

AS Level Chemistry B (Salters)
H033/01 Foundations of chemistry
Practice Question Paper

Date – Morning/Afternoon

Time allowed: 1 hour 30 minutes

You must have:

- the Data Sheet for Chemistry B (Salters)

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** A student prepares zinc sulfate crystals by reacting excess granulated zinc with dilute sulfuric acid.

What would be the best way to remove all unreacted zinc?

- A** adding more dilute sulfuric acid
- B** crystallisation
- C** filtration
- D** warming the mixture

Your answer

[1]

- 2** A set of instructions for preparing copper sulfate includes this statement:

‘Continue to add small quantities of the solid to the dilute sulfuric acid until no further bubbling occurs and a small amount of solid remains.’

What is the solid most likely to be?

- A** copper(II) carbonate
- B** copper metal
- C** copper(II) nitrate
- D** copper(II) oxide

Your answer

[1]

- 3** The process of cracking is important in the petrochemical industry.

Which statement about cracking is correct?

- A** Branched alkanes do not undergo cracking.
- B** Cracking always produces an alkene.
- C** Cracking never produces branched alkanes.
- D** The only products of cracking are shorter alkanes.

Your answer

☐

[1]

- 4** Which pollutant would be emitted in the exhaust gases from a car using hydrogen gas as a fuel?

- A** C
- B** CO
- C** H₂S
- D** NO_x

Your answer

☐

[1]

- 5** Which compound has one σ -bond and one π -bond between adjacent carbon atoms?

- A** cyclohexane
- B** cyclohexene
- C** ethane
- D** hexane

Your answer

☐

[1]

- 6 Which row is correct for the following two regions of the electromagnetic spectrum?

	UV	IR
A	high energy, short wavelength	low energy, low frequency
B	high energy, low frequency	low energy, long wavelength
C	high frequency, short wavelength	high energy, long wavelength
D	high frequency, long wavelength	low energy, low frequency

Your answer

[1]

- 7 One model explaining the function of a heterogeneous catalyst uses some or all of the following steps:

- 1 intramolecular bonds weaken and break
- 2 product molecules desorb off the catalyst surface
- 3 reactant molecules adsorb onto catalyst surface
- 4 new bonds form
- 5 intermolecular bonds weaken and break

What is the correct order of appropriate steps for this model?

- A 1 → 5 → 4 → 3
- B 3 → 1 → 4 → 2
- C 3 → 4 → 5 → 2
- D 3 → 5 → 4 → 2

Your answer

[1]

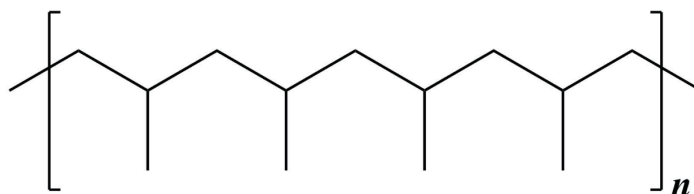
- 8 Which alcohol yields only **one** alkene when heated with concentrated H_2SO_4 ?

- A $\text{CH}_3\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- B $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}(\text{OH})\text{CH}_3$
- C $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{OH}$
- D $(\text{CH}_3\text{CH}_2)_2\text{C}(\text{OH})\text{CH}_3$

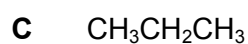
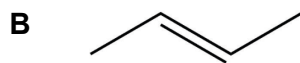
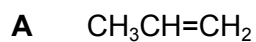
Your answer

[1]

- 9 The structural formula below represents part of polymer chain.



Which molecule when polymerised forms the above polymer?



Your answer

☐

[1]

- 10 Which halide does **not** dissolve in either dilute **or** concentrated ammonia solution?

A potassium chloride

B silver bromide

C silver chloride

D silver iodide

Your answer

☐

[1]

- 11 Which statement about chlorine is **not** correct?

A It oxidises bromide ions in solution.

B It boils at 332 K.

C It is reduced by iodide ions.

D It is a pale green gas at room temperature.

Your answer

☐

[1]

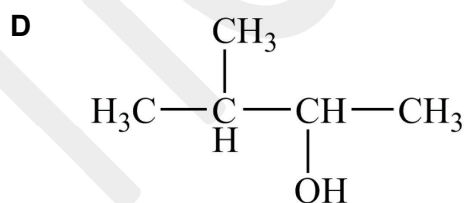
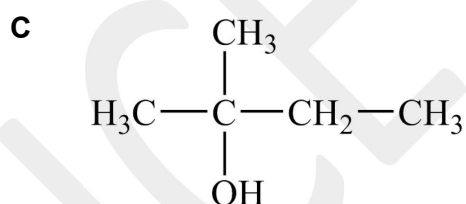
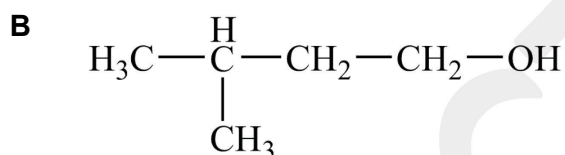
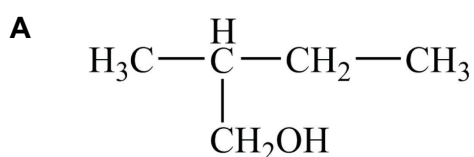
12 Which statement is correct for the hydrogen halides?

- A** They are all insoluble in water.
- B** They decrease in thermal stability from HF to HI.
- C** They are liquids at 20 °C.
- D** Their colours go from white to pale yellow.

Your answer ☐

[1]

13 Which formula represents a tertiary alcohol?



Your answer ☐

[1]

14 A student adds 5 g (an excess) of magnesium ribbon to 10 cm³ of dilute sulfuric acid at room temperature (22 °C). The temperature increases to 36 °C.

What is the approximate heat energy evolved in the reaction?

- A** 14 J
- B** 293 J
- C** 585 J
- D** 1505 J

Your answer ☐

[1]

- 15** Visible and UV light from the Sun is re-radiated by the Earth as IR radiation. Molecules can absorb this IR radiation.

Which statement correctly describes an effect of this absorption of IR radiation?

- A** The absorption increases the electronic energy of the molecules.
- B** The absorption causes the molecules to rotate more quickly.
- C** The absorption causes covalent bonds in the molecules to vibrate more.
- D** The absorption causes the molecules to undergo homolytic fission.

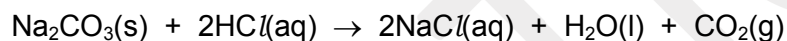
Your answer

☐

[1]

- 16** A student prepares sodium chloride by reacting 2.65 g of anhydrous sodium carbonate with excess hydrochloric acid.

The equation for the reaction is:



After completing the preparation the student has formed 2.47 g of sodium chloride.

What is the percentage yield?

- A** 42.2%
- B** 46.6%
- C** 84.4%
- D** 93.2%

Your answer

☐

[1]

17 What is the volume of 2.5 mol of gas at 100 kPa and 20 °C?

- A** 0.06 dm³
- B** 4.15 dm³
- C** 0.06 m³
- D** 4.15 m³

Your answer

[1]

18 Which statement about electronic orbitals is correct?

- A** An orbital is a region in space in which there is a high probability of an electron being found.
- B** The second electron shell consists of two s-orbitals.
- C** Within a particular electron shell an s-orbital is higher in energy than a p-orbital.
- D** A p-orbital can hold a maximum of six electrons.

Your answer

[1]

19 Which statement describes the visible emission spectrum of hydrogen?

- A** A set of lines that are randomly spaced.
- B** A set of lines that converge towards a high frequency value.
- C** A set of lines that converge towards a long wavelength value.
- D** A set of lines that converge towards a low energy value.

Your answer

[1]

20 What is the name of the mechanism taking place in the reaction between ethene and aqueous bromine?

- A** electrophilic addition
- B** electrophilic substitution
- C** nucleophilic addition
- D** radical substitution

Your answer ☐

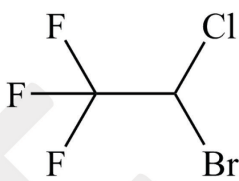
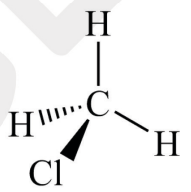
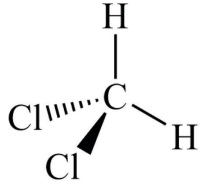
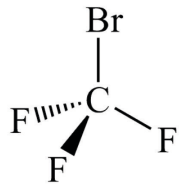
[1]

SECTION B

Answer **all** the questions.

- 21** Halogen-containing organic compounds find uses in medicine and technology. A large number of halogen-containing compounds are produced by natural processes.

(a) The table below lists some halogen-containing compounds.

Name of halogen compound	Notes	Molecular formula	Structural formula
2-bromo-2-chloro-1,1,1-trifluoroethane (halothane)	used as an anaesthetic	
chloromethane	produced by various marine organisms	CH_3Cl	
dichloromethane	produced by microalgae and volcanoes	CH_2Cl_2	
.....	used as a fire extinguishing agent	CBrF_3	

- (i) Complete the table by filling in the two missing pieces of information [1]
- (ii) Explain the meaning of the solid and dashed wedges shown in three of the structural formulae.

.....

.....

..... [1]

- (iii) Name the type of structural formula shown for 'halothane' in the first row of the table.

..... [1]

- (b) Of the molecules in the table, dichloromethane has the greatest potential to destroy stratospheric ozone.

- (i) Explain the role of dichloromethane in the destruction of ozone molecules and hence why it has the greatest potential of the four molecules.

.....

 [4]

- (ii) Iodomethane, CH_3I , is also formed by marine organisms. The C–I bond is easily broken by light energy in the troposphere.

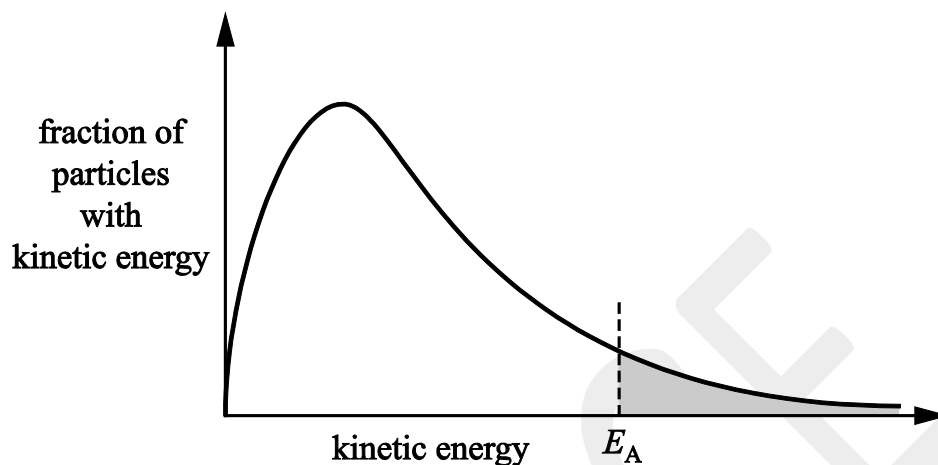
The average bond enthalpy of a C–I bond is $+240 \text{ kJ mol}^{-1}$

Calculate the frequency of light needed to break the C–I bond

frequency = Hz [3]

- (c) The destruction of ozone occurs more rapidly in the polar spring. The warmer temperatures increase the rate of the reactions that destroy ozone.

The following graph shows the Boltzmann distribution of molecular energies in a reacting system at a particular temperature, T .



- (i) Draw a second line on the graph to represent the distribution of the molecular energies at a temperature higher than T .

[2]

- (ii) E_A stands for the activation enthalpy.

State the meaning of the term 'activation enthalpy'.

.....
 [1]

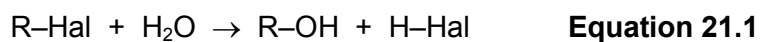
- (iii) A student says that chemical reactions go faster at higher temperatures because the molecules have more frequent collisions.

Discuss the student's statement.

.....

 [3]

- (d) In hot, humid conditions naturally occurring haloalkanes can react with water as represented by **Equation 21.1**.



- (i) Name the type of mechanism in the reaction in **Equation 21.1**.

.....

[1]

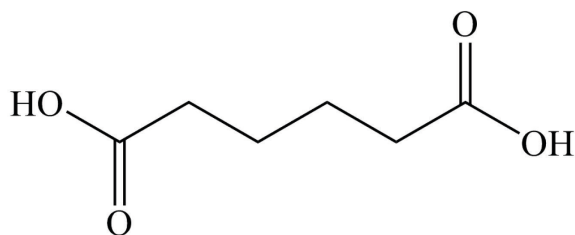
- (ii) Halothane reacts with water by heating it with an aqueous solution of silver nitrate. A cream-coloured precipitate forms in the reaction mixture.

Write an **ionic** equation for the precipitation reaction occurring. Include state symbols.

[2]

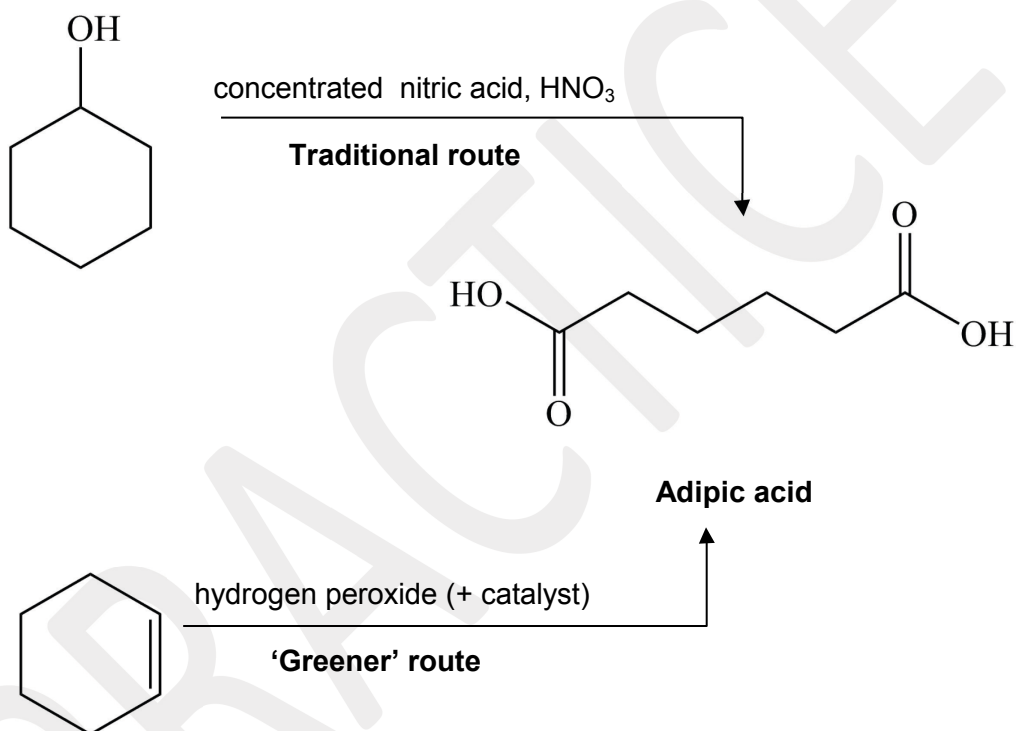
Turn over for the next question

- 22** Hexanedioic acid, sometimes called adipic acid, is used for the production of nylon-6,6 and as a building block for pharmaceuticals and pesticides.

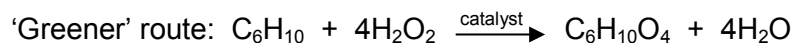


Adipic acid

Adipic acid used to be made by oxidising cyclohexanol with nitric acid, also producing toxic NO_x emissions. A new, 'greener' synthesis of adipic acid from cyclohexene uses hydrogen peroxide as the oxidising agent, and a heterogeneous catalyst.



- (a) Simplified equations for the two routes are shown below:



Calculate the atom economy for the production of adipic acid by each route.

atom economy of traditional route = %

atom economy of 'greener' route = % [2]

- (b) Traditional catalysts in many industrial organic processes have been homogeneous catalysts.

Suggest why heterogeneous catalysts are 'greener' alternatives than homogeneous catalysts.

..... [1]

Include:

- the properties required of a suitable solvent for use in recrystallisation
- an explanation of how the steps involved in the process of recrystallisation result in soluble and insoluble impurities being removed.

[illegible]

[5]

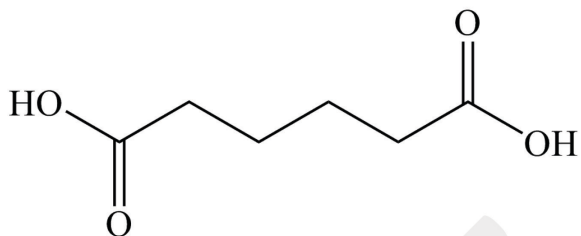
(ii) The percentage yield of this synthesis is around 90%.

Suggest **one** reason why it is not 100%.

[1]

- (iii) Diesters of adipic acid are called adipates and also have a variety of uses. For example, diethyl adipate is used as a paint remover.

Write the skeletal formula for diethyl adipate and name the other reactant in the formation of this ester from adipic acid.



Adipic acid

skeletal formula:

name of other reactant: [2]

Turn over for the next question

- 23** The 'birth' of elements starts with *nuclear fusion* reactions in stars. Fusion in the core of stars takes place when the pressure and temperature are high enough. There are different fusion cycles that occur in different phases of the life of a star.

- (a) Explain the term 'nuclear fusion' and why the pressure and temperature have to be very high for nuclear fusion to occur.

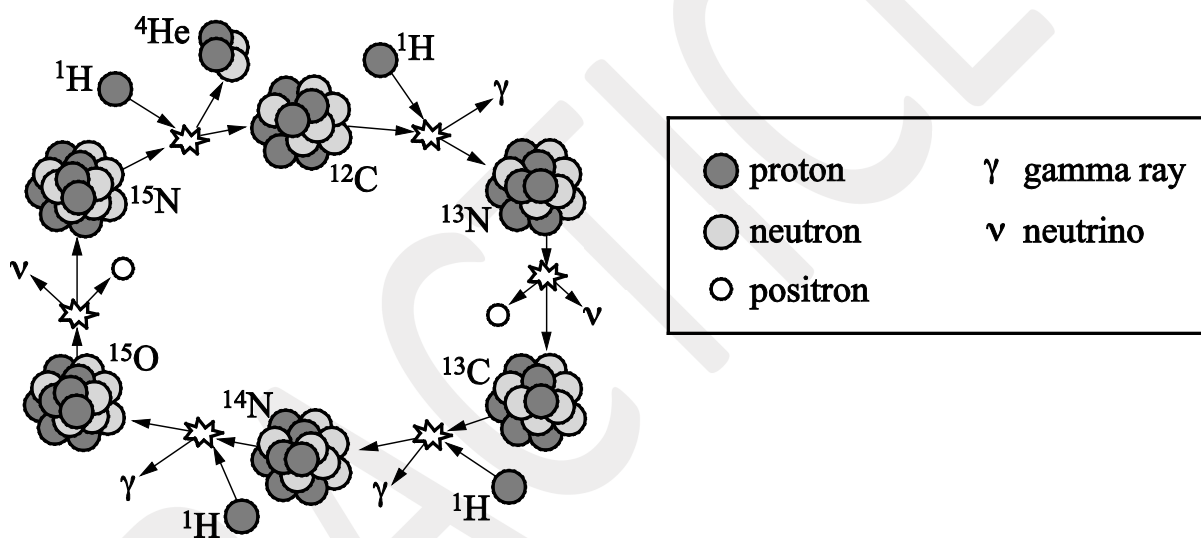
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.....

[2]

- (b) One fusion cycle in very hot stars is called the CNO cycle. It is represented in the diagram below.



In the CNO cycle isotopes of carbon, nitrogen and oxygen are formed.

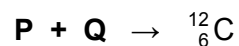
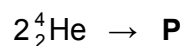
- (i) There are pairs of isotopes in the above cycle that have the same mass number.

Complete the table below for any **one** pair.

Isotope	Number of protons	Number of neutrons

[1]

- (ii) The $^{12}_6\text{C}$ isotope in the CNO cycle is formed as a result of two previous fusion reactions occurring in the star:



Give the full nuclear symbols for isotopes **P** and **Q**.

P =

Q =

[2]

- (c) On Earth, atomic nuclei are surrounded by electrons in atomic orbitals.

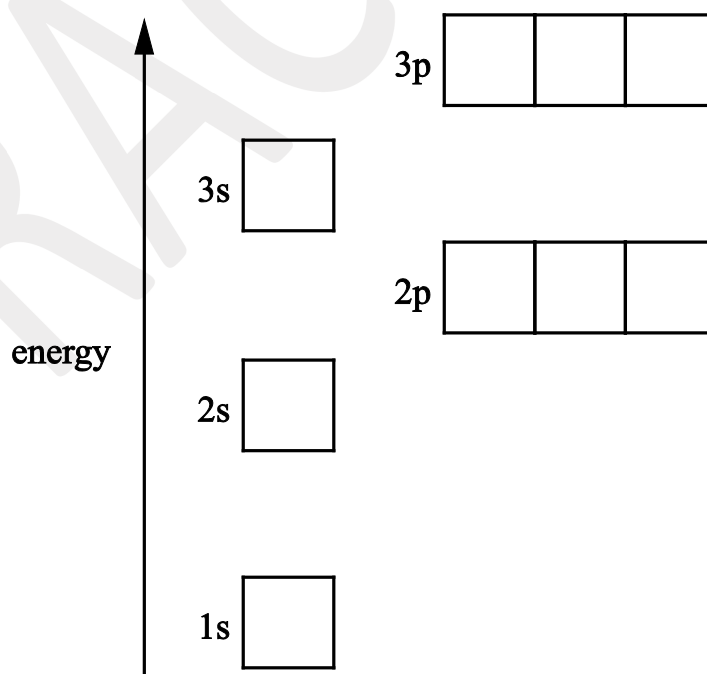
- (i) Draw the shapes of an s-orbital **and** a p-orbital.

s-orbital:

p-orbital:

[1]

- (ii) Fill in the table below to show the electronic configuration of an atom of the ^{15}N isotope. Use the 'electrons in boxes' model.



[2]

- (d) Mass spectrometry shows that there are only two naturally occurring isotopes of nitrogen, with the following percentage abundances.

Isotope	Abundance/%
^{14}N	99.630
^{15}N	0.3680

Calculate the relative atomic mass, A_r , of N. Give your answer to **three** decimal places.

$A_r = \dots\dots\dots$ [2]

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Turn over for the next question

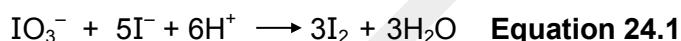
- 24** Iodine is needed in small amounts in our diet. Iodine deficiency can lead to impaired physical and mental development.

Common salt can be 'iodised' by the addition of potassium iodate, KIO_3 .

- (a) A student decides to determine the amount of the iodate ion, IO_3^- , in a sample of iodised salt by a redox titration using sodium thiosulfate.

The student first reacts the iodate ion with excess iodide ion, I^- , under acidic conditions, to produce iodine, I_2 .

Equation 24.1 for this reaction is given below:



Oxidation state:

- (i) Give the oxidation state of the iodine under each of the three iodine-containing species. **[2]**
- (ii) The student dissolves some of the iodised salt in a small volume of dilute hydrochloric acid. The student then transfers this solution to a 250 cm^3 volumetric flask and makes up to the mark with distilled water.

25.0 cm^3 of this solution is then added to a conical flask containing a solution of excess iodide ions. The iodine produced is titrated with a standard solution of $0.00100 \text{ mol dm}^{-3}$ sodium thiosulfate, $\text{Na}_2\text{S}_2\text{O}_3$, using starch indicator.

The reaction equation is:



The student's results give a mean titre of 15.40 cm^3 .

Calculate the amount (in mol) of IO_3^- in the 25.0 cm^3 of iodate solution.

amount of IO_3^- = mol **[2]**

- (iii) Calculate the amount of IO_3^- in the original solution and hence the mass, **in mg**, of potassium iodate(V) in the iodised salt dissolved.

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

mass of KIO_3 = mg **[2]**

- (b) The student notices purple iodine, I_2 , vapour in the conical flask after mixing the iodate and iodide solutions.

Iodine vapour is relatively toxic. The student decides to calculate the volume of iodine released, to check that it will not exceed the maximum limit for safe working.

The maximum safe working limit for iodine vapour is 0.1 **ppm by volume**.

The **mass** of iodine vapour released in the reaction was 0.20 g

The total volume of the laboratory is 300 m^3 .

Follow the student's method. Determine whether the concentration of iodine vapour in ppm will exceed the safe working limit once it has diffused evenly around the laboratory at room temperature and pressure.

[3]

- (c) Iodine can be extracted from solutions containing 100–150 ppm iodine as iodide ions. Chlorine is added to the solution and iodine is liberated by a displacement reaction.

Write the ionic equation for the displacement of iodine from brines using chlorine

.....

[1]

END OF QUESTION PAPER

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