Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/13**

Paper 1 Multiple Choice **May/June 2019**

1 hour

Additional Materials: Multiple Choice Answer Sheet
Soft clean eraser
Soft pencil (type B or HB is recommended)
Data Booklet

1914560653

READ THESE INSTRUCTIONS FIRST

Write in soft pencil.
Do not use staples, paper clips, glue or correction fluid.
Write your name, centre number and candidate number on the Answer Sheet in the spaces provided unless this has been done for you.
DO **NOT** WRITE IN ANY BARCODES.

There are **forty** 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.
Electronic calculators may be used.

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

Section A

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

Use of the Data Booklet may be appropriate for some questions.

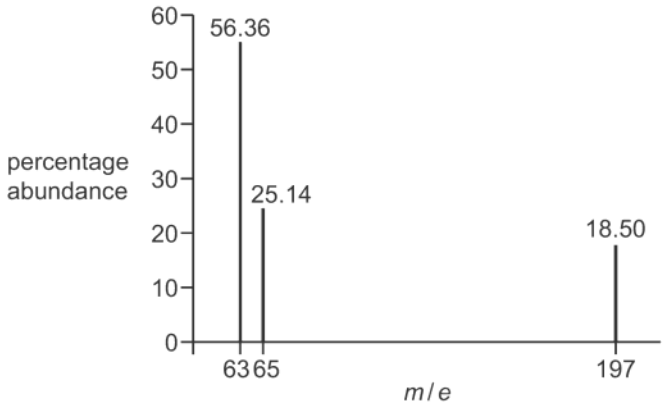
1 Manganese and nitrogen can show a range of different oxidation states.

Calculate the sum of the oxidation states of Mn and N in each row of the table.

In which row is this sum the smallest?

	manganese-containing species	nitrogen-containing species
A	$MnCl_4$	N_2
B	$MnCO_3$	NO_2^-
C	K_2MnO_4	NH_4^+
D	$Mn(OH)_3$	NH_2OH

2 The mass spectrum of an alloy of copper and gold is shown.



Cu^{63} & Cu^{65}

Which expression can be used to calculate the relative atomic mass, A_r, of copper present in this sample?

A $\dfrac{(56.36 \times 63)+(25.14 \times 65)}{(56.36+25.14+18.50)}$

B $\dfrac{(56.36 \times 63)+(25.14 \times 65)+(18.50 \times 197)}{(56.36+25.14+18.50)}$

C $\dfrac{(56.36 \times 63)+(25.14 \times 65)}{(56.36+25.14)}$

D $\dfrac{(56.36 \times 63)+(25.14 \times 65)}{(63+65)}$

3 Which atom has exactly three unpaired electrons?

A an isolated gaseous aluminium atom Al → $1s^2 2s^2 2p^6 3s^2 3p^1$ only 1 unpaired electron

B an isolated gaseous carbon atom C → $1s^2 2s^2 2p^2$ only 2 unpaired electrons

C an isolated gaseous chromium atom Cr → $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^5$ 6 unpaired electrons

D an isolated gaseous phosphorus atom P → $1s^2 2s^2 2p^6 3s^2 3p^3$

4 Element W is in period three of the Periodic Table and has a solid, white oxide, X. X is thermally stable and has a very high melting point.

X= Na_2O, MgO, Al_2O_3, SiO_2, P_4O_{10}, SO_2

X is slightly soluble in water.

Which row describes the structure and bonding of X?

	structure	bonding
A	giant three dimensional lattice ✓	covalent
B	strong double bonds within small molecules ✗	covalent
C	giant three dimensional lattice ✓	ionic ✓
D	strong ionic bonds within small molecules ✗	ionic

5 Ethane, CH_3CH_3, and fluoromethane, CH_3F, have the same number of electrons in their molecules.

Their boiling points are given.

CH_3CH_3	184.5 K
CH_3F	194.7 K

What is responsible for this difference in boiling points?

A CH_3F has a larger M_r than CH_3CH_3.

B CH_3F has a permanent dipole, CH_3CH_3 does not.

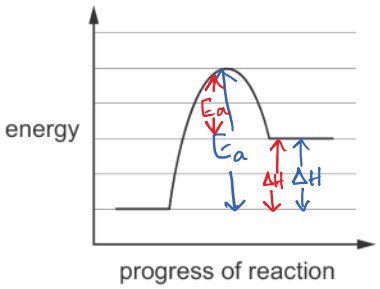
C CH_3F has a strong C–F bond, CH_3CH_3 does not.

D Hydrogen bonding occurs in CH_3F, but not in CH_3CH_3.

CH_3CH_3 has only van der waal forces while CH_3F also has permanent dipoles which are stronger intermolecular forces than temporary dipoles or van der waal forces

6 The reaction pathway diagram for a chemical reaction is shown.

forward = endothermic
backward = exothermic



red = for backward reaction
blue = for forward reaction

Which statement is correct?

A The activation energy of the forward reaction (+ve) and the enthalpy change of the backward reaction (−ve) have the same sign.

B The activation energy of the forward reaction is more than twice the enthalpy change of the backward reaction and opposite in sign. exactly twice

C The enthalpy change of the forward reaction (+ve) and the activation energy of the backward reaction (+ve) have the same sign.

D The enthalpy change of the forward reaction (+ve) is more than twice the activation energy of the backward reaction. they are equal

7 What changes in conditions or molecular properties make it more likely that gases approach ideal behaviour?

A higher pressure ← deviate from ideal behaviour

B lower temperature ←

C more polar molecules

D weaker intermolecular forces thats something ideal

8 Ethanol can be oxidised to ethanal by dilute acidified dichromate(VI) ions. distill not reflux

The oxidation reaction equation is $C_2H_5OH \rightarrow C_2H_4O + 2H^+ + 2e^-$.

The reduction reaction equation is $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$.

We should combine them & make a single equation
① There are 2e on top equation so we can multiply the whole equation by 3 to cancel e from both equations.

Which equation is correct?

A $Cr_2O_7^{2-} + 8H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + 3C_2H_4O$

B $Cr_2O_7^{2-} + 12H^+ + C_2H_5OH \rightarrow 2Cr^{3+} + 7H_2O + C_2H_4O$

C $Cr_2O_7^{2-} + 12H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 6H_2O + 3C_2H_4O$

D $Cr_2O_7^{2-} + 14H^+ + 3C_2H_5OH \rightarrow 2Cr^{3+} + 6H_2O + 3C_2H_4O$

$3C_2H_5OH \rightarrow 3C_2H_4O + 6H^+$

$Cr_2O_7^{2-} + 14H^+ \rightarrow 2Cr^{3+} + 7H_2O$

Main equation is:

$3C_2H_5OH + Cr_2O_7^{2-} + 14H^+ \rightarrow 3C_2H_4O + 6H^+ + 2Cr^{3+} + 7H_2O$

$= 3C_2H_5OH + Cr_2O_7^{2-} + 8H^+ \rightarrow 3C_2H_4O + 2Cr^{3+} + 7H_2O$

9 What is the correct expression for K_c for the reaction shown?

$$I_2(aq) + 2Fe^{2+}(aq) \rightleftharpoons 2I^-(aq) + 2Fe^{3+}(aq)$$

A $\dfrac{[2I^-][2Fe^{3+}]}{[I_2][2Fe^{2+}]}$ **B** $\dfrac{[I^-]^2[Fe^{3+}]^2}{[I_2][Fe^{2+}]^2}$ **C** $\dfrac{[I_2][2Fe^{2+}]}{[2I^-][2Fe^{3+}]}$ **D** $\dfrac{[I_2][Fe^{2+}]^2}{[I^-]^2[Fe^{3+}]^2}$

10 X and Y react together to form Z in a reversible reaction.

The equilibrium yield of Z is lower at higher temperature. forward reaction is exothermic also

The equilibrium yield of Z is lower at lower pressure. More moles on the left

Which equation could represent this reaction?

A $X(g) + Y(g) \rightleftharpoons Z(g)$ $\Delta H = -100\,kJ\,mol^{-1}$

B $X(g) + Y(g) \rightleftharpoons Z(g)$ $\Delta H = +100\,kJ\,mol^{-1}$ forward reaction isn't exothermic

C $X(s) + Y(g) \rightleftharpoons 2Z(g)$ $\Delta H = -100\,kJ\,mol^{-1}$

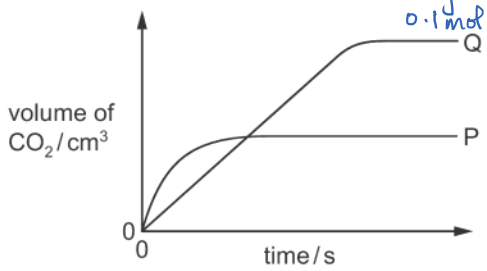
D $X(s) + Y(g) \rightleftharpoons 2Z(g)$ $\Delta H = +100\,kJ\,mol^{-1}$

} Pressure change will have no effect on Z's yield since equal no. of moles on both sides.

11 The volume of carbon dioxide collected by reacting 0.100 mol of magnesium carbonate with 50.0 cm^3 of 1.00 mol dm^{-3} sulfuric acid is measured against time. The volume produced is plotted against time and the line labelled P on the graph is obtained.

$MgCO_3 + H_2SO_4 \rightarrow MgSO_4 + H_2O + CO_2$

0.1 mol 0.05 mol 1200 cm^3



2nd reaction gives almost double the volume of CO_2 than that in 1st reaction.

The experiment is repeated using 0.100 mol of the same magnesium carbonate, and a different sample of acid. All other conditions remain the same. Plotting these results gives the line labelled Q.

Which sample of acid could give the line labelled Q?

A 100 cm^3 of 0.500 mol dm^{-3} sulfuric acid would give same volume of CO_2

B 100 cm^3 of 1.00 mol dm^{-3} sulfuric acid although it gives 2400 cm^3 of CO_2, graph shape is diff.

C 200 cm^3 of 0.500 mol dm^{-3} hydrochloric acid would give only 1200 cm^3 of CO_2

D 200 cm^3 of 1.00 mol dm^{-3} hydrochloric acid

$2HCl + MgCO_3 \rightarrow MgCl_2 + H_2O + CO_2$

12 Sodium and sulfur react together to form sodium sulfide, Na_2S.

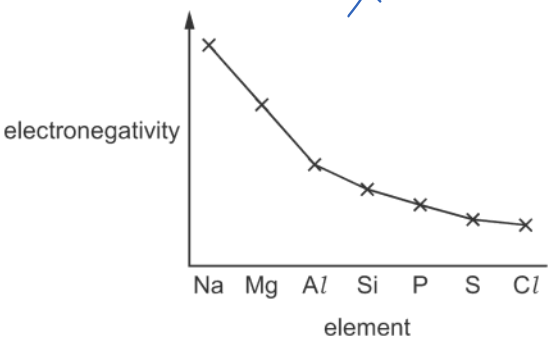
How do the atomic radius and ionic radius of sodium compare with those of sulfur?

	atomic radius	ionic radius
A	sodium < sulfur	sodium > sulfur
B	sodium < sulfur	sodium < sulfur
C	sodium > sulfur	sodium > sulfur
D	sodium > sulfur	sodium < sulfur

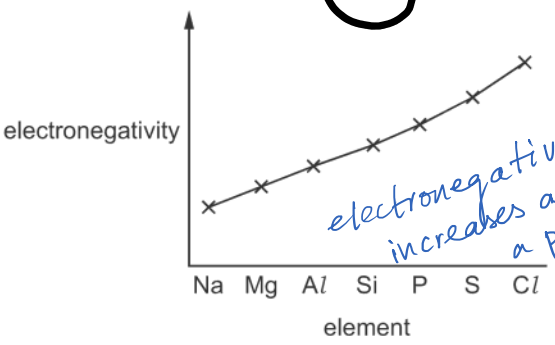
Sodium forms +ve ion i.e cation & sulphur forms anion. Sodium metal has greater atomic radius than sulphur bcz of fewer electrons but its ionic radius is smaller than that of sulphur as sulphur ion gets extra electrons which due to repulsion distance themselves.

13 Which graph represents the variation in electronegativity for Period 3 elements?

A

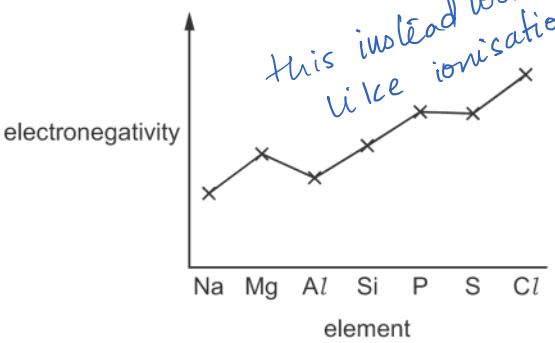


B



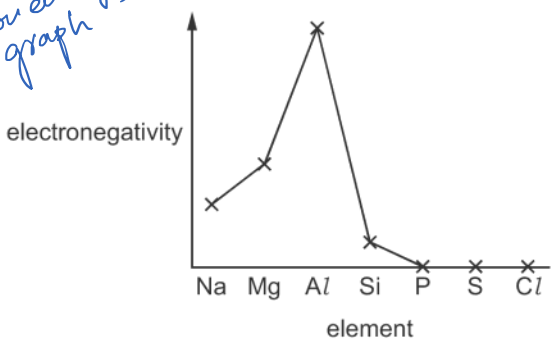
electronegativity increases along a period.

C



this instead looks like ionisation energy graph

D



$BaCO_3 + HCl \longrightarrow BaCl_2 + H_2O + CO_2$

$MgCO_3 + HCl \longrightarrow MgCl_2 + H_2O + CO_2$

14 Dilute hydrochloric acid is added to solid barium carbonate and solid magnesium carbonate in separate test-tubes.

$BaCl_2 + NaOH \longrightarrow Ba(OH)_2 + NaCl$ (soluble)

Dilute sodium hydroxide is added to 0.1 mol dm^{-3} barium chloride and 0.1 mol dm^{-3} magnesium chloride in separate test-tubes.

$MgCl_2 + NaOH \longrightarrow Mg(OH)_2 + NaCl$ (insoluble)

Which row is correct?

	$BaCO_3$(s) + HCl(aq)	$BaCl_2$(aq) + NaOH(aq)	$MgCO_3$(s) + HCl(aq)	$MgCl_2$(aq) + NaOH(aq)
A	no change ✗	white ppt ✗	no change ✗	no change ✗
B	effervescence CO_2 ✓	no change ✓	effervescence ✓	no change ✗
C	effervescence CO_2 ✓	no change ✓	effervescence ✓	white ppt ✓
D	effervescence CO_2 ✓	white ppt ✗	effervescence ✓	white ppt ✓

15 River water in an agricultural area contains NH_4^+, CO_3^{2-}, HCO_3^-, Cl^- and NO_3^- ions. In a water treatment plant, this water is treated by adding a calculated quantity of calcium hydroxide.

What is precipitated from the river water when calcium hydroxide is added?

A $CaCl_2$ **B** $CaCO_3$ **C** $Ca(NO_3)_2$ **D** NH_4OH

16 The solids sodium chloride and sodium iodide both react with concentrated sulfuric acid at room temperature.

With NaCl, the products are $NaHSO_4$ and HCl.
With NaI, the products are $NaHSO_4$, HI, I_2, SO_2, H_2O, S and H_2S.

What is the explanation for this difference in products? this all has to do with reducing/oxidising power of halides.

A Chloride ions will displace iodine from solution.

B Hydrogen chloride is more volatile than hydrogen iodide.

C Iodide ions are better reducing agents than chloride ions. and Cl^- is better oxidising agent

D Sulfuric acid is able to act as a dehydrating agent with NaI.

$CaCl_2$, $CaBr_2$ or CaI_2

17 An aqueous solution of a calcium compound is treated with a mixture of dilute aqueous nitric acid and aqueous silver nitrate. The resulting white precipitate dissolves when dilute aqueous ammonia is added.

chloride

its $CaCl_2$

What is the relative molecular mass, M_r, of the calcium compound?

A 54.0 **B** 75.6 **C** 111.1 **D** 199.9

$CaX + AgNO_3 + HNO_3$

$\downarrow$

AgX (white ppt.) which is soluble in aq(NH_3)

18 Which statement about the ammonium ion is correct?

A It can act as a Brønsted-Lowry base. that's NH_3

B It can react with OH^- to give ammonia. $(NH_4)_2SO_4 + NaOH \longrightarrow NH_3 + Na_2SO_4 + H_2O$

C It is pyramidal with bond angles of 107°. tetrahedral with bond angles of 109.5°

D The nitrogen atom is sp^2 hybridised.

19 In a catalytic converter 5.6 g of carbon monoxide reacts with an excess of nitrogen monoxide.

What is produced in this reaction?

A 2.4 g of C and 6.0 g of NO_2

B 2.4 g of C and 9.2 g of NO_2

C 8.8 g of CO_2 and 1.4 g of N_2

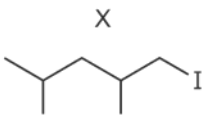
D 8.8 g of CO_2 and 2.8 g of N_2

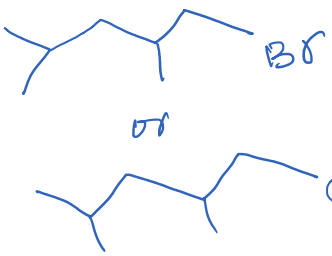
$2CO + 2NO \longrightarrow 2CO_2 + N_2$

5.6g = 0.2mol $\longrightarrow$ 8.8g & 2.8g

20 The Finkelstein reaction occurs when NaI in propanone reacts with a chloroalkane or bromoalkane. The halogen is directly replaced by I. The reaction only works for primary halogenoalkanes.

Which halogenoalkane produces compound X?





A $(CH_3)_2CHCH(CH_3)CH_2CH_2Br$

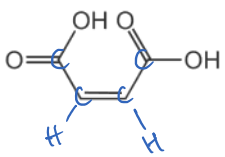
B $(CH_3)_2CHCH(CH_3)CH_2Br$

C $(CH_3)_2CHCH_2CH_2CH(CH_3)Cl$

D $(CH_3)_2CHCH_2CH(CH_3)CH_2Cl$

21 The diagram shows the skeletal formula of compound Y.

Y



$C_4H_4O_4$

What is the empirical formula of Y?

A CHO B CH_2O_2 C C_2HO_2 D $C_4H_4O_4$

22 In polymer Z every carbon atom in the polymer chain is bonded to one hydrogen atom and one methyl group.

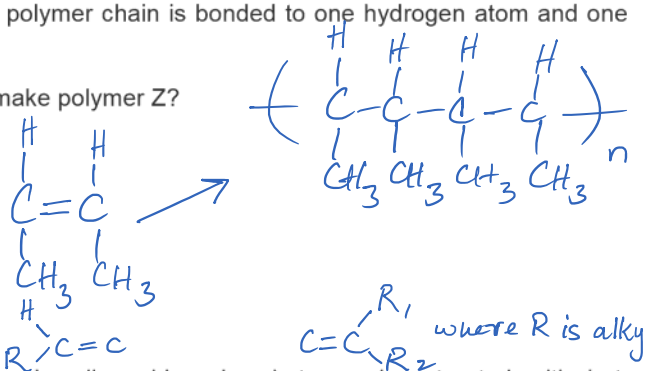
Which alkene could be polymerised to make polymer Z?

A but-1-ene

B but-2-ene

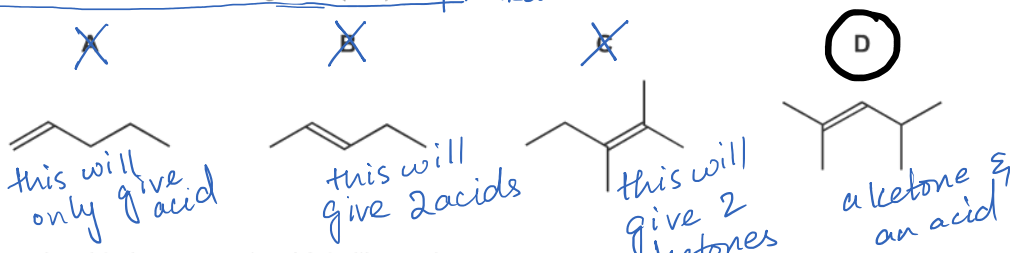
C methylpropene

D propene



23 Which compound would produce a carboxylic acid and a ketone when treated with hot, concentrated acidified manganate(VII) ions?

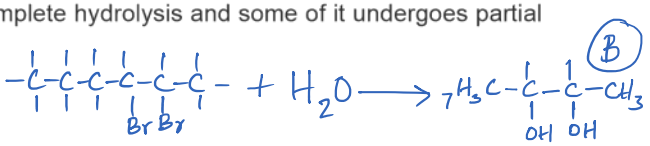
for alkenes



24 Water is added to a sample of 2,3-dibromohexane.

Some of the 2,3-dibromohexane undergoes complete hydrolysis and some of it undergoes partial hydrolysis.

What is **not** present in the mixture of products?

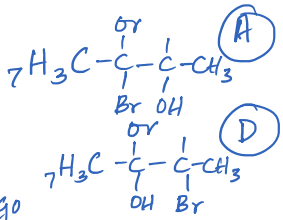


A $CH_3CH(OH)CHBrCH_2CH_2CH_3$

B $CH_3CH(OH)CH(OH)CH_2CH_2CH_3$

C $CH_3CH_2CH(OH)CH(OH)CH_2CH_3$

D $CH_3CH_2CH_2CH(OH)CHBrCH_3$



only tertiary halogenoalkanes undergo

25 Which statement about the mechanism of an S_N1 reaction of a halogenoalkane is correct?

A A nucleophile is substituted by an electrophile.

halogenoalkane is responsible for intermediate

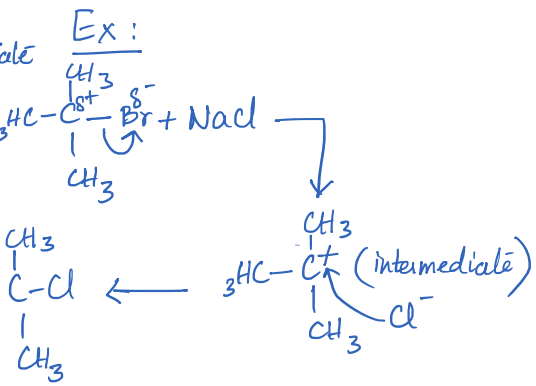
B One intermediate is formed from two reacting molecules.

C The intermediate is stabilised by adjacent alkyl groups.

D The intermediate is uncharged.

its +vely charged

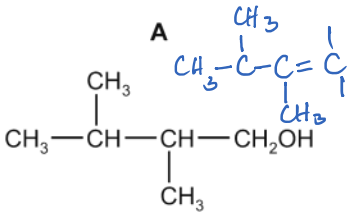
Ex :



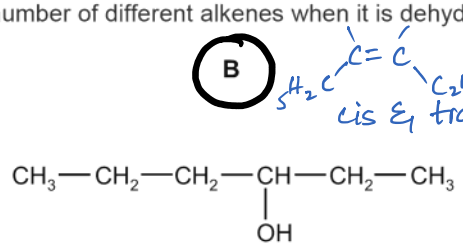
26 Structural isomerism and stereoisomerism should be considered when answering this question.

Which isomer of $C_6H_{13}OH$ gives the greatest number of different alkenes when it is dehydrated?

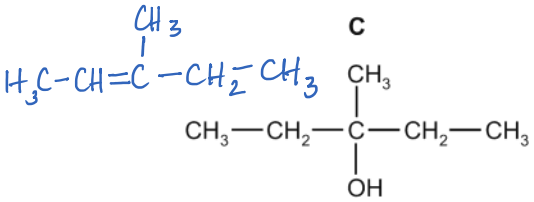
A



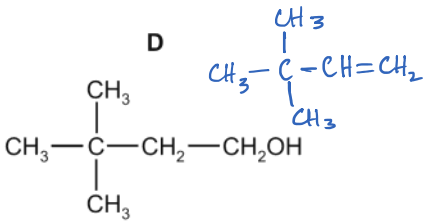
B



C



D



27 Compound Q reacts with 2,4-dinitrophenylhydrazine to give a precipitate.

Compound Q does not produce a precipitate when warmed with Fehling's solution.

What could be the identity of compound Q?

A CH_3COCH_3

B $CH_2(OH)CH_2CH_3$

C $CH_3CH_2CO_2H$

D CH_3CH_2CHO

28 Structural isomerism **only** should be considered when answering this question.

A set of isomeric compounds, with molecular formula $C_5H_{10}O$, all react in a 1:1 ratio with an excess of HCN by nucleophilic addition.

How many isomeric compounds are in the set?

A 5 **B** 6 **C** 7 **D** 8

29 Which pair of substances could react to give the ester $CH_3CH_2CO_2CH_3$?

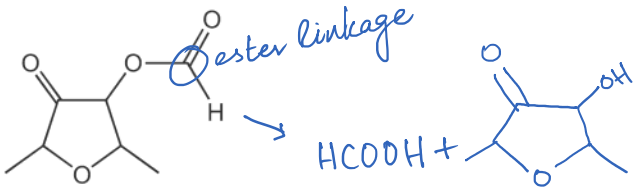
A ethanol and ethanoic acid

B methanol and ethanoic acid

C methanol and propanoic acid

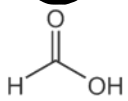
D propan-1-ol and methanoic acid

30 An ester is shown.

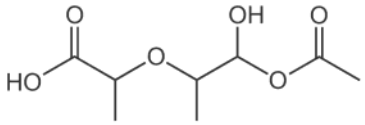


What is the structure of the carboxylic acid that would be obtained by acid hydrolysis of the ester linkage?

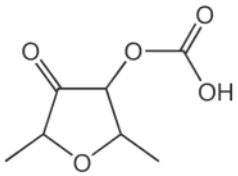
A



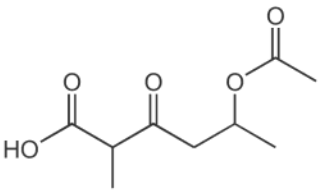
B



C



D



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.

Use of the Data Booklet may be appropriate for some questions.

31 Which deductions about the $^{209}_{83}Bi$ atom are correct? D

- ✓ **1** It has 83 electrons. → p = 83, n = 209 − 83 = 126, e = 83
- ✗ **2** It has 126 nucleons. 209 nucleons
- ✗ **3** It has 83 neutrons. 126 neutrons

32 Which statements are correct when referring to the two common isotopes of chlorine? A

- ✓ **1** The isotopes have different masses. isotopes have same atomic no. but diff. neutron no.
- ✓ **2** The isotopes have different numbers of nucleons. mass no.
- ✓ **3** The isotopes have the same chemical reactions. bcz they've same no. of electrons & thats what chemical properties depend on

33 For which enthalpy changes is the value of ΔH always negative? B

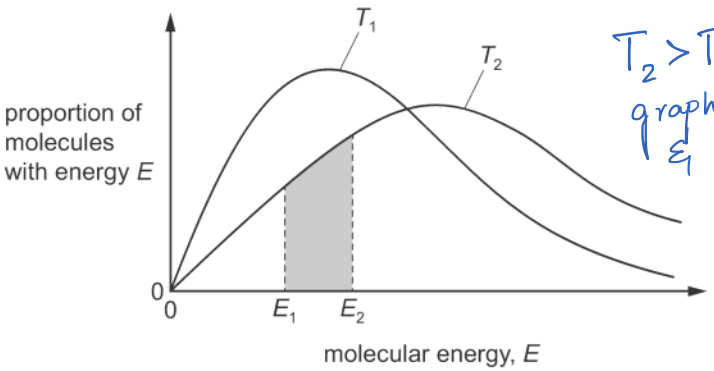
- ✓ **1** combustion energy is given out
- ✓ **2** hydration
- ✗ **3** solution

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.

34 The diagram shows the Boltzmann distribution of molecular energies in one mole of a gas at two temperatures, T_1 and T_2.



$T_2 > T_1$ thats why graph towards right & lowered.

Which statements are correct? **A**

1 The shaded area represents the proportion of molecules with energies between E_1 and E_2 at temperature T_2.

2 No particles have zero energy at either temperature. Even at lowest energy state, molecules possess some energy.

3 T_2 is a higher temperature than T_1.

35 Which statements about sodium chloride are correct? **A**

$Cl_2 + NaOH \longrightarrow NaCl + NaClO + H_2O$

$Cl_2 + NaOH \longrightarrow NaCl + NaClO_3 + H_2O$

1 It is a product of the reaction between chlorine and cold aqueous sodium hydroxide.

2 It is a product of the reaction between chlorine and hot aqueous sodium hydroxide.

3 It is a product of the reaction between chlorine and aqueous sodium bromide.

36 Which gases will dissolve in water causing a lowering of the pH? (acid forms) **C**

$Cl_2 + NaBr \longrightarrow NaCl + Br_2$

Chlorine is more reactive than bromine so it displaces Br from its solution, NaBr.

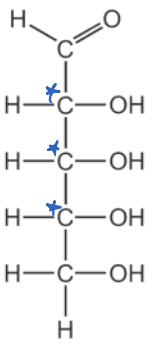
1 ~~ammonia~~

2 sulfur dioxide $SO_2 + H_2O \longrightarrow H_2SO_3$

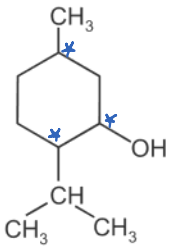
3 nitrogen dioxide $NO_2 + H_2O \longrightarrow HNO_3$

37 Which compounds have optical isomers? **B**

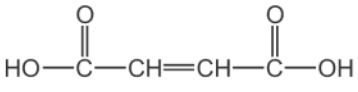
1



2



3



38 Bromine reacts with ethene in an addition reaction. **D**

Which statements about this reaction are correct?

1 It is the basis of a test for unsaturation in alkenes. if yes, brown to colourless

2 It leads to an increase in each of the H–C–H bond angles. 120° to 109.5°

3 A nucleophile attacks the C=C bond in ethene. Br_2 is electrophile

39 An unknown organic compound Z reacts with sodium to give a combustible gas as one product. Z does **not** give a yellow precipitate with alkaline aqueous iodine. not ketone or ethanal or secondary alcohol

What is a possible identity of Z? **A**

1 ethanoic acid gives $H_2(g)$

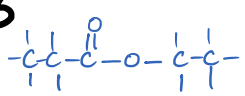
2 pentan-3-ol gives $H_2(g)$

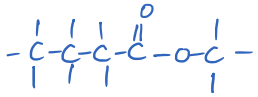
3 propan-1-ol gives $H_2(g)$

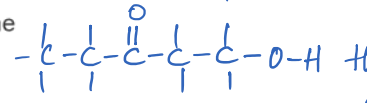
40 An organic molecule X has a molecular formula of $C_5H_{10}O_2$. Its infra-red spectrum has a strong peak at 1250 cm^{-1}, a strong peak at 1720 cm^{-1} but no strong peak above 3100 cm^{-1}.

C–O C=O no O–H

What could X be? **B**

1 ethyl propanoate 

2 methyl butanoate 

3 1-hydroxypentan-3-one  this one would have peak above 3100 cm^{-1}

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