



CANDIDATE
NAME

SUGGESTED ANSWERS

CG

H1 GROUP

1 / 2 / 3

CHEMISTRY

8873 /01

Paper 1

13 September 2024

Additional Materials: Multiple Choice Answer Sheet
Data Booklet

1 hour

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.

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

Write your name and class in the spaces at the top of this page and 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** and **D**.

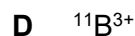
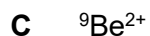
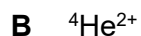
Choose the **one** you consider correct and record your choice in **soft pencil** on the separate Answer Sheet.

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.

- 1 Which of the species in their gaseous state shown below will be deflected by the smallest angle in an electric field?



Answer: C

angle of deflection $\propto \frac{\text{charge}}{\text{mass}}$ of the particle

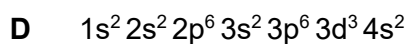
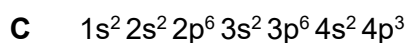
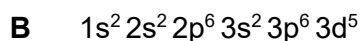
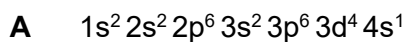
A $^1\text{H}_2$ Not deflected since it is not charged

B $^4\text{He}^{2+}$ $\frac{2}{4} = 0.5$

C $^9\text{Be}^{2+}$ $\frac{2}{9} = 0.222$

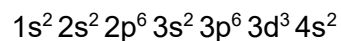
D $^{11}\text{B}^{3+}$ $\frac{3}{11} = 0.273$

- 2 What is the electronic configuration of vanadium, $_{23}\text{V}$?



Answer: D

V atom has 23 protons and 23 electrons.



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

How many atoms of gold, $_{79}\text{Au}$, are there in a pure gold coin with a mass of 3.94g?

A 1.20×10^{21}

B 2.00×10^{21}

C 1.20×10^{22}

D 2.00×10^{22}

Answer: **C**

Amount of Au = $3.94 \div 197 = 2 \times 10^{-2}$ mol

No. of atoms = $(2 \times 10^{-2}) \times (6.02 \times 10^{23}) = 1.20 \times 10^{22}$

- 4 10cm³ of gaseous hydrocarbon is burnt completely in 70cm³ of oxygen. When cooled to room temperature, the gaseous volume was 50cm³. A further decrease of 40cm³ in the gaseous volume was observed when the gaseous mixture is passed through aqueous potassium hydroxide.

What is the molecular formula of the hydrocarbon?

A C₂H₆

B C₃H₈

C C₄H₈

D C₅H₁₂

Answer: **C**

Reduction of gaseous volume due to reaction with KOH(aq)

→ CO₂(g) is an acidic gas and reacts with KOH(aq) via acid-base reaction

→ volume of CO₂(g) = 40 cm³,

Volume of oxygen unreacted = 50 – 40 = 10 cm³

Volume of O₂ reacted = 70 – 10 = 60 cm³

	C _x H _y	: O ₂	CO ₂	: H ₂ O
stoichiometric ratio from balanced equation	1 mol	$(x + \frac{y}{4})$ mol	x mol	
volume ratio	10 cm ³	60 cm ³	40 cm ³	
	1 cm ³	6 cm ³	4 cm ³	
mole ratio	1 mol	6 mol	4 mol	

$x = 4, (x + \frac{y}{4}) = 6, y = 8$

The molecular formula of the hydrocarbon is C₄H₈

- 5 A student added 12.5cm³ of 0.0500mol dm⁻³ sodium hydroxide to 25.0cm³ of 0.100mol dm⁻³ hydrochloric acid.

What is the concentration of hydrochloric acid remaining in the reaction mixture?

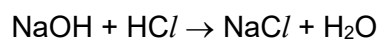
A 0.0333mol dm⁻³

B 0.0500mol dm⁻³

C 0.066mol dm⁻³

D 0.0750mol dm⁻³

Answer: **B**



Amount of NaOH = $\frac{12.5}{1000} \times 0.0500 = 6.25 \times 10^{-4} \text{ mol}$ (limiting reagent)

Amount of HCl = $\frac{25.0}{1000} \times 0.100 = 2.50 \times 10^{-3} \text{ mol}$

Number of moles of HCl remaining = $(2.50 \times 10^{-3}) - (6.25 \times 10^{-4}) = 1.875 \times 10^{-3} \text{ mol}$

Concentration of HCl remaining = $\frac{1.875 \times 10^{-3}}{\frac{37.5}{1000}} = 0.0500 \text{ mol dm}^{-3}$

6 Substance T

- is soluble in polar solvent.
- does not conduct electricity in solid but conducts electricity when molten.
- is a solid at room temperature.

What could be the structure of T?

A giant molecular

B giant ionic

C giant metallic

D simple molecular

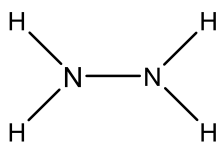
Answer: **B**

Ionic compounds are soluble in polar solvent due to the formation of ion-dipole interactions.

They are able to conduct electricity in the molten state as the ions are mobile and acts as charge carrier.

Ionic compounds generally have high melting point and hence are usually solid at room temperature.

- 7 Hydrazine, N_2H_4 , has some properties that are similar to those of ammonia, NH_3 .



Which statement explain why hydrazine molecules are more soluble in water than ammonia molecules?

- A** Hydrazine is more polar than ammonia.
- B** The covalent bonding in hydrazine is stronger than that in water.
- C** There are stronger permanent dipole interactions between hydrazine and water than between ammonia and water.
- D** There are more hydrogen bonds between hydrazine and water than between ammonia and water.

Answer: **D**

- * Bonds between hydrazine/ammonia with water: hydrogen bond (not covalent)
- * Covalent bond refers to the bonding between N-H.

No. of H-bonds form in ammonia = 1 (only one lone pair in electronegative atom N)

No. of H-bonds form in hydrazine = 2 (two lone pairs in electronegative atom N)

Therefore hydrazine able to form more hydrogen bonds with water molecules.

- 8 Which row correctly describes the change in the properties for Group 1 elements down the group?

	reducing power	ionic radius	first ionisation energy
A	increases	increases	increases
B	decreases	decreases	increases
C	increases	increases	decreases
D	increases	decreases	decreases

Answer: **C**

Reducing power

As effective nuclear charge decreases down the group, the attraction of nucleus for electrons decreases and hence ease of losing electrons increases. Thus, the reducing power increases as well.

Ionic radius

Down the group, each element has 1 more principal quantum shell and hence bigger ionic radius.

Ionisation energy

As effective nuclear charge decreases down the group, the attraction of nucleus for electrons decreases and hence ease of losing electrons increases. Thus, the energy needed to remove electrons (ionisation energy) decreases.

- 9 The proton number of the element X is less than 20.

The aqueous chloride of X is acidic and gives a white precipitate when neutralised with NaOH(aq). The precipitate dissolves on reacting either with NaOH(aq) or with H₂SO₄(aq).

In which Group of the Periodic Table is X likely to be found?

- A** 2 **B** 13 **C** 14 **D** 15

Answer: **B**

Since the aqueous chloride of X is acidic, X can be from Group 13, 14 or 15 of the Periodic Table. The white precipitate is a hydroxide of the element. Since the hydroxide is amphoteric, X is likely to be in Group 13.

- 10** Pure germanium is an important element in the electronic industry and is used in transistors. To manufacture pure germanium, the metal is separated from other metals by the formation of germanium tetrachloride, GeCl_4 , followed by fractional distillation.

GeCl_4 is a liquid at room temperature and has similar properties to SiCl_4 .

Which statement about germanium tetrachloride is correct?

- A** The bond angle in germanium tetrachloride is 120° .
- B** Germanium tetrachloride is an ionic compound.
- C** Germanium tetrachloride will conduct electricity.
- D** Germanium tetrachloride is hydrolysed by water.

Answer: **D**

- A** Incorrect.
 GeCl_4 is tetrahedral in shape and the bond angle in germanium tetrachloride is 109.5° .
- B** Incorrect.
Germanium tetrachloride is a covalent compound.
- C** Incorrect.
All valence electrons in Ge is used for bonding and there are no mobile charge carrier.
- D** Correct.
Germanium tetrachloride is hydrolysed by water to give GeO_2 and HCl .

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

The element selenium is immediately below sulfur in the Periodic Table.

Which statements are correct?

- 1** Selenium has a lower first ionisation energy than sulfur.
- 2** Se^{2-} has a larger ionic radius than S^{2-} .
- 3** Se^{2-} has a smaller ionic radius than Br^- .

A 1, 2 and 3

B 1 and 2

C 2 and 3

D 1 only

Answer: **B**

- 1** Correct.
Ionisation energy decreases down the group, thus Se has lower first ionisation energy than S.
- 2** Correct.
 Se^{2-} has larger ionic radius than S^{2-} since Se^{2-} will have one more quantum shell than S^{2-} .
- 3** Incorrect.
Both Se^{2-} and Br^- have the same number of electrons of 36. However, Br^- has higher nuclear charge than Se^{2-} . Thus, the electrons in Br^- are more strongly attracted towards the nucleus. Thus, Br^- has smaller ionic radius than Se^{2-} .

12 Each of the following equilibria is subjected to two changes which are 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 reactants?

- A** $\text{H}_2(\text{g}) + \text{I}_2(\text{g}) \rightleftharpoons 2\text{HI}(\text{g}); \quad \Delta H = +53\text{kJmol}^{-1}$
- B** $4\text{NH}_3(\text{g}) + 5\text{O}_2(\text{g}) \rightleftharpoons 4\text{NO}(\text{g}) + 6\text{H}_2\text{O}(\text{g}); \quad \Delta H = -950\text{kJmol}^{-1}$
- C** $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g}) \quad \Delta H = -92\text{kJmol}^{-1}$
- D** $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) \quad \Delta H = +180\text{kJmol}^{-1}$

Answer: **C**

For the position of the equilibrium to shift to the left when

- the pressure is reduced, the left hand-side must have greater number of moles of gaseous particles than the right hand-side.
- the temperature is increased, the forward reaction must be exothermic.

13 For a reversible reaction, what is the effect of a catalyst on the rate constant k_1 for the forward reaction, the rate constant k_{-1} for the reverse reaction, and the equilibrium constant K ?

	k_1	k_{-1}	K
A	increases	increases	no effect
B	increases	increases	increases
C	increases	decreases	no effect
D	no effect	no effect	increases

Answer: **A**

When a catalyst is added to a reaction mixture, it lowers the activation energies of both the forward and reverse rate and hence the values of the rate constants for both the forward and reverse reaction will increase.

The value of the equilibrium constant is only affected by temperature. Hence adding a catalyst has no effect on its value.

- 14 When a mixture of 1 mol of ethane-1,2-diol and 2 mol of ethanoic acid is allowed to reach equilibrium at a given temperature, the mixture is found to contain x mol of the diol.



You should assume that these are the only four species present at equilibrium.

What are the amounts of the four species at equilibrium?

	diol / mol	acid / mol	ester / mol	water / mol
A	x	$2x$	$1 - x$	$2(1 - x)$
B	x	$2 - x$	$1 - x$	$2 - x$
C	x	$2x$	x	$2x$
D	x	$2(1 - x)$	x	$2x$

Answer: **A**

	diol	acid	ester	H ₂ O
initial	1	2	0	0
change	$-(1 - x)$	$-2(1 - x)$	$+(1 - x)$	$+2(1 - x)$
equilibrium	x	$2x$	$1 - x$	$2(1 - x)$

- 15 Which row gives the correct expression for the K_b of methylamine, CH_3NH_2 , and for K_w ?

	$K_b (\text{CH}_3\text{NH}_2)$	K_w
A	$K_b = [\text{OH}^-][\text{CH}_3\text{NH}_3^+]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]/[\text{H}_2\text{O}]$
B	$K_b = [\text{H}^+][\text{CH}_3\text{NH}^-]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]/[\text{H}_2\text{O}]$
C	$K_b = [\text{OH}^-][\text{CH}_3\text{NH}_3^+]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]$
D	$K_b = [\text{H}^+][\text{CH}_3\text{NH}^-]/[\text{CH}_3\text{NH}_2]$	$K_w = [\text{H}^+][\text{OH}^-]$

Answer: **C**

Auto-ionisation of water: $\text{H}_2\text{O} \rightleftharpoons \text{H}^+ + \text{OH}^-$

Base dissociation of CH_3NH_2 : $\text{CH}_3\text{NH}_2 + \text{H}_2\text{O} \rightleftharpoons \text{CH}_3\text{NH}_3^+ + \text{OH}^-$

In both cases, $[\text{H}_2\text{O}]$ is not included as it is a constant.

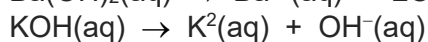
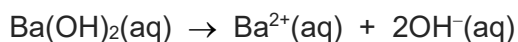
- 16** A solution was made by mixing 0.020mol of $\text{Ba}(\text{OH})_2(\text{aq})$ and 0.010mol of $\text{KOH}(\text{aq})$. Water was added until the volume of the solution was 2dm^3 .

What is the pH of the solution?

- A** 12.6 **B** 12.4 **C** 12.2 **D** 12.0

Answer: **B**

$\text{Ba}(\text{OH})_2$ is a strong diacidic base while KOH is a strong monoacidic base.



Total amount of $\text{OH}^{-}(\text{aq})$ ion after mixing = $(0.020 \times 2) + 0.010 = 0.050 \text{ mol}$

$$[\text{OH}^{-}] = 0.050 \div 2 = 0.0250 \text{ mol dm}^{-3}$$

$$\text{pOH} = -\log (0.0250) = 1.6$$

$$\text{pH} = 14.0 - 1.6 = 12.4$$

- 17** Which aqueous mixture will resist changes in pH on the addition of small amounts of an acid or a base?

- 1** ammonia + ammonium chloride
- 2** hydrochloric acid + potassium chloride
- 3** propanoic acid + sodium propanoate
- 4** sodium chloride + sodium hydroxide

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

Answer: **A**

A buffer is made up of a weak acid and its salt (an acidic buffer) or a weak base and its salt (an alkaline buffer).

- 18** When a weak acid is added to a strong base an increase in pH from pH 6.0 to pH 11 occurs at the end-point.

Which indicator would be suitable for use in a weak acid and strong base titration?

	indicator	pH range
A	phenolphthalein	8.2–10.0
B	chlorophenol red	4.8–6.7
C	methyl orange	3.1–4.4
D	alizarin yellow	10.1–13.0

Answer: **A**

The suitable indicator must have a pH range that lies within the pH increase range of the titration for the indicator to give the distinct colour change at the end-point.

- 19** The reaction between two reagents, X and Y , in aqueous solution follows the general rate equation

$$\text{rate} = k[X]^\alpha[Y]^\beta$$

In a kinetic study the following values were obtained at 298K.

$[X]_0/\text{mol dm}^{-3}$	$[Y]_0/10^{-4} \text{ mol dm}^{-3}$	initial rate/ $\text{mol dm}^{-3} \text{ s}^{-1}$
0.040	2.40	2.63×10^{-3}
0.040	4.80	1.05×10^{-2}
0.040	7.20	2.35×10^{-2}
0.080	4.80	2.09×10^{-2}
0.160	2.40	1.05×10^{-2}

$[X]_0$ represents the initial concentration of X .

What are the values of α and β respectively for the above rate equation?

- A** $\alpha = 0$ and $\beta = 2$
- B** $\alpha = 1$ and $\beta = 1$
- C** $\alpha = 1$ and $\beta = 2$
- D** $\alpha = 2$ and $\beta = 1$

Answer: **C**

Comparing Experiment 1 and 2, when the $[Y]$ increases by 2 times, the initial rate increases by 4 times. Hence the order of reaction with respect to $[Y]$ is 2 and $\beta = 2$.

Comparing Experiment 1 and 5, when the $[X]$ increases by 4 times, the initial rate increases by 4 times. Hence the order of reaction with respect to $[X]$ is 1 and $\alpha = 1$.

20 The rate equation for the reaction between P and Q is

$$\text{rate} = k[P]^2[Q]$$

If the concentration of P is halved, what must be done to the concentration of Q to make the reaction proceed at 50% of its former rate?

- A** halve $[Q]$
- B** increase $[Q]$ by a factor of two
- C** increase $[Q]$ by a factor of four
- D** keep $[Q]$ constant

Answer: **B**

When the $[P]$ is halved, the rate of the reaction is decreased by 4 times, which is $\frac{1}{4}$ of the former rate, since the order of reaction with respect to $[P]$ is 2.

Since the order of reaction with respect to $[Q]$ is 1 and to increase the rate to $\frac{1}{2}$ of the former rate from $\frac{1}{4}$ of the former rate, the $[Q]$ must increase by 2 times.

21 Use of Data Booklet is relevant to this question.

Butane is used as a fuel for cooking.

When 0.025mol of butane was burnt under a vessel containing 500g of water, it was found that the temperature of the water rose by 25°C.

Which value for the enthalpy change of combustion of butane is given by these results?

- A** -338kJmol^{-1} **B** -500kJmol^{-1} **C** -1306kJmol^{-1} **D** -2090kJmol^{-1}

Answer: **D**

Heat transferred = $500 \times 4.18 \times 25 = 52.25 \text{ kJ}$

$\Delta H_c = -(52.25 \div 0.025) = -2090 \text{ kJ mol}^{-1}$

22 In 1947 a ship full of ammonium nitrate fertiliser exploded, devastating Texas City.

Two reactions took place.

reaction 1 $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2\text{O} + 2\text{H}_2\text{O}$

followed by

reaction 2 $\text{NH}_4\text{NO}_3 \rightarrow \text{N}_2 + 2\text{H}_2\text{O} + \frac{1}{2}\text{O}_2$

compound	$\Delta H_f^\circ/\text{kJ mol}^{-1}$
NH_4NO_3	-366
N_2O	+82
H_2O	-286

Using the standard enthalpy change data in the table, which statements are correct?

- 1** Reaction 2 gives off 80kJmol^{-1} more energy than Reaction 1 under standard conditions.
- 2** The enthalpy change for Reaction 2 is -206kJmol^{-1} under standard conditions.
- 3** Reaction 1 is exothermic.

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

Answer: **C**

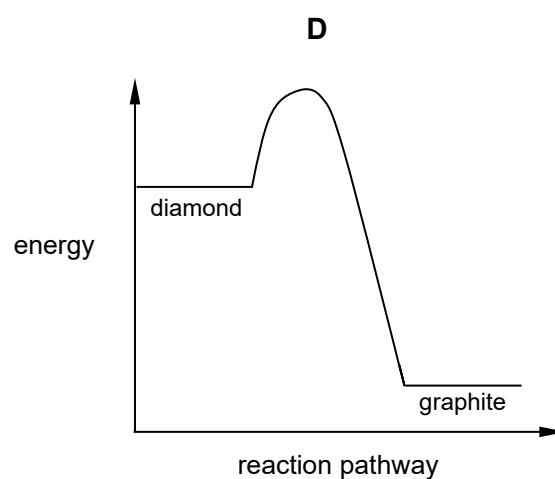
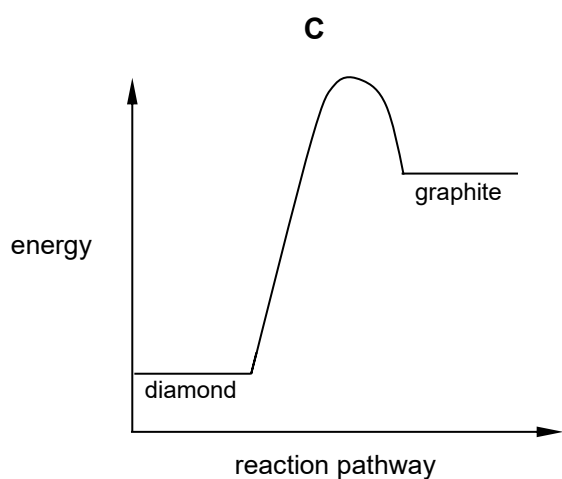
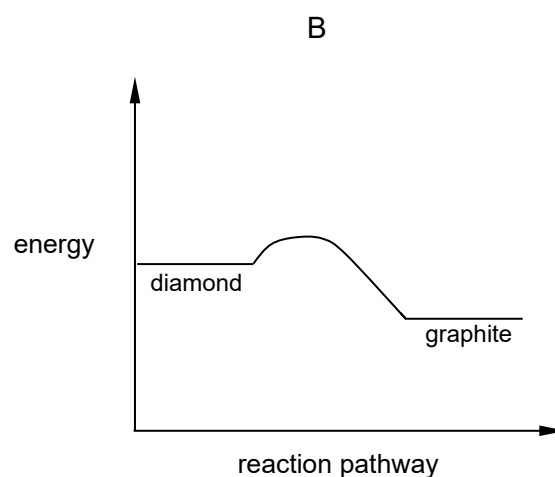
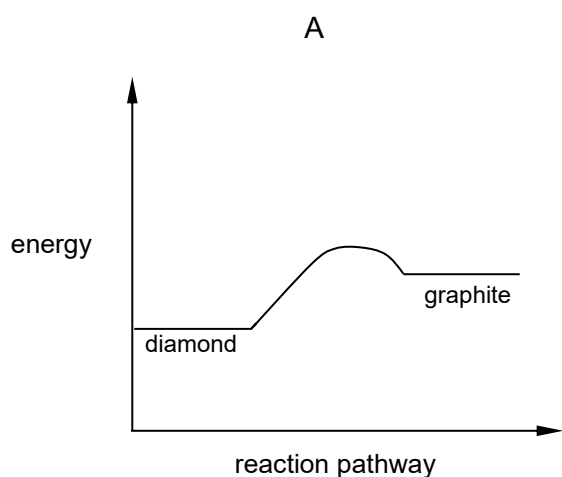
$$\Delta H^\circ (\text{reaction 1}) = (+82 + 2 \times -286) - (-366) = -124 \text{ kJ mol}^{-1}$$

$$\Delta H^\circ (\text{reaction 2}) = (2 \times -286) - (-366) = -206 \text{ kJ mol}^{-1}$$

Reaction 2 gives off 82 kJ mol^{-1} more energy than Reaction 1 under standard conditions.

- 23** The conversion of diamond into graphite is exothermic by 2 kJ mol^{-1} . Diamond does not readily change into graphite.

Which reaction pathway diagram correctly represents this conversion?



Answer: **D**

Since the conversion of diamond into graphite is an exothermic process, diamond will be at a higher energy level than graphite.

Since diamond does not readily change into graphite, it indicates that the activation energy of this conversion is very high.

24 How many constitutional (structural) isomers with the molecular formula $C_4H_8O_2$ are esters?

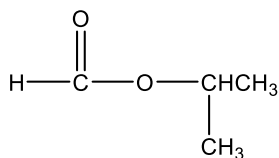
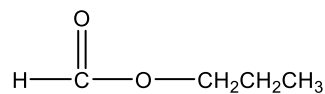
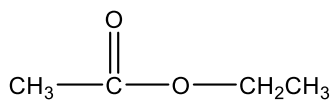
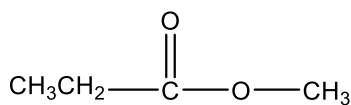
A 3

B 4

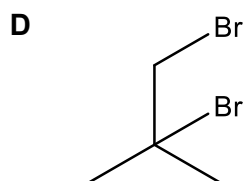
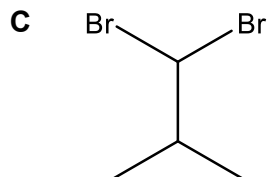
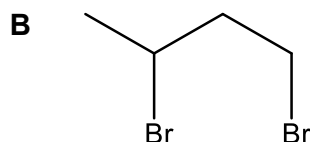
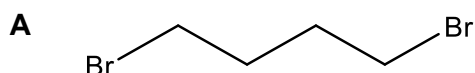
C 5

D 6

Answer: B



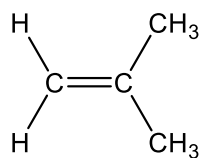
25 Which compound could be formed by reacting bromine with an alkene of formula C_4H_8 ?



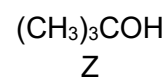
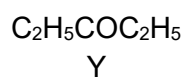
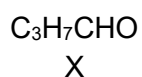
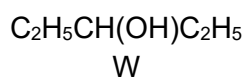
Answer: D

An alkene reacts with Br_2 via an addition reaction where the two Br atoms are added to adjacent C atoms. Hence A, B and C cannot form an alkene.

The alkene in which Compound D is formed from.



26 In which pair of compounds can one compound be oxidised and the other can be reduced?



	oxidised	reduced
A	W	X
B	X	Z
C	Y	W
D	Z	Y

Answer: **A**

W is a secondary alcohol

X is an aldehyde

Y is a ketone

Z is a tertiary alcohol

Alcohol W can be oxidised to form a ketone.

Aldehyde X can be oxidised to carboxylic acid. It can also be reduced to form primary alcohol.

Ketone Y cannot be oxidised, it can however be reduced to secondary alcohol.

Alcohol Z cannot be further reduced and cannot be oxidised since it is a tertiary alcohol.

27 Which statements about poly(propene) are correct?

- 1 On combustion, poly(propene) can produce carbon monoxide and carbon dioxide
- 2 When poly(propene) is buried in a landfill site, it will not significantly biodegrade
- 3 The empirical formula of poly(propene) is the same as its monomer

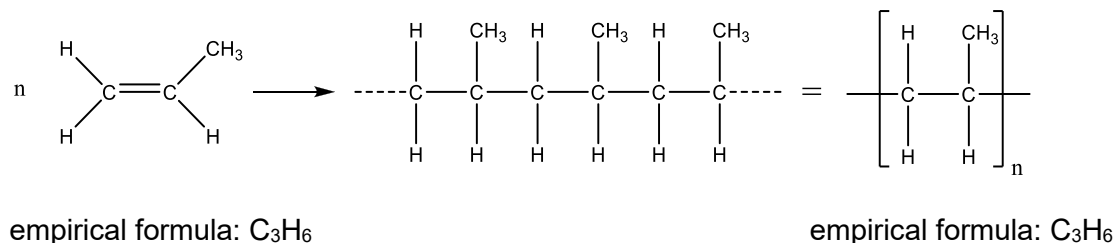
- A** 2 only
- B** 1 and 3 only
- C** 2 and 3 only
- D** 1, 2 and 3

Answer: **D**

Statement 1 is correct as incomplete combustion of hydrocarbons can give CO while complete combustion can give CO₂.

Statement 2 is correct as poly(propene) does not undergo hydrolysis to break down the polymer.

Statement 3 is correct because:



28 High density polyethylene (HDPE) is commonly used as medicine bottle, juice container and shampoo bottles while low density polyethylene (LDPE) is used in squeezable bottles, lids, toys, and plastic bags.

Which statement regarding HDPE and LDPE is correct?

- A** HDPE is more flexible than LDPE
- B** HDPE has more branching than LDPE
- C** HDPE is less dense than LDPE
- D** HDPE is harder than LDPE

Answer: **D**

HDPE has no branching, hence is more compact and thus is harder.

29 Which statement best explains that geckos are able to stick on walls?

- A** The millions of tiny setae on its feet can be attached on the rough surface of the wall.
- B** The bending of the tiny setae on the surface of the wall causes surface area of contact to increase.
- C** Its body weight on the wall causes a reactive force from the wall to itself which is sufficient to support its own body weight.
- D** The millions of tiny setae on the wall have a large surface area to volume ratio to generate extensive hydrogen bonds to support its own body weight.

Answer: **B**

The bending of the tiny setae on the surface of the wall causes surface area of contact to increase. This generates significant instantaneous dipole-induced dipole forces of attraction between its feet and the surface of the wall, causing it to stick onto the wall surface.

30 Which statements about nanoparticles are true?

- 1 They can enter the human body through ingestion only.
- 2 They have a high surface area to volume ratio.
- 3 They cannot be used as a catalyst.

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

Answer: **A**

- 1 False.
Nanoparticles are small enough to pass through pores in the skin as well.
- 2 True.
They have a high surface area to volume ratio.
- 3 False.
They can be used as a catalyst. For example, Platinum nanoparticles is used in the catalytic converter,

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