AS Level Chemistry A
H032/01 Breadth in chemistry
Practice Question Paper

Date – Morning/Afternoon
Time allowed: 1 hour 30 minutes

You must have:
• the Data Sheet for Chemistry A

You may use:
• a scientific calculator

First name	
Last name	

Centre number					Candidate number				

INSTRUCTIONS
• Use black ink. You may use an HB pencil for graphs and diagrams.
• Complete the boxes above with your name, centre number and candidate number.
• Answer **all** the questions.
• Write your answer to each question in the space provided.
• Additional paper may be used if required but you must clearly show your candidate number, centre number and question number(s).
• Do **not** write in the bar codes.

INFORMATION
• The total mark for this paper is **70**.
• The marks for each question are shown in brackets **[ ]**.
• This document consists of **24** pages.

SECTION A

You should spend a maximum of 25 minutes on this section.

You should put the letter of the correct answer in the box provided.

Answer **all** the questions.

1   Information about two isotopes of an element is given in the table.

Isotope	Mass number	% Abundance
A	144	24
B	145	9

Which statement is correct?

A   The relative atomic mass of the element is 47.61.

B   Isotope **B** has more protons than isotope **A**.

C   Isotope **B** has fewer neutrons than isotope **A**.

D   The relative isotopic mass of isotope **B** is 145.

Your answer ☐

[1]

2   What is the oxidation number of vanadium in the ion $V_2O_7^{4-}$?

A   +5

B   +7

C   +10

D   +14

Your answer ☐

[1]

3 What is the electron configuration for an Mg^{2+} ion?

A $1s^22s^2$

B $1s^22s^22p^6$

C $1s^22s^22p^63s^2$

D $1s^22s^22p^63s^23p^63d^4$

Your answer ☐

[1]

4 Predict the shape and bond angle in a molecule that has 2 bonding pairs and 2 lone pairs around a central atom.

A linear, 180°

B non-linear, 104.5°

C tetrahedral, 109.5°

D trigonal planar, 120°

Your answer ☐

[1]

5 Which molecule is polar?

A CH_4

B C_2H_4

C CH_3Cl

D CCl_4

Your answer ☐

[1]

6   Which particles are attracted in metallic bonding?

    A   anions and delocalised electrons

    B   cations and delocalised electrons

    C   oppositely charged ions

    D   protons and electrons

Your answer [ ]

[1]

7   Which halogen most readily forms 1– ions?

    A   bromine

    B   chlorine

    C   fluorine

    D   iodine

Your answer [ ]

[1]

8   Which statement is **not** correct for Group 2 metals?

    A   An unpaired electron is present in an s-orbital.

    B   Chemical reactivity increases with increasing atomic number.

    C   The first ionisation energy decreases with increasing atomic number.

    D   Atomic radius increases with increasing atomic number.

Your answer [ ]

[1]

9 HBr(aq), forms two ions in solution.

Which observation is correct for reactions of HBr(aq)?

A It effervesces addition of sodium carbonate solution.

B It forms a white precipitate on addition of silver nitrate solution.

C It turns orange on addition of silver nitrate solution.

D It turns brown on addition of potassium chloride solution.

Your answer

[1]

10 Three qualitative tests are carried out on a solution of an unknown compound.

Test 1: On heating with NaOH(aq), a pungent smelling gas evolves which turns red litmus paper blue.

Test 2: On addition of $AgNO_3$(aq), a white precipitate forms which is soluble in dilute NH_3(aq).

Test 3: On addition of Na_2CO_3(aq), there is no visible reaction.
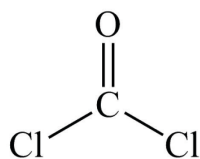
What is the unknown compound?

A ammonium bromide, NH_4Br

B ammonium chloride, NH_4Cl

C hydrochloric acid, HCl

D sodium chloride, $NaCl$

Your answer

[1]

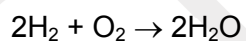**11** The diagram shows the bonds present in a molecule of $COCl_2$.

$$\begin{array}{c} O \\ \| \\ Cl \diagdown C \diagup Cl \end{array}$$

What is the shape of a molecule of $COCl_2$?

A non-linear

B pyramidal

C tetrahedral

D trigonal planar

Your answer ☐

[1]

12 Equations for two reactions that form H_2O are shown below.

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

$$2H_2 + O_2 \rightarrow 2H_2O$$

Which statement is correct?

A Hydrogen is reduced in both reactions.

B Hydrogen is reduced in only one of the reactions.

C Oxygen is oxidised in both reactions.

D Oxygen is oxidised in only one of the reactions.

Your answer ☐

[1]

13 0.010 mol of barium is added to 500 cm^3 of water. The equation is shown below:

$$Ba(s) + 2H_2O(l) \rightarrow Ba(OH)_2(aq) + H_2(g)$$

The volume of water does not change during the reaction.

Which statement is correct?

A The number of hydroxide ions formed is $0.010 \times 6.02 \times 10^{23}$.

B The volume of hydrogen gas produced is 0.24 cm^3, measured at room temperature and pressure.

C The concentration of $Ba(OH)_2(aq)$ formed is 0.020 mol dm^{-3}.

**D** 0.0050 mol of water reacts.

Your answer ☐

[1]

14 Which statement is **not** correct for a system in dynamic equilibrium?

A The concentrations of products and reactants are the same.

B The equilibrium can be achieved from both sides.

C The rate of the forward reaction is equal to the rate of the reverse reaction.

D The system is closed.

Your answer ☐

[1]

15 What is the systematic name for the molecule shown below?
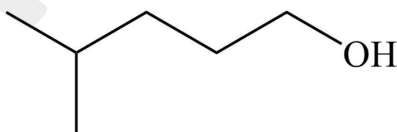
A hexan-1-ol

B 2-methylpentan-5-ol

C 4-methylpentan-1-ol

D 4-methylpentanol

Your answer ☐

[1]

16   Which molecule has the highest boiling point?

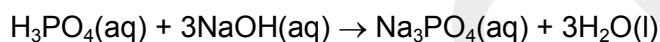   **A**   2,3-dimethylbutane

    B   2-methylheptane

    C   2,3,4-trimethylpentane

    D   3-ethylpentane

Your answer [   ]

<div align="right">

[1]

</div>

17   The equation for the reaction of aqueous phosphoric(V) acid, H_3PO_4, with aqueous sodium hydroxide, NaOH(aq) is shown below.

$$H_3PO_4(aq) + 3NaOH(aq) \rightarrow Na_3PO_4(aq) + 3H_2O(l)$$

25.0 cm^3 of a 0.200 mol dm^{-3} H_3PO_4(aq) is titrated with 0.600 mol dm^{-3} NaOH(aq).

Which statement is correct?

    A   The end point occurs when 25.00 cm^3 of NaOH(aq) has been added.

    B   The end point occurs when 75.00 cm^3 of NaOH(aq) has been added.

    C   After titration the final solution contains 0.0150 mol of Na_3PO_4.

    D   After titration the final solution contains 0.0150 mol of H_2O.

Your answer [   ]

<div align="right">

[1]

</div>

18   A chemist determines some properties of two substances, **C** and **D**.

The results are shown in the table.

	C	**D**
Melting point / °C	660	801
Electrical conductivity when solid	Yes	No
Electrical conductivity when molten	Yes	Yes
Solubility in water	No	Yes

Which row correctly identifies the bonding and structure in **C** and **D**?

	C	**D**
A	giant ionic	giant metallic
B	giant ionic	giant ionic
C	giant metallic	giant metallic
D	giant metallic	giant ionic

Your answer

[1]

19   A chemist collects 1.00×10^{-6} m^3 of a gaseous compound at 295 K and 1.01×10^5 Pa.

What is the correct expression for the amount, in mol, of the gaseous compound?

A $$\dfrac{8.314 \times 295}{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}$$

B $$\dfrac{(1.00 \times 10^{-6}) \times 295}{8.314 \times (1.01 \times 10^5)}$$

C $$\dfrac{8.314 \times (1.00 \times 10^{-6})}{(1.01 \times 10^5) \times 295}$$

D $$\dfrac{(1.01 \times 10^5) \times (1.00 \times 10^{-6})}{8.314 \times 295}$$

Your answer

[1]

20 Which statement explains why the rate of a reaction increases when the temperature is increased?

    A The activation energy for the reaction decreases.

    B The activation energy for the reaction increases.

    C The proportion of molecules exceeding the activation energy decreases.

    D The proportion of molecules exceeding the activation energy increases.

Your answer [ ]

[1]

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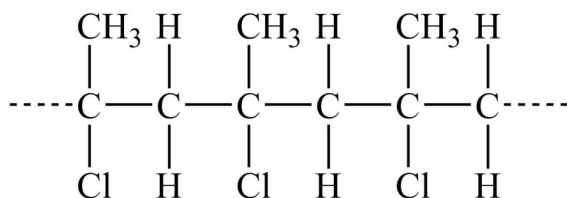**PLEASE DO NOT WRITE ON THIS PAGE**

Turn over for the next question

SECTION B

Answer **all** the questions.

21 This question looks at organic halogen compounds.

(a) A section of a halogenated polymer is shown.

$$\begin{array}{cccccc}
CH_3 & H & CH_3 & H & CH_3 & H \\
| & | & | & | & | & | \\
\text{-----C---C---C---C---C---C-----} \\
| & | & | & | & | & | \\
Cl & H & Cl & H & Cl & H
\end{array}$$

(i) Draw the structure of the monomer that could be used to make this polymer.

[1]

(ii) Combustion of this polymer produces HC*l*, which is a toxic gas.

Describe how HC*l* is removed from the waste gases produced.

.... **[1]**

(iii) Polymers made from natural foods such as corn starch are replacing halogenated polymers.

An advantage of this is that these polymers do not produce toxic gases on combustion.

State **one** other advantage of using polymers made from natural foods.

.... **[1]**

(b) Haloalkanes can undergo hydrolysis.

A student carries out an experiment to find the relative rate of hydrolysis of 1-chloropropane, C_3H_7Cl, 1-bromopropane, C_3H_7Br, and 1-iodopropane, C_3H_7I.

The student adds 2 cm^3 of ethanol to 2 cm^3 of aqueous silver nitrate to three test tubes labelled **A**, **B** and **C**.

The student adds 5 drops of a different haloalkane to each test tube in rapid succession and shakes each tube. The student measures the time for a precipitate to form in each test tube.

The results are shown below.

Test tube	Haloalkane	Time taken for reaction to take place
A	C_3H_7Cl	about half an hour
B	C_3H_7Br	a few minutes
C	C_3H_7I	a few seconds

(i) Write an **ionic** equation involving aqueous silver nitrate for formation of **one** of the precipitates.
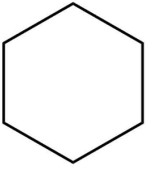
.... **[1]**
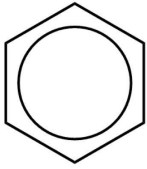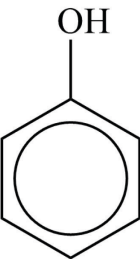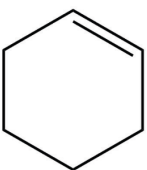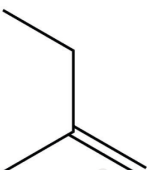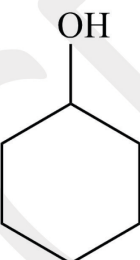
(ii) What do the experimental results tell you about the carbon–halogen bond enthalpies?

....

.... **[1]**

(iii) How could the student modify their experiment so that it could be completed in less time?

.... **[1]**

22 The organic compounds in the table below can be termed, aliphatic, alicyclic or aromatic.

E	F	G
		OH
H	**I**	**J**
		OH

(a) Identify, using letters **E**, **F**, **G**, **H**, **I**, **J**, the compound(s) which are the following types.

Each response may contain more than one letter.

aliphatic ……………………………………..

alicyclic ……………………………………..

aromatic ……………………………………..

[3]

(b) Compound **I** has one alkyl group.

What is the general formula of alkyl groups?

………………………………………………………………………………………………… **[1]**

(c) Compound **H** can be prepared in an elimination reaction by heating compound **J** with an acid catalyst.

A student carries out this preparation using 7.65 g of compound **J**.

The student obtains 2.05 g of compound **H**.

(i) Write an equation for this reaction, using molecular formulae.

Calculate the percentage yield of compound **H**.

Give your answer to **one** decimal place.

percentage yield = ………………………… % **[4]**

(ii) Describe a simple test that the student could carry out to confirm the presence of the functional group in compound **H**.

Draw the structure of the organic product from the test.

test: ……………………………………………………………………………………………………..

………………………………………………………………………………………………………

organic product =

[2]

23 Europium, atomic number 63, has two isotopes, ^{151}Eu and ^{153}Eu.

(a) Complete the table to show the number of protons, neutrons and electrons in the ^{153}Eu^{3+} ion of europium.

	protons	neutrons	electrons
^{153}Eu^{3+}			

[1]

(b) Atoms of europium have electrons in orbitals within the first five shells. The first three shells of europium are full.

Complete the table to show the number of electrons in the following regions of a europium atom.

	number of electrons
the 1s sub-shell	
a 3p orbital	
the 3rd shell	

[3]

(c) Calculate the number of europium atoms in 0.0019 g of europium.

Give your answer **in standard form** to an **appropriate** number of significant figures.

= …………..…………… atoms   **[2]**

(d) Europium reacts with dilute sulfuric acid, forming a solution of europium sulfate and hydrogen gas.

A chemist reacts 0.608 g of europium with an excess of $H_2SO_4(aq)$ and collects 144 cm^3 of hydrogen gas at room temperature and pressure.
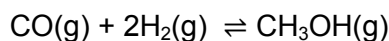
Analyse the chemist's results to write the overall equation for the reaction between europium and sulfuric acid.

Show **all** your working.

equation: .... **[3]**

24 This question looks at two equilibrium reactions used by industry for preparing important chemicals.

(a) Methanol can be manufactured by reacting carbon monoxide with hydrogen.

$$CO(g) + 2H_2(g) \rightleftharpoons CH_3OH(g)$$

An equilibrium mixture contains 3.10×10^{-3} mol dm^{-3} CO, 2.40×10^{-3} mol dm^{-3} H$_2$ and an unknown concentration of CH$_3$OH.

(i) Write an expression for the equilibrium constant, K_c.

[1]

(ii) The value of K_c for this equilibrium is 14.6 dm^6 mol^{-2}.

Determine the equilibrium concentration methanol, CH$_3$OH(g).

Give your answer to **three** significant figures.

equilibrium concentration of CH$_3$OH(g) = ... dm^6 mol^{-2} **[2]**

(b) Ammonia is used in the manufacture of nitric acid. The first stage of this process is a dynamic equilibrium.

$$4NH_3(g) + 5O_2(g) \rightleftharpoons 4NO(g) + 6H_2O(g)$$
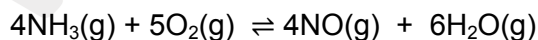
(i) When the temperature is increased, K_c for this reaction decreases.

State the effect, if any, on the equilibrium yield of NO in this reaction.

Explain your answer.

....

....   **[1]**

(ii) Which element has been oxidised and which element has been reduced in the reaction?

Include signs with the oxidation numbers.

Oxidised ……………… Oxidation number change from ……… to ………

Reduced ……………… Oxidation number change from ……… to ………   **[2]**

25 This question looks at neutralisation reactions.

(a) A student carries out an experiment to determine the enthalpy change for a neutralisation reaction.

The student measures out 35.0 cm^3 of 2.40 mol dm^{-3} KOH and 35.0 cm^3 of 1.20 mol dm^{-3} H_2SO_4. The temperature of each solution is 19.5 ºC.

The student mixes the solutions. The KOH is all neutralised and the maximum temperature reached is 36.0 °C.

(i) Write the overall equation for the reaction that takes place.

[1]

(ii) Calculate the enthalpy change for the neutralisation of 1 mol KOH by H_2SO_4.

Assume that the density of the mixture is 1.00 g cm^{-3} and that the specific heat capacity for the solution is the same as for water.

ΔH = ... kJ   **[3]**

(iii) Explain, why the answer to **(ii)** is the enthalpy change of neutralisation.

....

....   **[1]**

(iv) In this experiment, the student uses a thermometer with an uncertainty of ±0.5 °C in each reading.

Calculate the percentage uncertainty in the temperature rise.

percentage uncertainty = ... %   **[1]**

(b) In an experiment, a scientist prepared a 0.500 g sample of a salt made by neutralisation.

Analysis of the sample gave the following data.

Element	Mass present / g
hydrogen	0.025
oxygen	0.300
nitrogen	0.175

(i) Calculate the empirical formula of the salt.

empirical formula = ………………………… **[2]**

(ii) Suggest the formula of the acid and base that the scientist used to prepare this salt.

acid: ……………………………………………………………………………………

base:……………………………………………………………………………………

[1]

26 This question looks at alkanes

(a) Ethane reacts with chlorine by radical substitution.

Describe fully, with equations, the mechanism for this reaction.
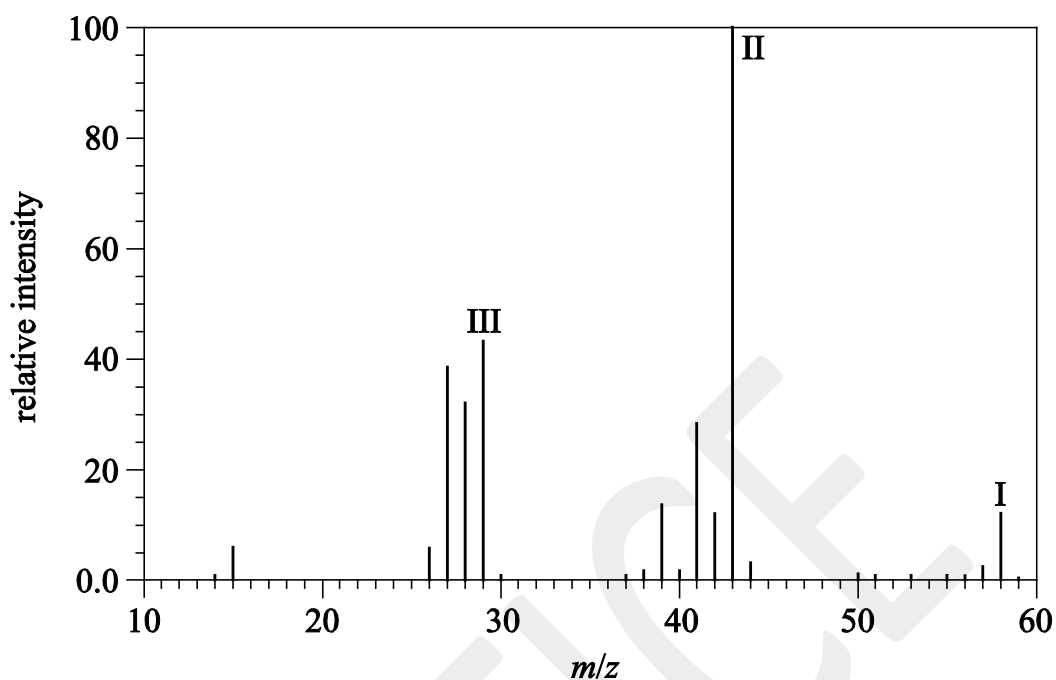
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.... **[5]**

(b) Two students were provided with the mass spectrum of an alkane, shown below.

One student analysed peaks **I** and **II** and concluded that the alkane was one of two structures.

The other student analysed peaks **I**, **II** and **III** and was able to identify the alkane.

Analyse the peaks and explain why the two students obtained different conclusions.

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.... **[5]**

END OF QUESTION PAPER