Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

CHEMISTRY **9701/12**

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

0538565917

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.

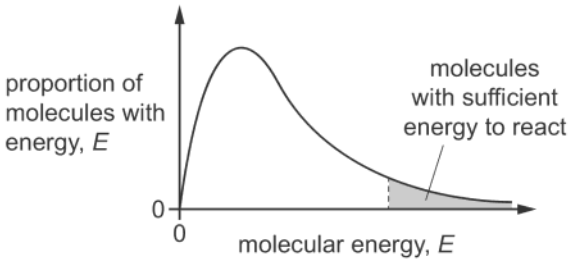
This document consists of **14** printed pages and **2** blank pages.

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.

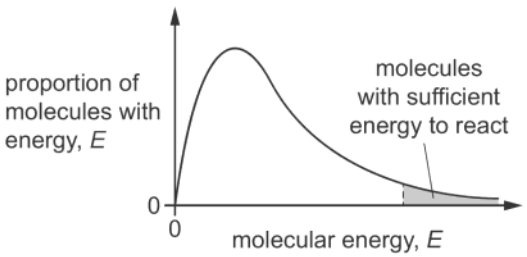
1 The Boltzmann distribution of molecular energies in a sample of aqueous hydrogen peroxide at room temperature is shown.



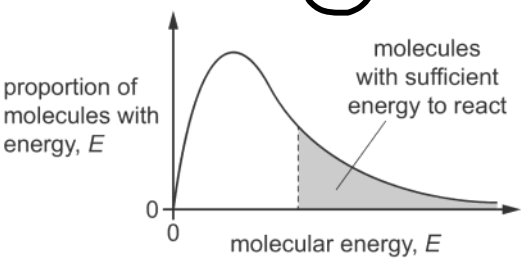
Addition of catalyst does nothing to graph but the area of shaded region just increases meaning now more molecules have energy greater than activation energy.

Which diagram shows the Boltzmann distribution of molecular energies of aqueous hydrogen peroxide maintained at room temperature when a catalyst, manganese(IV) oxide, is added?

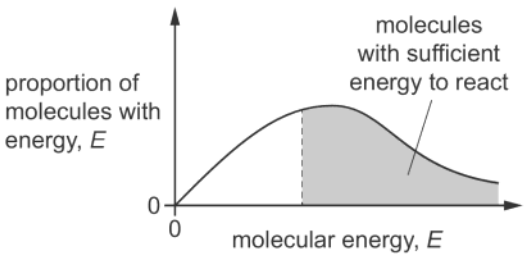
A



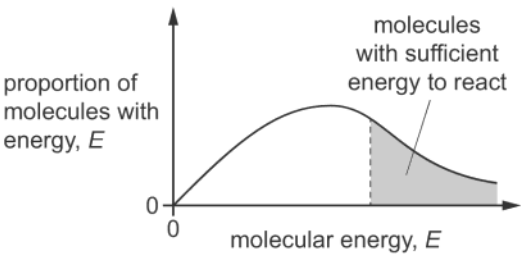
B



C



D



2 Oxygen has three stable isotopes, $^{16}_{8}O$, $^{17}_{8}O$ and $^{18}_{8}O$. All three isotopes are present in a sample of oxygen gas, O_2, which was analysed using a mass spectrometer.

How many peaks associated with the O_2^+ ion would be expected?

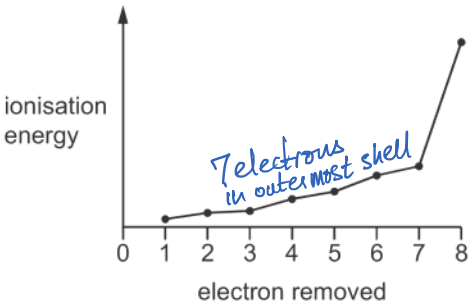
A 3 **B** 5 **C** 6 **D** 9

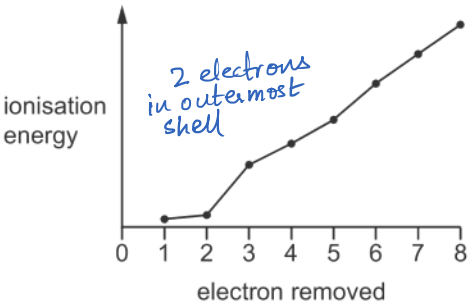
O_2^+ can be combination of:

1. ^{16}O & ^{16}O = 32
2. ^{16}O & ^{17}O = 33
3. ^{16}O & ^{18}O = 34
4. ^{17}O & ^{18}O = 35
5. ^{18}O & ^{18}O = 36

Although more combinations are possible they'll give same mass.

3 The first eight successive ionisation energies for two elements of Period 3 of the Periodic Table are shown in the graphs.



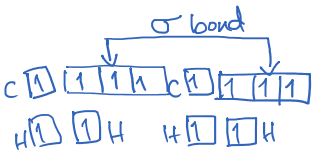


What is the formula of the ionic compound formed from these elements?

A $MgCl_2$ **B** $CaBr_2$ Period 4 **C** Na_2S **D** K_2Se

4 A σ bond is made between two carbon atoms in a molecule of ethene.

σ bond

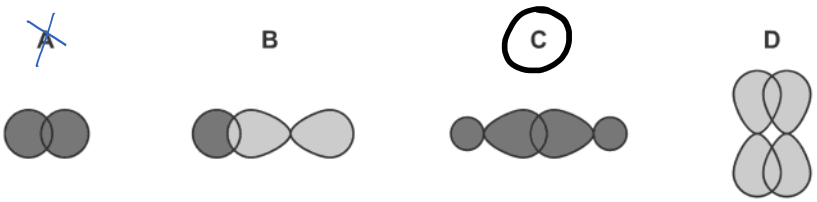


Which diagram shows the orbital overlap that occurs to form this bond?

p-p overlapping where 2 half filled p orbitals

$1s^2 2s^2 2p^2$

A **B** **C** **D**



5 The table shows some properties of four substances.

Which substance could be potassium iodide? KI ionic compound

	melting point of solid / °C	electrical conductivity when molten
A	–66	poor
B	–39	good
C	680 high mp	good
D	1600	poor

conductivity is good only in molten state

6 X, Y and Z are all gases that behave ideally and react according to the equation shown.

$$X(g) + 2Y(g) \rightarrow 2Z(g)$$

1.5mol + 0mol → 3mol

When 3.0 mol of X and 3.0 mol of Y are placed inside a container with a volume of 1.0 dm^3, they react to form the maximum amount of Z.

1000 cm^3

Here Y is limiting reagent as 3 mol of X needs 6 mol of Y however we've only got 3 mol of Y hence amount of Z is just 3 mol. After reaction finishes, 3 mol of Z and 1.5 mol of X which was in excess will be left in container

The final temperature of the reaction vessel is 120 °C.

What is the final pressure inside the reaction vessel?

A 4.49×10^6 Pa

B 9.80×10^6 Pa

C 1.47×10^7 Pa

D 1.96×10^7 Pa

$P \times \frac{1000}{(100)^3} = 4.5 \times 8.314 \times (120+273)$

$P = 1.47 \times 10^7$ Pa

7 Which pair of substances are both simple molecular?

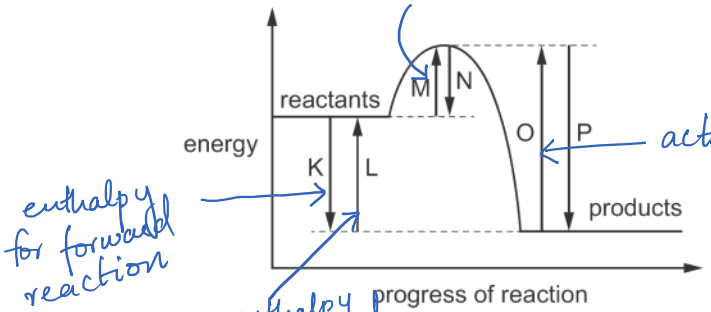
A C_{60} and graphene — form of graphite thus giant covalent structure.

B C_{60} and iodine

C graphene and graphite — giant molecular

D graphite and iodine — giant molecular

8 A reaction pathway diagram is shown.



Which row is correct?

	enthalpy change of the forward reaction	activation energy of the reverse reaction
A	K	M
B	K	O
C	L	O
D	P	M

9 X is either chlorine or an oxide of chlorine.

X reacts with water, under suitable conditions, to form the two acids HC*l* and HC*l*O_3 in the mole ratio of 1 (HC*l*) : 5 (HC*l*O_3).

$6ClO_2 + 3H_2O \rightarrow HCl + 5HClO_3$

What could be X?

A Cl_2 balancing not possible

B Cl_2O

C ClO_2

D Cl_2O_7

10 Ethyl ethanoate undergoes the following reaction.

$$CH_3CO_2C_2H_5 + H_2O \rightleftharpoons C_2H_5OH + CH_3CO_2H \qquad K_c = 0.27$$

0.42 0.42

Equal amounts of ethanoic acid and ethanol were mixed together and allowed to reach equilibrium.

Reaction was started with C_2H_5OH & CH_3CO_2H & their concentration before reaching equilibrium is supposedly x mol/dm³ & at that time, no products were formed hence ester & water had 0 mol/dm³

At equilibrium, the concentrations of both ethanoic acid and ethanol were 0.42 mol dm^{-3}.

What is the concentration of ethyl ethanoate at equilibrium?

A 0.22 mol dm^{-3}

B 0.65 mol dm^{-3}

C 0.81 mol dm^{-3}

D 1.54 mol dm^{-3}

	$CH_3CO_2C_2H_5$ + H_2O ⇌	C_2H_5OH +	CH_3CO_2H
Initially	0	0	x	x
Change	x+0.42	x+0.42	x−042	x−0.42
At Equil.	x+0.42	x+0.42	0.42	0.42

$$0.27 = \frac{0.42 \times 0.42}{(x+0.42)^2}$$

$$\sqrt{(x+0.42)^2} = \sqrt{\frac{(0.42)^2}{0.27}}$$

$x + 0.42$ = concentration of $CH_3CO_2C_2H_5$

11 Which row is an example of heterogeneous catalysis? mainly in contact, haber process

	reaction	catalyst
A	esterification	sulfuric acid X
B	the Contact process	divanadium pentoxide
C	destruction of the ozone layer	chlorine radicals X
D	atmospheric formation of sulfur trioxide	nitrogen dioxide homogeneous

12 Element Q readily oxidises in air. The oxide produced reacts with water to form a solution of very low pH. acid

Where could element Q be found in the Periodic Table?

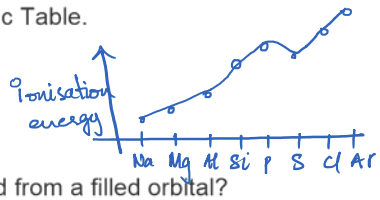
	period	group
A	2	1 X ← would form base
B	2	14 X ← their oxides are insoluble in water like SiO_2
C	3	14 X ←
D	3	15

$P + O_2 \rightarrow P_4O_{10} + H_2O \rightarrow H_3PO_4$ (phosphoric acid)

13 The eight elements sodium to argon are in the same period of the Periodic Table.

The equation corresponding to the first ionisation energy is shown.

$$X(g) \rightarrow X^+(g) + e^-$$



For which of these eight elements is the electron in this equation removed from a filled orbital?

A Mg, Al, Si, P, S, Cl and Ar

B Al, Si, P, S, Cl and Ar only

C Mg, S, Cl and Ar only $3s^2, 3p^4, 3p^5$ & $3p^6$

D S, Cl and Ar only

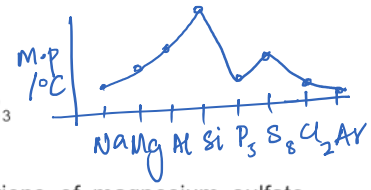
Na → $1s^2 2s^2 2p^6 3s^1$
Mg → $3s^2$
Al → $3s^2 3p^1$
Si → $3s^2 3p^2$
P → $3s^2 3p^3$
S → $3s^2 3p^4$ lower a.e than last one
Cl → $3s^2 3p^5$
Ar → $3s^2 3p^6$

Cl or Ar but Ar doesn't react so it's Cl

14 Elements D and E are both in Period 3. Element D has the smallest atomic radius in Period 3. Cl & Ar
There are only two elements in Period 3 which have a lower melting point than element E. P
Elements D and E react together to form compound L.

Which compound could be L?

A $MgCl_2$ **B** MgS **C** Na_2S **D** PCl_3



15 How many of the solutions shown, when added to separate portions of magnesium sulfate solution, produce a white precipitate?

$MgSO_4$ (soluble)

$HCl(aq)$	$NH_3(aq)$	$(NH_4)_2CO_3(aq)$	$Ba(NO_3)_2(aq)$
	$Mg(OH)_2$	$MgCO_3$	$BaSO_4$

A 0 **B** 1 **C** 2 **D** 3

16 A white solid, Z, is soluble in water. A sample of Z is heated with a Bunsen burner until there is no further change. When the residue is shaken with water a solution is formed with no solid remaining. soluble hydroxide

$Ba(NO_3)_2 \rightarrow BaO + NO_2 + O_2$

$BaO + H_2O \rightarrow Ba(OH)_2$

What could Z be?

A $MgCO_3$ **B** $Mg(NO_3)_2$ **C** $BaCO_3$ **D** $Ba(NO_3)_2$

B: $Mg(OH)_2$ is not a solution

C: although this also produces BaO but $BaCO_3$ is insoluble in water

17 An excess of chlorine was bubbled into 100 cm^3 of hot 6.0 mol dm^{-3} sodium hydroxide.

How many moles of sodium chloride would be produced in the reaction?

A 0.3 **B** 0.5 **C** 0.6 **D** 1.2

Since Cl_2 is in excess, we'll use mole ratio of NaOH & NaCl to find the answer

$3Cl_2 + 6NaOH \rightarrow 5NaCl + NaClO_3 + 3H_2O$
0.6 moles → 0.5 moles

18 Ammonium sulfate, $(NH_4)_2SO_4$, and ammonium nitrate, NH_4NO_3, are used as fertilisers.

These salts have different percentages by mass of nitrogen. They have the same effect as each other on the pH of wet neutral soil.

Which row is correct?

% of N in $(NH_4)_2SO_4$ $\longrightarrow \frac{2\times14}{132.1}\times100\% = 21.2\%$

% of N in NH_4NO_3 $\longrightarrow \frac{2\times14}{80}\times100\% = 35\%$

Taking nitrogen in the form of ammonium reduces pH of soil

	higher percentage of nitrogen by mass	effect on pH of soil
A	ammonium nitrate	decrease
B	ammonium nitrate	increase
C	ammonium sulfate	decrease
D	ammonium sulfate	increase

19 Which reaction gives a product that is an atmospheric pollutant causing acid rain?

NO/NO_2 or SO_2/SO_3

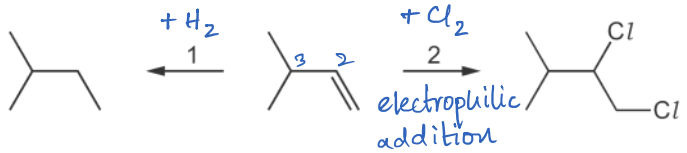
A $3Mg(s) + SO_2(g) \rightarrow MgS(s) + 2MgO(s)$

B $(NH_4)_2SO_4(s) + Ca(OH)_2(s) \rightarrow 2NH_3(g) + CaSO_4(s) + 2H_2O(l)$

C $2MnO_4^-(aq) + 5SO_2(g) + 2H_2O(l) \rightarrow 2Mn^{2+}(aq) + 4H^+(aq) + 5SO_4^{2-}(aq)$

D $2FeSO_4(s) \rightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$

20 3-methylbut-1-ene can undergo different types of reaction.



electrophilic addition

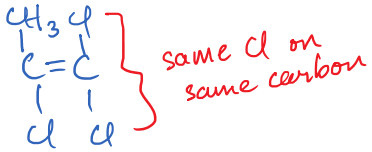
Which row correctly identifies the reaction types?

there is no nucleophile here in the Q

	reaction 1	reaction 2
A	oxidation	electrophilic addition
B	oxidation	nucleophilic addition ✗
C	reduction (gain of hydrogen)	electrophilic addition
D	reduction	nucleophilic addition ✗

21 Compound X does **not** show cis-trans isomerism.

What could be the identity of compound X?



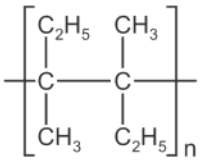
A 1,1,2-trichloropropene

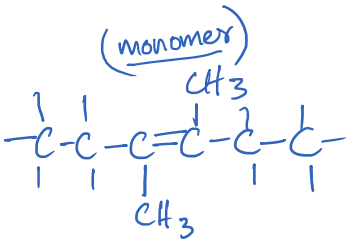
B 1,2,3-trichloropropene

C 1-chlorobut-1-ene

D 1-chlorobut-2-ene

22 The diagram shows the repeat unit of an addition polymer.





What is the correct name for the monomer that would form this polymer?

A cis-1,2-diethyl-1,2-dimethylethene

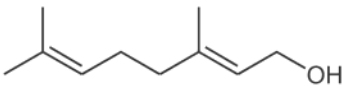
B cis-2-ethyl-3-methylpent-2-ene

C trans-2-ethyl-3-methylpent-2-ene

D trans-3,4-dimethylhex-3-ene

23 A molecule of geraniol is shown.

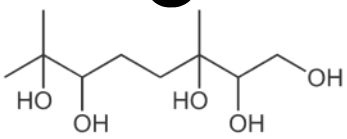
geraniol



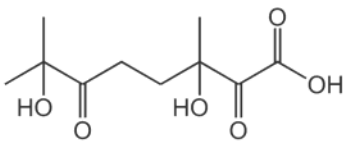
expands C=C & attaches 2 -OH groups

What is formed when geraniol is reacted with an excess of cold, dilute, acidified manganate(VII) ions?

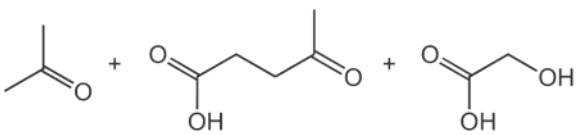
A



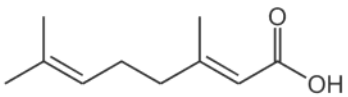
B



C



D

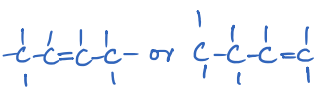


not primary alcohol

24 Alcohol W **cannot** be made by reducing a carboxylic acid with $LiAlH_4$. Alcohol W gives only one product when dehydrated with concentrated sulfuric acid.

What could be the identity of W?

~~A~~ butan-1-ol

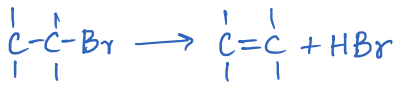
~~B~~ butan-2-ol →  or

~~C~~ propan-1-ol

D propan-2-ol

25 Which product can be made from bromoethane by an elimination reaction?

A ethanol

B ethene — 

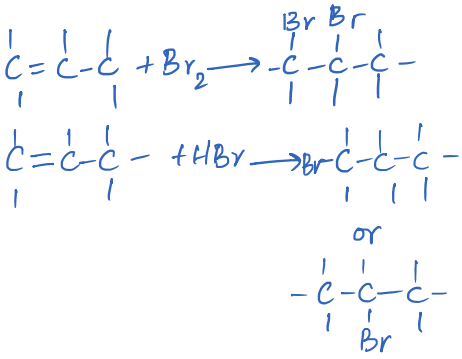
C ethylamine

D propanenitrile

26 Propene, bromine and hydrogen bromide are mixed in the dark.

A number of products are formed, some in very small quantities.

Which substance will **not** be present in the mixture of products?



A 1-bromopropane

B 2-bromopropane

C 1,1-dibromopropane

D 1,2-dibromopropane

27 Which reagent could be used to distinguish between ethanal and propanal?

aldehyde aldehyde

can test with I_2 + NaOH & the only aldehyde that will give the result with alkaline iodine.

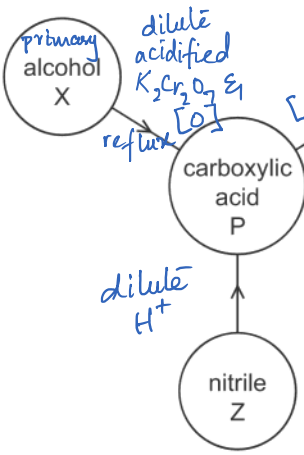
A 2,4-dinitrophenylhydrazine

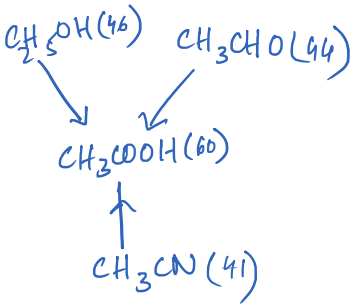
B I_2 / NaOH(aq)

C $K_2Cr_2O_7$ / H_2SO_4(aq)

D Tollens' reagent

28 The diagram shows that a carboxylic acid P may be formed from X, Y or Z.



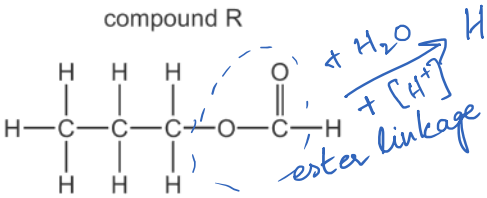


Which row is correct?

	alcohol X is	the change in M_r is greatest for
A	primary	Y to P
B	primary	Z to P ✓
C	secondary	Y to P
D	secondary	Z to P

29 One molecule of compound R is shown.

compound R



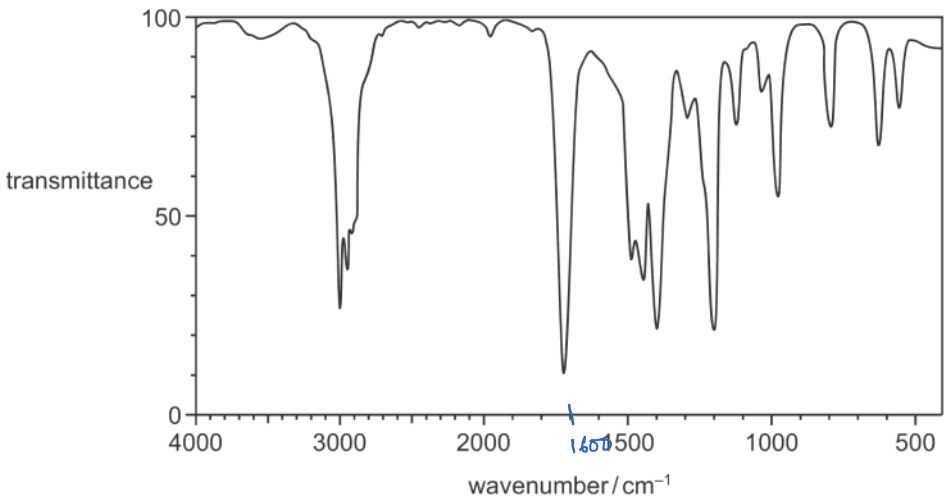
$HCOOH + C_3H_7OH$
methanoic acid
propanol
propyl methanoate (ester, R)

What is the name of compound R and how does its boiling point compare with that of butanoic acid?

	name of R	boiling point of R
~~A~~	methyl propanoate	higher than butanoic acid
~~B~~	methyl propanoate	lower than butanoic acid
C	propyl methanoate	higher than butanoic acid
D	propyl methanoate	lower than butanoic acid

butanoic acid has hydrogen bonding

30 The diagram shows the infra-red spectrum of Q.



What could be Q?

~~A~~ butan-1-ol no strong peak on 3200 – 3650 /cm

~~B~~ butanoic acid no broad peak from 2500/cm

C butanone

D 3-hydroxybutanal no strong peak on 3200–3650/cm

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 When O_2 reacts with H_2S the products are SO_2 and H_2O. $H_2S + \frac{3}{2}O_2 \longrightarrow H_2O + SO_2$

Mixture Y contains an equal number of the two molecules shown, and **no other molecules**.

$^{16}_{8}O = {}^{18}_{8}O$ $\qquad$ $^{1}_{1}H - {}^{32}_{16}S - {}^{1}_{1}H$

Which statements about Y are correct? **A**

1 The average M_r in Y is 34. $\frac{34+34}{2} = 34$

2 If some oxygen molecules are removed from Y, the average M_r of the mixture remains the same.

3 When mixture Y is ignited, some H_2S remains unreacted. $\frac{3}{2}$ moles of O_2 only require 1 mole of H_2S. Since the Q has asked to take equal moles of reactants, some H_2S will be left

32 Which statements about an atom of $^{99}_{43}Tc$ are correct? **D**

1 It has 13 fewer protons than neutrons. p=43 n=56

2 It forms $^{99}Tc^{2+}$ which has 45 electrons. has 41 electrons

3 It has 56 nucleons. 56 neutrons but 99 nucleons

33 In which reactions are nitrogen atoms reduced? (oxidation no. ↓) **A**

1 $2\overset{+4}{N}O_2 \rightarrow \overset{0}{N_2} + 2O_2$

2 $4\overset{+4}{N}O_2 \rightarrow 2\overset{+1}{N_2}O + 3O_2$

3 $4\overset{+4}{N}O_2 + 6H_2O \rightarrow 4\overset{-3}{N}H_3 + 7O_2$

34 The manufacture of ammonia from nitrogen and hydrogen is an important industrial process.

Which of the following would leave the equilibrium constant, K_p, for the formation of ammonia unchanged? **A**

K_p changes when temp. alters

$N_2 + 3H_2 \rightleftharpoons 2NH_3$

$K_p = \frac{[NH_3]_p^2}{[N_2]_p[H_2]_p^3}$

1 ✓ addition of an iron catalyst — nothing to do with change in pressure.

2 ✓ addition of ammonia

3 ✓ an increase in pressure

35 Which reactions involving calcium and its compounds produce two gaseous products? **D**

NO_2 & O_2

1 ✓ heating solid anhydrous calcium nitrate

2 ✗ heating solid anhydrous calcium carbonate — only $CO_2(g)$

3 ✗ adding calcium metal to water — only $H_2(g)$

36 A small quantity of hot, concentrated sulfuric acid is added separately to solid samples of potassium halides, KX.

Which potassium halides react and produce a mixture of products that include a halogen, X_2? **B**

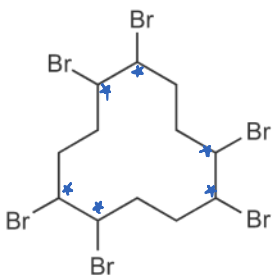
only Br^- & I^-

1 ✓ potassium iodide

2 ✓ potassium bromide

3 ✗ potassium chloride — $KCl + H_2SO_4 \longrightarrow K_2SO_4 + HCl$

37 The diagram shows a compound used as a flame retardant.



$C_{12}H_{18}Br_6$

Which statements about this structure are correct? **A**

1 ✓ The empirical formula is C_2H_3Br.

2 ✓ The C_{12} ring is not planar.

3 ✓ There are six chiral carbon atoms.

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.

38 Halogenoalkanes can be hydrolysed using aqueous sodium hydroxide.

Which compounds tend to be hydrolysed by an S_N1 mechanism? **B**

only tertiary halogenoalkane

1 $CH_3CH_2CCl(CH_3)CH_2CH_3$

2 $CH_3CH_2CBr(CH_3)CH_2CH_3$

3 $CH_3CH_2CH(CH_3)CH_2CH_2Br$

$\frac{\text{actual yield}}{\text{predicted yield}} \times 100\%$

39 In an organic synthesis, a 62% yield of product is achieved.

Which conversions are consistent with this information? **A**

1 74.00 g of butan-2-ol → 44.64 g of butanone

$C_4H_9OH + [O] \longrightarrow C_4H_8O + H_2O$

74g should give 72 g of butanone

2 74.00 g of butan-1-ol → 54.56 g of butanoic acid

$C_4H_9OH + 2[O] \longrightarrow C_3H_7COOH + H_2O$

74g should give 88g of butanoic acid

3 74.00 g of 2-methylpropan-1-ol → 54.56 g of 2-methylpropanoic acid

$C_4H_9OH + 2[O] \longrightarrow C_3H_7COOH + H_2O$

74g should give 88g of 2 methyl propanoic acid

40 An oxidising agent that can oxidise ethanal to ethanoic acid or ethanoate ions will also oxidise methanoic acid, HCO_2H, to carbon dioxide and water.

Which reagents, on heating, will react differently with HCO_2H and CH_3CO_2H? **C**

ethanoate ion CH_3COO^-

1 $Na_2CO_3(aq)$ metal carbonate + any acid → salt + H_2O + CO_2

2 Fehling's reagent

3 dilute acidified $KMnO_4$

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