigid, open, hexagonal crystal lattice structure due to hydrogen bonds.
- ✓2 Ethanoic acid dimerizes in benzene due to strong intermolecular hydrogen bonding between the carbonyl oxygen of one molecule and the hydroxyl hydrogen of another, forming a stable ring-like structure known as a dimer
- ×3 When sodium chloride dissolves in water, the ions form ion–dipole interactions with water molecules.

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

The maximum tolerable daily intake of ascorbic acid, also known as vitamin C, for adults is 2000 mg, beyond which there may be adverse effects on the human body.

What is the number of molecules in 2000 mg of ascorbic acid, $\text{C}_6\text{H}_8\text{O}_6$?

- | | | | |
|----------|-----------------------|----------|-----------------------|
| A | 6.84×10^{18} | B | 1.20×10^{24} |
| C | 6.84×10^{21} | D | 1.20×10^{27} |

- 9 **Answer: C**

$$M_r \text{ of } \text{C}_6\text{H}_8\text{O}_6 = 6(12) + 8(1) + 6(16) = 176$$

$$2000 \text{ mg} = 2000/1000 = 2 \text{ g}$$

$$\text{Amount of } \text{C}_6\text{H}_8\text{O}_6 = 0.01136 \text{ mol}$$

$$\text{Number of molecules} = 0.01136 \times 6.02 \times 10^{23} = 6.84 \times 10^{21}$$

- 10 1 mol of acidified $\text{Cr}_2\text{O}_7^{2-}$ reacted with 3 mol of Mn^{2+} . The products are Cr^{3+} and a manganese cation, of an unknown oxidation state.

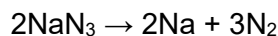
What is the oxidation state of the manganese cation?

- | | | | |
|----------|----|----------|----|
| A | +3 | B | +4 |
| C | +5 | D | +6 |

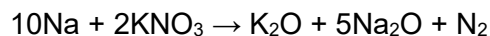
- 10 **Answer: B**

1 mol $\text{Cr}_2\text{O}_7^{2-}$ takes in 6 mol of e^- when reduced to 2 mol of Cr^{3+} . Thus, the 6 mol of e^- is given out by 3 mol of Mn^{2+} . 1 mol of Mn^{2+} thus gives out 2 mol of e^- to form Mn^{4+} .

- 11 Sodium azide, NaN_3 , is the compound that inflates the airbags in a car in event of a collision. However, it produces sodium as a byproduct.



To ensure that the sodium does not add further injuries to people, potassium nitrate, KNO_3 , is added in excess to the sodium azide.



What is the volume of nitrogen gas, at r.t.p., obtained when an airbag, containing 0.100 mol of sodium azide, is activated?

- | | | | |
|----------|---------------------|----------|---------------------|
| A | 1500 cm^3 | B | 1600 cm^3 |
| C | 3600 cm^3 | D | 3840 cm^3 |

11 Answer: D

0.100 : 0.100 : 0.150 (mol of species)



0.100 : 0.010 (mol of species)

Total amount of N_2 formed = $0.150 + 0.10 = 0.160$ mol

Volume of N_2 = $0.160 \times 24000 = 3840$ cm³

12 The following statements describes the behaviour of an element, **T**, in Period 3 of the Periodic Table.

Three of the statements describing the behaviour of element **T** are true and one is false.

Which of the statements is false?

- A** **T** has a lower ionisation energy than the element before it.
- B** **T** has a larger atomic radius than the element after it.
- C** **T** forms an oxide that is insoluble in water.
- D** **T** can react with chlorine to form TCl_5 .

12 Answer: D

If **T** was Na, statements C and D would be false.

If **T** was Mg, statements A and D would be false.

If **T** was Al, statements D would be the only false statement. ✓

If **T** was Si, statements A and D would be false.

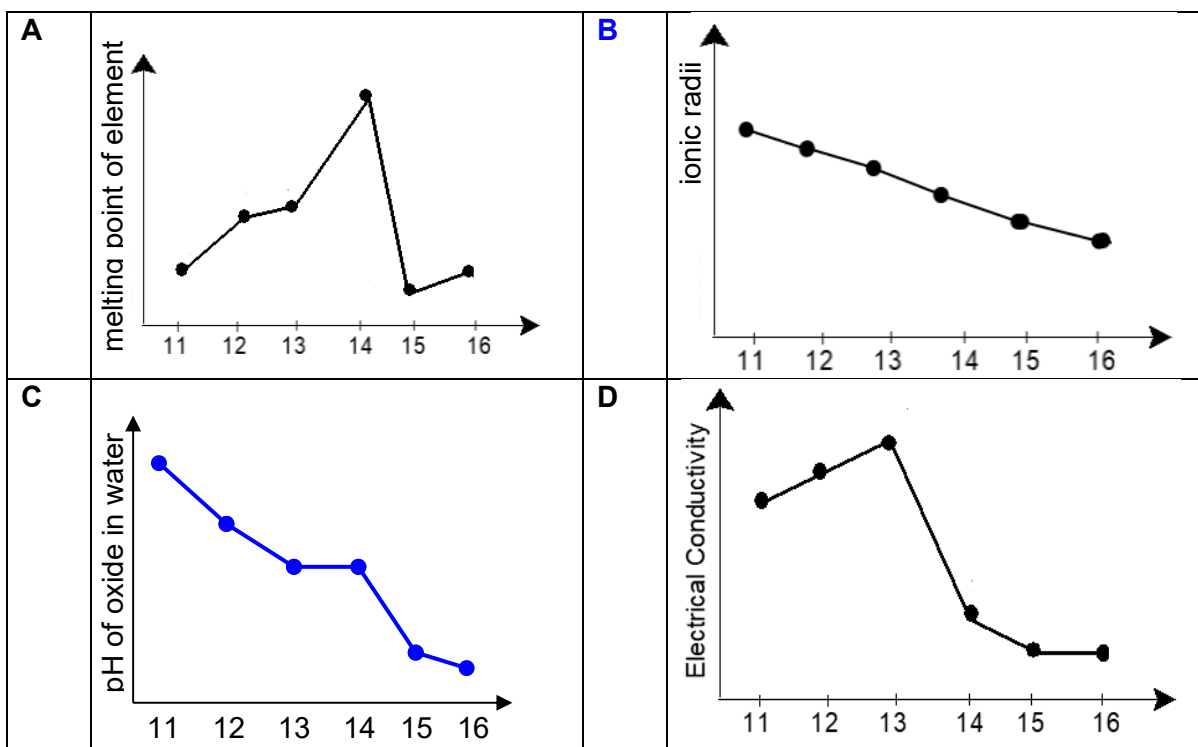
If **T** was P, statements A and C would be false.

If **T** was S, statements C and D would be false.

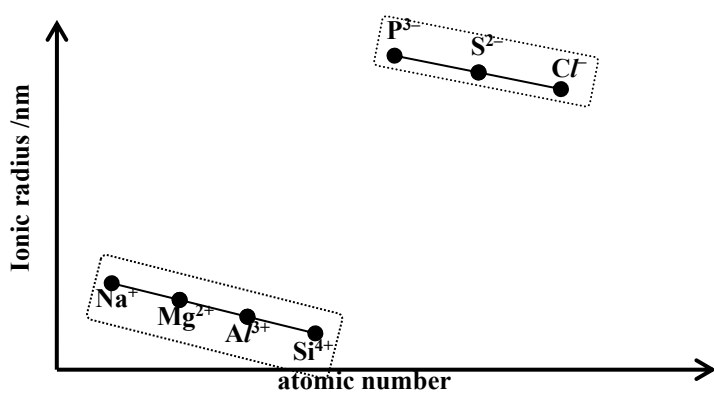
If **T** was Cl, statements A, C and D would be false.

- 13 The properties of Period 3 elements and their compounds are plotted against increasing atomic number.

Which of the following graphs is **incorrect**?



13 Answer: B



14 Which statements about Group 17 elements and their compounds are correct?

- 1 The first ionisation energy of the atoms decreases down the group.
- 2 The oxidising power of the halogens decreases down the group.
- 3 The boiling point of the hydrogen halides decreases down the group.

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

14 Answer: B

Only 3 is wrong as the number of electrons that can be polarised increases down the group, leading to stronger instantaneous dipole–induced dipole forces of attractions between the hydrogen halide molecules. Thus, boiling point increases.

15 Which equation corresponds to the enthalpy change stated?

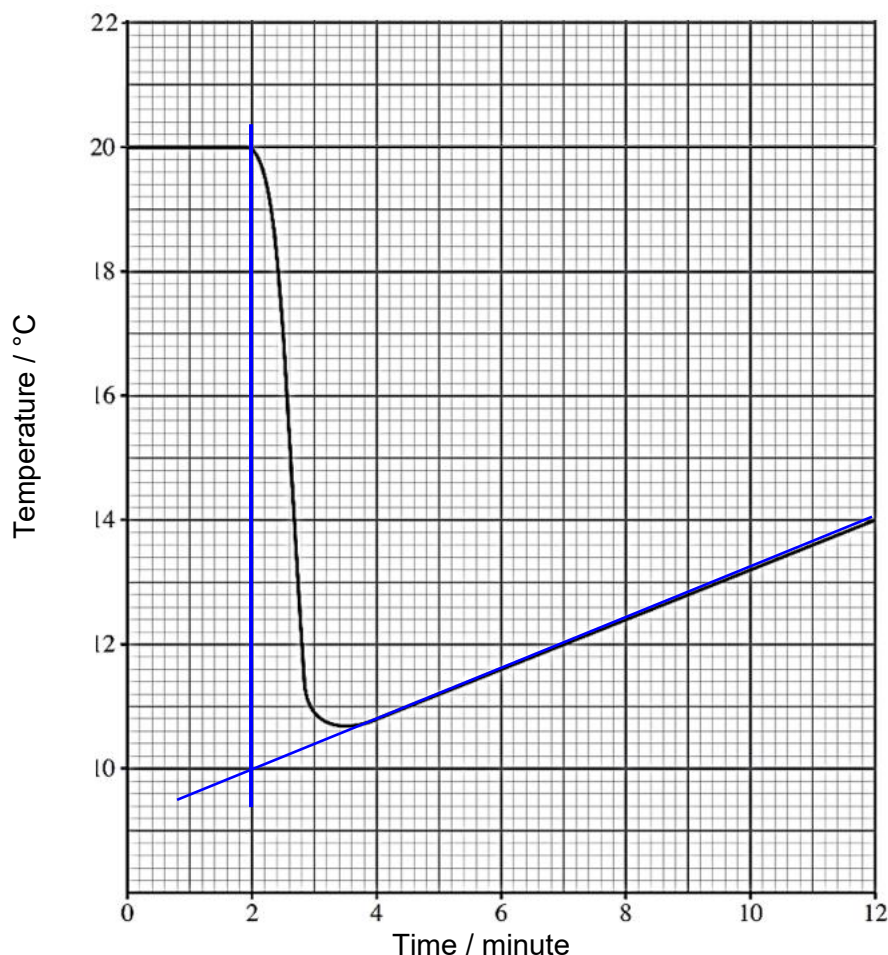
A	$\text{CH}_4(\text{g}) \rightarrow \text{C}(\text{g}) + 4\text{H}(\text{g})$	Bond energy(C–H)
B	$2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{H}_2\text{O}(\text{l})$	$\Delta H^\circ_{\text{combustion}}(\text{H}_2)$
C	$2\text{Na}(\text{s}) + \text{C}(\text{s}) + \text{O}_3(\text{g}) \rightarrow \text{Na}_2\text{CO}_3(\text{s})$	$\Delta H^\circ_{\text{formation}}(\text{Na}_2\text{CO}_3)$
D	$\frac{1}{2}\text{H}_2\text{SO}_4(\text{aq}) + \frac{1}{2}\text{Ba}(\text{OH})_2(\text{aq}) \rightarrow \frac{1}{2}\text{BaSO}_4(\text{aq}) + \text{H}_2\text{O}(\text{l})$	$\Delta H^\circ_{\text{neutralisation}}$

15 Answer: D

- ×A The equation shows 4 x Bond energy(C–H)
 ×B $\Delta H^\circ_{\text{combustion}}(\text{H}_2)$ is for the combustion of 1 mol of H_2 .
 ×C For $\Delta H^\circ_{\text{formation}}(\text{Na}_2\text{CO}_3)$ the reactants must be in the elemental form. Oxygen exists as O_2 .
 ✓D $\Delta H^\circ_{\text{neutralisation}}$ is the formation of 1 mol of H_2O when an acid reacts with a base.

16 Use of the Data Booklet is relevant to this question.

An experiment was conducted to determine the enthalpy change of solution of ammonium nitrate, NH_4NO_3 . A styrofoam cup was filled with 50.0 g of water and the temperature of the water was measured at intervals of 1 minute. At 2 minutes, 6.50 g of NH_4NO_3 was added and the temperature of the mixture was recorded every minute. The following graph was obtained.



What is the enthalpy change of solution of ammonium nitrate, NH_4NO_3 ?

- A** $-25.7 \text{ kJ mol}^{-1}$
C $+25.7 \text{ kJ mol}^{-1}$

- B** $-24.1 \text{ kJ mol}^{-1}$
D $+24.1 \text{ kJ mol}^{-1}$

16 Answer: C

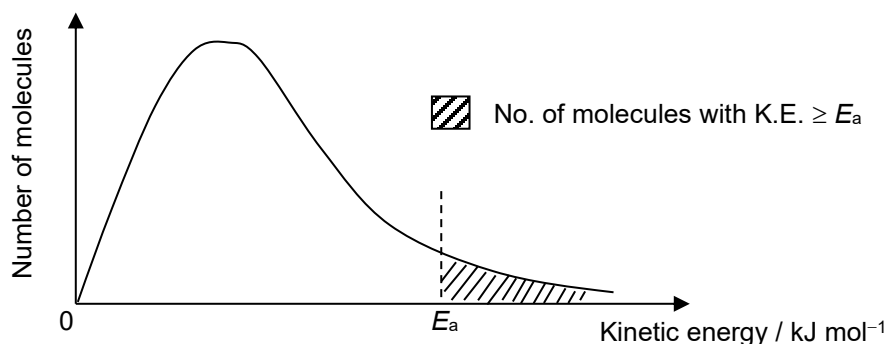
$$M_r \text{ of } \text{NH}_4\text{NO}_3 = 2(14) + 4(1) + 3(16) = 80$$

$$\text{Amount of } \text{NH}_4\text{NO}_3 = 6.50 / 80 = 0.08125 \text{ mol}$$

$$\text{Heat gained by reaction} = q = mc\Delta T = 50 \times 4.18 \times (20 - 10) = 2090 \text{ J} = 2.090 \text{ kJ}$$

$$\Delta H = +q / n = 2.090 / 0.08125 = +25.7 \text{ kJ mol}^{-1}$$

- 17 The graph shows the Boltzmann distribution for a sample of gas at 298 K.



Which of the following describes what would happen to the graph when a catalyst is added?

- A The maxima of the graph shifts up.
- B The maxima of the graph shifts to the left.
- C The maxima of the graph shifts to the right.
- D The maxima of the graph does not change.

17 Answer: D

When a catalyst is added, only the E_a of the reaction changes. The graph is only affected by temperature.

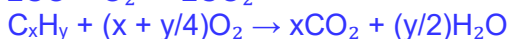
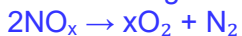
- 18 In many countries, it is mandatory to install catalytic converters in motor vehicles to remove pollutants from the exhaust gases.

Which of these substances are not removed by the catalytic converters?

- A CO
- B CO_2
- C NO_2
- D C_8H_{18}

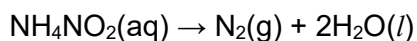
18 Answer: B

The following reactions takes place at the catalytic converter.



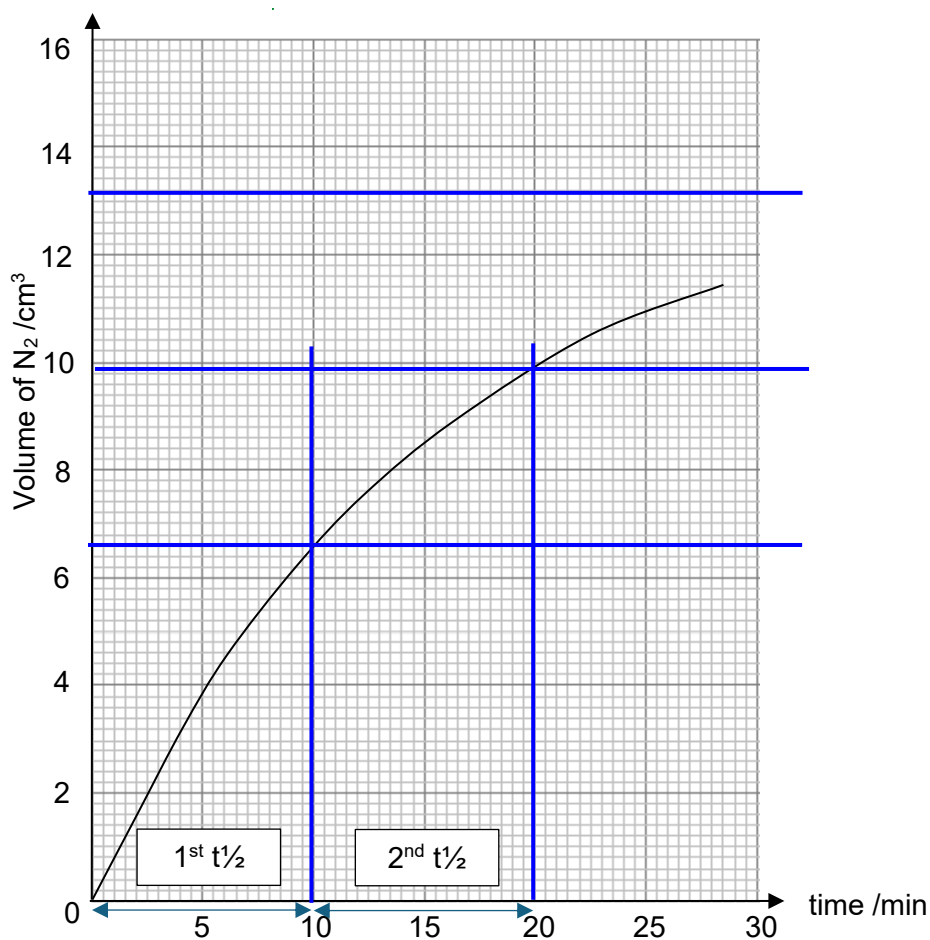
CO_2 is not removed.

- 19 Ammonium nitrite decomposes according to the equation below.



The kinetics of the decomposition of a 100 cm^3 sample of $5.50 \times 10^{-3}\text{ mol dm}^{-3}$ NH_4NO_2 sample was studied by measuring the volume of nitrogen gas produced, at r.t.p., at various time intervals.

A graph of volume of nitrogen gas against time was plotted, as shown below.



What is the half-life, determined from the graph above, and the order of reaction with respect to NH_4NO_2 ?

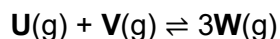
	Half-life / min	Order of reaction w.r.t. NH_4NO_2
A	10.0	0
B	13.8	0
C	10.0	1
D	13.8	1

19 Answer: C

Amount of $\text{NH}_4\text{NO}_2 = 100/1000 \times 5.50 \times 10^{-3} = 0.000550 \text{ mol} = \text{amount of } \text{N}_2$
 Max volume of $\text{N}_2 = 0.000550 \times 24000 = 13.2 \text{ cm}^3$ (when all reactants used up)

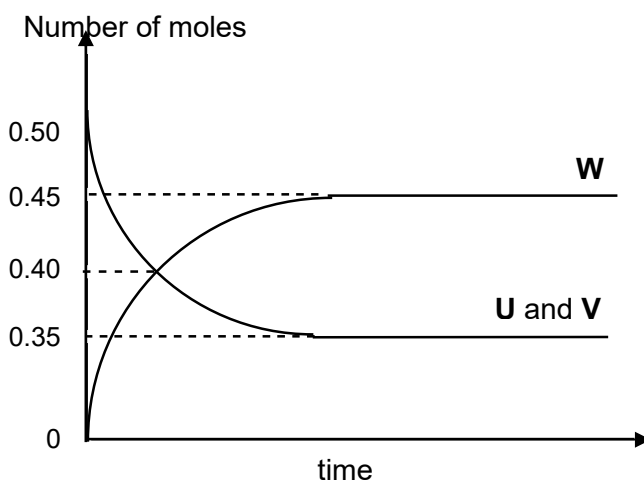
First half-life (from 0 cm^3 to 6.6 $\text{cm}^3 \text{ N}_2$) = 10 min
 Second half-life (from 6.6 cm^3 to 9.9 $\text{cm}^3 \text{ N}_2$) = 10 min

Since consecutive half-lives are constant, order of reaction w.r.t NH_4NO_2 is 1.

20 Two gases, **U** and **V**, react as follows.

A mixture containing **U** and **V** is heated in a 2 dm^3 closed vessel and the reaction is allowed to reach equilibrium.

The following graph shows how the number of moles of each gas varies with time.



What is the value of the equilibrium constant K_c for this reaction?

A 0.372

B 0.744

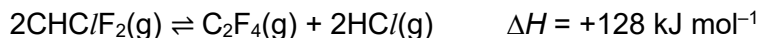
C 1.35

D 2.69

20 Answer A

$$K_c = \frac{[\text{W}]^3}{[\text{U}][\text{V}]} = \frac{\left(\frac{0.45}{2}\right)^3}{\frac{0.35}{2} \times \frac{0.35}{2}} = 0.372$$

- 21 Poly(tetrafluoroethene) is a polymer used as a coating in non-stick kitchen utensils and for replacement of bone joints. One of the stages in the manufacture of the polymer is shown in the equation below.



Which of the following conditions will shift this equilibrium to the right?

- 1 high temperature
- 2 low pressure
- 3 using catalyst

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

21 **Answer A**



- 1 High temperature will favour endothermic reaction. Since forward reaction is endothermic, equilibrium will shift to the right to remove some of the added heat. ✓
- 2 Decrease in pressure will favour the side with greater number of moles of gas. Hence, equilibrium will shift to the right to increase the number of moles of gas. ✓
- 3 Use of catalyst does not affect the position of equilibrium. ✗

- 22 An enzyme, found in the stomach, operates at maximum efficiency when in an aqueous solution buffered at pH 5.

Which combination of substances, when dissolved in 1 dm³ of water, would give the necessary acidic buffer solution?

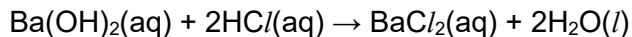
- A** 2 mol of CH₃CO₂H and 1 mol of NaOH
B 1 mol of CH₃CO₂H and 2 mol of NaOH
C 1 mol of HCl and 1 mol of CH₃CO₂Na
D 2 mol of NH₃ and 1 mol of CH₃CO₂NH₄

22 **Answer: A**

The buffer at pH 5 is an acidic buffer which is made up of a weak acid and its salt.

- ✓**A** Mixture of a weak acid and its salt, CH₃COO⁻Na⁺
 ✗**B** Mixture of NaOH (strong base) and CH₃COO⁻Na⁺
 ✗**C** Mixture of a strong acid and some salt.
 ✗**D** This is an alkaline buffer. Weak base and its salt.

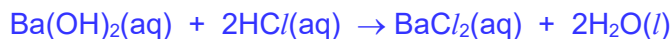
- 23 20 cm³ of 0.10 mol dm⁻³ of aqueous barium hydroxide, Ba(OH)₂ was mixed with 20 cm³ of 0.10 mol dm⁻³ of aqueous hydrochloric acid. The following reaction occurs:



What is the pH of the resulting solution?

- A 1.30 B 2.60 C 11.4 D 12.7

23 Answer: D



Amount of Ba(OH)₂ = 2.00 x 10⁻³ mol

Amount of HCl = 2.00 x 10⁻³ mol

Amount of Ba(OH)₂ in excess = 1.00 x 10⁻³ mol

Amount of OH⁻ = 2 x 1.00 x 10⁻³ = 2.00 x 10⁻³ mol

$$[\text{OH}^-] = \frac{0.00200}{\frac{40}{1000}} = 0.05$$

pOH = 1.30

pH = 14 - 1.3 = 12.7

- 24 Values for the ionic product of water, K_w , at two different temperatures are given below.

temperature / °C	K_w / mol ² dm ⁻⁶
25	1.00 x 10 ⁻¹⁴
30	1.44 x 10 ⁻¹⁴

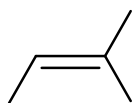
What of the following statement is **false**?

- A The dissociation of water is an endothermic process.
 B pH = 14 – pOH at 25 °C
 C [OH⁻] = 1.00 x 10⁻⁷ mol dm⁻³ at 25 °C
 D Water is acidic at 30 °C.

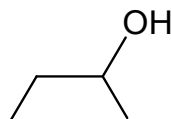
24 Answer: D

- ×A At higher T (favours endothermic reaction), K_w is larger (forward reaction is favoured). Forward reaction is endothermic.
- ×B $\text{pH} = \text{p}K_w - \text{pOH}$. Since K_w is 1.00×10^{-14} , $\text{p}K_w = 14$
- ×C $K_w = [\text{H}^+][\text{OH}^-]$. Since $[\text{H}^+] = [\text{OH}^-]$, $[\text{OH}^-] = (1.00 \times 10^{-14})^{0.5}$
- ✓D Since $[\text{H}^+] = [\text{OH}^-]$, water is neutral.

25 Which set of reagents and conditions can identify 2-methylbut-2-ene from butan-2-ol?



2-methylbut-2-ene



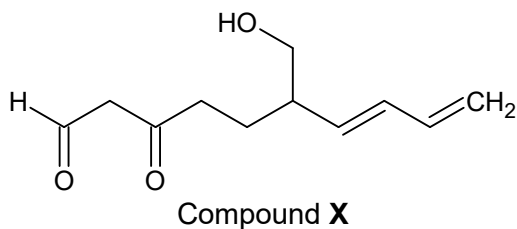
butan-2-ol

- A $\text{Br}_2(\text{aq})$
- B H_2 gas, Ni
- C LiAlH_4 in dry ether
- D Hot excess concentrated H_2SO_4

25 Answer: A

- ✓A Orange $\text{Br}_2(\text{aq})$ will decolourise for 2-methylbut-2-ene but not butan-2-ol.
- ×B H_2 gas will reduce 2-methylbut-2-ene but there are no visible observations.
- ×C LiAlH_4 does not react with both compounds.
- ×D Butan-2-ol will undergo elimination with hot excess concentrated H_2SO_4 but there are no visible observations.

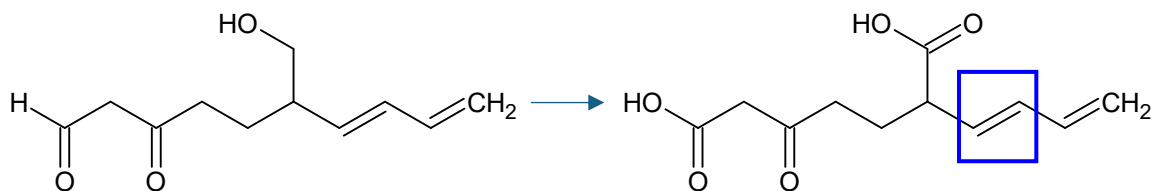
- 26 Compound X reacts with hot acidified potassium dichromate.



Which row correctly describes the number of cis-trans isomers and oxygen atoms in the organic product formed?

	number of cis-trans isomers	number of oxygen atoms
A	2	3
B	2	5
C	4	3
D	4	5

26 Answer: B

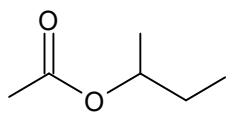


There is one C=C where cis-trans isomerism can exist (2 isomers) and a total of 5 oxygen atoms in the product.

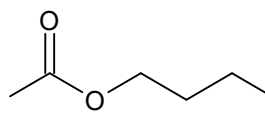
- 27 Ethanoic acid can react with butan-2-ol to form an ester.

Which of the following is the ester?

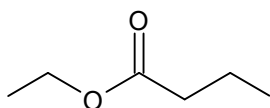
A



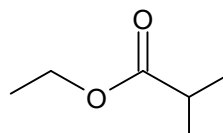
B



C

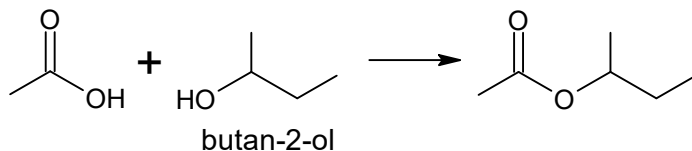


D



27 Answer: A

ethanoic acid



- 28 A lot of research has gone into developing superabsorbent polymers. The applications of these polymers include disposable diapers, to retain water in soil and even for creating artificial snow.

Which repeat unit best represents a condensation superabsorbent polymer?

- A $-\text{CH}_2\text{C}(\text{OH})_2-$
 B $-\text{CHC}/\text{CHC}/-$
 C $-\text{NHCH}(\text{C}_6\text{H}_5)\text{CO}-$
 D $-\text{NHCH}(\text{OH})\text{CH}(\text{OH})\text{CO}-$

28 Answer: D

- ×A There are 2 $-\text{OH}$ groups which can form hydrogen bonding with water. It is also an addition polymer.
 ×B There are no groups which can form hydrogen bonding with water. It is also an addition polymer.
 ×C It is a condensation polymer. The $\text{N}-\text{H}$ and $\text{C}=\text{O}$ can form hydrogen bonding with water.
 ✓D It is a condensation polymer. The $\text{N}-\text{H}$ and $\text{C}=\text{O}$ can form hydrogen bonding with water. There are also 2 $-\text{OH}$ groups which can form hydrogen bonding with water. This polymer can form hydrogen bonding with the most number of water molecules and hence the most superabsorbent.

- 29 Which statement correctly describes the difference between low density poly(ethene), LDPE and high density poly(ethene), HDPE?
- A LDPE has higher strength than HDPE.
 B LDPE has a higher melting point than HDPE.
 C LDPE chains have more branching than HDPE chains.
 D LDPE chains can be packed tighter than HDPE chains.

29 Answer: C

- ×A HDPE has higher strength.
- ×B HDPE has a higher melting point.
- ✓C LDPE has chains with more branching.
- ×D Due to the lack of branching, HDPE chains can be packed more tightly.

30 In which contexts is surface area important?

- 1 prevention of atmospheric pollution using catalytic converters
- 2 the ability of a gecko to climb a wall.
- 3 high tensile strength of graphene

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

30 Answer B

- 1 A large surface area is required for the catalyst particles to increase their efficiency. ✓
- 2 In a gecko, a large surface area increases the cumulative instantaneous dipole–induced dipole forces of attraction for it to stick to surfaces. ✓
- 3 The high tensile strength of graphene is the result of the strong covalent bonds between the C atoms. ×

End of Paper

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