Oxford Cambridge and RSA

# A Level Chemistry B (Salters)

## H433/01 Fundamentals of chemistry

# Practice paper – Set 2

## Time allowed: 2 hours 15 minutes

**You must have:**
- the Data Sheet for Chemistry B (Salters)

**You may use:**
- a scientific or graphical 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. If additional space is required, use the lined page(s) at the end of this booklet. The question number(s) must be clearly shown.
- Do **not** write in the barcodes.

**INFORMATION**
- The total mark for this paper is **110**.
- The marks for each question are shown in brackets **[ ]**.
- Quality of extended responses will be assessed in questions marked with an asterisk (*).
- This document consists of **32** pages.

## SECTION A

**You should spend a maximum of 40 minutes on this section.**

**Write your answer to each question in the box provided.**

Answer **all** the questions.

**1** Which statement is correct about fusion reactions?

**A** They occur at room temperature and pressure.

**B** They result in the formation of new elements.

**C** They only occur in stars.

**D** They only occur when a large nucleus collides with a small nucleus.

Your answer ☐

**[1]**

**2** Which statement is correct about orbitals?

**A** s-orbitals are circular.

**B** Orbitals always contain two electrons

**C** A$l$ has an orbital containing a single electron.

**D** A p-orbital can contain up to six electrons.

Your answer ☐

**[1]**

**3** Which statement is correct about the melting points and structures of the elements in Period 2?

**A** The melting points increase across the Period.

**B** Elements on the left have ionic structures.

**C** Elements on the right have covalent structures.

**D** Metals have the highest melting points.

Your answer ☐

**[1]**

**4** How many σ and π bonds are there in a molecule of propanone?

| | σ bonds | π bonds |
|---|---|---|
| **A** | 8 | 1 |
| **B** | 8 | 2 |
| **C** | 9 | 2 |
| **D** | 9 | 1 |

Your answer ☐

**[1]**

**5** What is a reason that the first ionisation enthalpy increases across a Period?

**A** Each electron is attracted to more protons.

**B** The electrons are further from the nucleus.

**C** The atoms get larger.

**D** The charge density of the ions increases.

Your answer ☐

**[1]**

**6** Which compounds will react together under appropriate conditions?

**A** phenols and acid anhydrides

**B** carboxylic acids and phenol

**C** alcohols and phenols

**D** ethers and carboxylic acids

Your answer ☐

**[1]**

**7** Which compound does **not** exist?

**A** $Fe_2SO_4$

**B** $Ag_2SO_4$

**C** $PbSO_4$

**D** $Fe_2(SO_4)_3$

Your answer ☐

**[1]**

**8** One method of producing hydrogen is the thermal decomposition of steam in the presence of a catalyst.

$$2H_2O(g) \rightleftharpoons 2H_2(g) + O_2(g) \qquad \Delta_r H = +484\,kJ\,mol^{-1}$$

Which set of conditions will produce the highest yield of hydrogen?

| | **Temperature** | **Pressure** |
|---|---|---|
| **A** | High | High |
| **B** | High | Low |
| **C** | Low | Low |
| **D** | Low | High |

Your answer ☐

**[1]**

**9** A dipeptide is hydrolysed by heating with moderately concentrated hydrochloric acid. The products of hydrolysis are then analysed using paper chromatography.

Which statement is **not** correct?

**A** Dots of the hydrolysis mixture, together with the likely amino acids present, are put on a pencil line on the paper.

**B** The spots can be made visible by spraying with ninhydrin.

**C** The $R_f$ value can be found from:

$$\frac{\text{distance of solvent front from baseline}}{\text{distance of spot from baseline.}}$$

**D** At the start the solvent must not touch the baseline on the chromatography paper.

Your answer ☐

**[1]**

**10** What is correct for **all** ionic solids dissolving in water?

**A** The sum of the enthalpy changes of hydration of the ions is more exothermic than the lattice enthalpy.

**B** The entropy of the water increases.

**C** $\Delta_{sol}H$ is exothermic.

**D** The formation of ion-dipole bonds between water and ions is exothermic.

Your answer ☐

**[1]**

**11** Geiger and Marsden fired $\alpha$-particles at a gold foil.

Which result did they observe?

**A** All the $\alpha$-particles were deflected slightly.

**B** Most $\alpha$-particles were not deflected but some were deflected slightly.

**C** All the $\alpha$-particles were deflected through large angles.

**D** Most $\alpha$-particles were not deflected but some were deflected through large angles.

Your answer ☐

**[1]**

**12** What is correct about covalent bonds?

**A** They are only formed between atoms of the same electronegativity.

**B** They consist of attractive forces between nuclei and electrons.

**C** They do not exist in giant structures.

**D** They do not exist in ions.

Your answer ☐

**[1]**

**13** Tests are done on an aqueous solution containing two sodium salts.

The results are shown below.

| Test | Result |
|---|---|
| Add aqueous chlorine followed by an organic solvent | Brown aqueous layer and brown organic layer |
| Add aqueous barium nitrate | White precipitate |

What are the anions in the solution?

**A** bromide and sulfate

**B** sulfate and iodide

**C** sulfate and chloride

**D** bromide and chloride

Your answer ☐

**[1]**

**14** What is a reason that $BF_3$ has no overall dipole?

**A** It is the same shape as ammonia.

**B** B and F have very similar electronegativities.

**C** It is trigonal.

**D** It is a small molecule.

Your answer ☐

**[1]**

**15** What is the correct arrangement of the following compounds in order of boiling point with the lowest first?

**A** $CH_3OH$ $CH_3CHO$ $(CH_3)_3CH$ $CH_3CH_2CH_2CH_3$

**B** $(CH_3)_3CH$ $CH_3CH_2CH_2CH_3$ $CH_3CHO$ $CH_3OH$

**C** $(CH_3)_3CH$ $CH_3CH_2CH_2CH_3$ $CH_3OH$ $CH_3CHO$

**D** $CH_3CH_2CH_2CH_3$ $(CH_3)_3CH$ $CH_3CHO$ $CH_3OH$

Your answer ☐

**[1]**

**16** What is correct about a solution of phenol?

**A** It will give a red colour with neutral iron(III) chloride.

**B** It will fizz with sodium carbonate.

**C** It will get warm when sodium hydroxide is added.

**D** It will react with a solution of ethanoic acid to form an ester.

Your answer ☐

**[1]**

**17** What describes the reaction between propanone and HCN?

**A** electrophilic substitution

**B** nucleophilic addition

**C** electrophilic addition

**D** nucleophilic substitution

Your answer ☐

**[1]**

**18** A medicine can inhibit the function of an enzyme, slowing down the reaction of a substrate.

What is correct about the medicine molecules?

**A** They have the same shape as the active site of the enzyme.

**B** They react in the active site.

**C** They fit into the active site.

**D** They have a complementary shape to the substrate.

Your answer ☐

**[1]**

**19** A polymer has the repeat unit shown.

—CO—$(CH_2)_3$—O—

What is/are the correct monomer(s) for the polymer?

**A** $HOOC(CH_2)_3COOH$

**B** $HOOC(CH_2)_3OH$

**C** $HOCH{=}CHOH$ and $H_2C{=}CH_2$

**D** $HO(CH_2)_4OH$

Your answer ☐

**[1]**

**20** What is **not** correct about the amino acid $H_2NCH_2COOH$?

**A** It reacts with both $CH_3COCl$ and $CH_3OH$.

**B** It has a chiral centre.

**C** It forms zwitterions.

**D** It is able to form condensation polymers with other similar molecules.

Your answer ☐

**[1]**

**21** What is the electronic configuration of a $Cr^{3+}$ ion?

**A** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$

**B** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$

**C** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^0$

**D** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^3\ 4s^0$

Your answer ☐

**[1]**

**22** $MnO_4^-$ ions react with $Fe^{2+}$ ions according to the equation shown below.

$$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

What volume of 0.100 mol dm$^{-3}$ potassium manganate(VII) is needed to react with 0.250 grams of iron dissolved in sulfuric acid?

**A** 8.96 cm$^3$

**B** 22.4 cm$^3$

**C** 44.8 cm$^3$

**D** 224 cm$^3$

Your answer ☐

**[1]**

**23** In order to find the activation enthalpy for a reaction, a student must plot a graph. In one experiment the rate constant, *k*, was 4.50 x 10$^{-3}$ s$^{-1}$ and the temperature was 60.0°C.

What point would the student plot for this result?

**A** (−5.40, 3.61 x 10$^{-4}$)

**B** (−2.35, 3.00 x 10$^{-3}$)

**C** (−5.40, 3.00 x 10$^{-3}$)

**D** (−2.35, 1.67 x 10$^{-2}$)

Your answer ☐

**[1]**

**24** 25 cm$^3$ 0.50 mol dm$^{-3}$ HC$l$ is reacted with excess magnesium.

What mass of MgC$l_2$ is produced in solution?

**A** 0.15 g

**B** 0.60 g

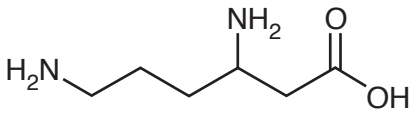
**C** 1.19 g

**D** 2.38 g

Your answer ☐

**[1]**

**25** The amino acid beta-lysine has the structure shown.




25.0 $cm^3$ of a 0.0100 mol $dm^{-3}$ solution of beta-lysine is titrated separately with 0.0150 mol $dm^{-3}$ hydrochloric acid and 0.0200 mol $dm^{-3}$ sodium hydroxide.

Which row represents the correct volumes of solution that react with the lysine?

| | **Volume 0.0150 mol $dm^{-3}$ HCl / $cm^3$** | **Volume 0.0200 mol $dm^{-3}$ NaOH / $cm^3$** |
|---|---|---|
| **A** | 8.33 | 50.0 |
| **B** | 16.7 | 12.5 |
| **C** | 33.3 | 12.5 |
| **D** | 33.3 | 25.5 |

Your answer ☐

**[1]**

**26** Which row is correct for the shapes of xenon compounds?

| | **Formula** | **Shape** |
|---|---|---|
| **A** | $XeF_2$ | bent (angle 107°) |
| **B** | $XeF_4$ | tetrahedral |
| **C** | $XeO_3$ | pyramidal |
| **D** | $XeO_4$ | square planar |

Your answer ☐

**[1]**

**27** Which statement(s) about DNA and RNA is/are correct?

1 A nucleotide is composed of a phosphate, a sugar and a base.
2 Guanine and cytosine are joined by 3 hydrogen bonds in DNA.
3 Adenine and thymine are joined by 2 hydrogen bonds in RNA.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐

**[1]**

**28** Which statement(s) about nitrogen compounds is/are correct?

1 The ammonium ion has a H—N—H bond angle of 109.5°.
2 The ammonia molecule has a tetrahedral shape.
3 $N_2O$ reacts with air to form a brown gas.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐

**[1]**

**29** Which statement(s) about the greenhouse effect is/are correct?

1 Carbon dioxide, methane and water vapour all absorb the same frequencies of infrared radiation.

2 Energy from visible and ultra violet light is absorbed by the Earth.

3 The Earth emits infrared radiation from its surface.

**A** 1, 2 and 3

**B** Only 1 and 2

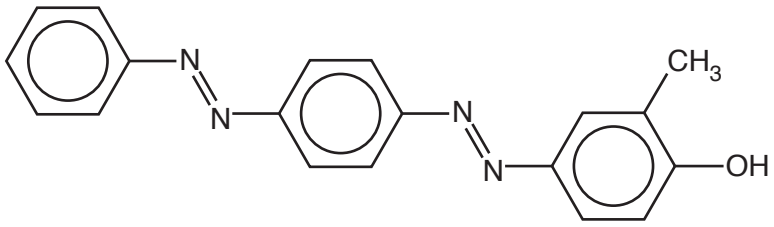
**C** Only 2 and 3

**D** Only 1

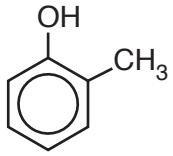
Your answer ☐

**[1]**

**30** Which statement(s) about the dye shown below is/are correct?




1 It could be formed in a coupling reaction using the compound shown.




2 It is likely to be colourfast when bonded to polyester fibres.

3 It is insoluble in water.

**A** 1, 2 and 3

**B** Only 1 and 2

**C** Only 2 and 3

**D** Only 1

Your answer ☐

**[1]**

## SECTION B

Answer **all** the questions.

**31** Ozone is a pollutant in the troposphere but beneficial in the stratosphere.

**(a)** Ozone in the troposphere is formed from gases in vehicle exhaust emissions reacting with hydroxyl radicals.

**(i)** Oxides of nitrogen are present in vehicle exhausts.

Explain why they are present.

.....

..... **[1]**

**(ii)** Draw a '*dot-and-cross*' diagram of an OH radical and explain why OH is a radical.

Explanation ..... **[2]**

**(b)** Ozone is produced in the series of reactions shown below.

$HO\bullet + CO \rightarrow HOCO\bullet$ **Equation 31.1**

$HOCO\bullet + O_2 \rightarrow HO_2\bullet + CO_2$ **Equation 31.2**

$HO_2\bullet + NO \rightarrow HO\bullet + NO_2$ **Equation 31.3**

$NO_2 + h\nu \rightarrow NO + O$ **Equation 31.4**

$O_2 + O \rightarrow O_3$ **Equation 31.5**

**(i)** Many of these reactions may be classified as propagation reactions.

Explain the meaning of the term propagation reaction.

.....

..... **[1]**

**(ii)** **Equations 31.1–31.5** can all be combined to give one overall equation.

Give the overall equation.

**[1]**

**(c)** Many of the species in **equations 31.1–31.5** can be described as homogeneous catalysts.

State the meaning of the terms homogeneous and catalyst.

Homogeneous .....

.....

Catalyst .....

.....

**[2]**

**(d)** Explain how the presence of ozone in the stratosphere benefits us.

.....

.....

..... **[2]**

**(e)** The destruction of ozone in the stratosphere is catalysed by chlorine atoms. These are produced by the breaking of C–C$l$ bonds in CFCs due to the absorption of UV light.

**(i)** Using $CF_2Cl_2$ as an example of a CFC, show, using curly arrows, how the chlorine atom is produced. Name the type of bond breaking occurring.

Type of bond breaking ..... **[2]**

**(ii)** The C–C$l$ bond enthalpy is +346 kJ mol$^{-1}$. The highest frequency of UV radiation reaching the Earth's surface is $8.50 \times 10^{14}$ Hz.

Use this information to explain why chlorine atoms are not produced in the troposphere.

You must show your working.

**[3]**

**32** Bromine is increasingly used as an alternative to chlorine to treat water, as it is less affected by sunlight. Both chlorine and bromide ions are extracted from seawater.

**(a)** Bromine is obtained by the reaction between chlorine and bromide ions.

**(i)** Give an **ionic** equation for the reaction and explain which is the oxidising agent in the reaction.

.....

..... **[2]**

**(ii)** In the Dead Sea the concentration of bromide ions is higher than in other seas. Much bromine extraction is carried out near the Dead Sea.
Some Dead Sea water has a chloride ion concentration of 20.8% (mass of solute per volume of solution). The bromide concentration is 500 mg per 100 $cm^3$.

Calculate the ratio of the chloride ion concentration to the bromide ion concentration, both measured in mol $dm^{-3}$.

ratio [$Cl^-$]: [$Br^-$] = ..... : 1 **[3]**

**(iii)** Many of the industries using bromine are sited near the Dead Sea to avoid transportation of the bromine.

Suggest one reason why the transportation of bromine is dangerous.

..... **[1]**

**(b)** Chlorine reacts with water to produce a mixture of acids according to the equation shown.

$$Cl_2 + H_2O \rightarrow HCl + HClO$$

..... ..... .....

**(i)** Write the oxidation state of chlorine in each species on the dotted lines. **[1]**

**(ii)** $HClO$ is responsible for killing bacteria in water.

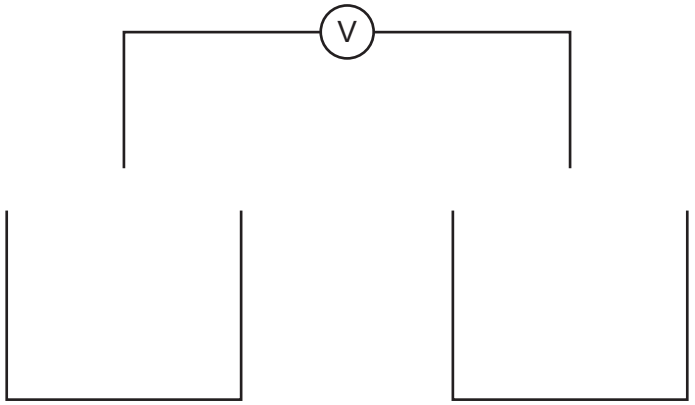
Give the systematic name of $HClO$.

..... **[1]**

**(c)** A student wants to measure the $E^{\theta}_{cell}$ when $ClO^-$ oxidises $I^-$ ions.

| Half reaction | $E^{\theta}$/V |
|---|---|
| $I_2(aq) + 2e^- \rightleftharpoons 2I^-(aq)$ | +0.54 |
| $ClO^-(aq) + 2H^+(aq) + 2e^- \rightleftharpoons Cl^-(aq) + H_2O(l)$ | +1.50 |

Complete and label the diagram below to show how the cell should be set up in the laboratory. On your diagram show the direction of the flow of electrons and give the equation for the reaction taking place.




Equation:

**[5]**

**(d)** The students investigate the hydrogen halides, HC*l*, HBr, and HI. They warm NaC*l*, NaBr and NaI with concentrated sulfuric acid.

In the case of NaBr and NaI, the halogen is produced in addition to the hydrogen halide.

Use oxidation states (or some other method) to balance the following equations:

$$.....HBr + .....H_2SO_4 \rightarrow .....Br_2 + .....SO_2 + .....H_2O$$

$$.....HI + .....H_2SO_4 \rightarrow .....I_2 + .....H_2S + .....H_2O$$

**[2]**

**(e)** The students want to oxidise HC*l* (aq) to chlorine.

Use the electrode potentials below to suggest which oxidising agent(s) would enable them to prepare chlorine.

Explain your answer and give balanced equation(s) for any reaction(s).

| **Half reaction** | $E^{\theta}$/**V** |
|---|---|
| $MnO_2(s) + 4H^+(aq) + 2e^- \rightleftharpoons Mn^{2+}(aq) + 2H_2O(l)$ | +1.23 |
| $Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$ | +1.33 |
| $Cl_2(aq) + 2e^- \rightleftharpoons 2Cl^-(aq)$ | +1.36 |
| $MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$ | +1.51 |

.....

.....

.....

Equation(s):

**[3]**

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**33** Esters have many uses in organic chemistry, including in polymers.

**(a)** Some students want to determine the equilibrium constant for the esterification reaction in **equation 33.1** in acidic conditions.

$CH_3COOH + CH_3CH_2OH \rightleftharpoons CH_3COOCH_2CH_3 + H_2O$ **Equation 33.1**

They set up their experiment with known masses of ethanol, ethanoic acid and concentrated sulfuric acid catalyst.

They place the reactants in a stoppered bottle and wait a week for equilibrium to be established.

Suggest how the students could find the amount of ethanoic acid in the bottle at equilibrium.

.....

..... **[2]**

**(b)** By using the method from **(a)**, the students find that the amount of ethanoic acid present at equilibrium is 0.123 mol.
They produce the table below.

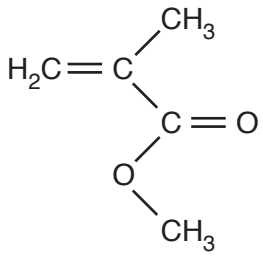
| Substance | Mass present at the start / g | Amount present at the start / mol | Amount present at equilibrium / mol |
|---|---|---|---|
| ethanol | 15.8 | | |
| ethanoic acid | 21.0 | | 0.123 |
| ethyl ethanoate | 0 | 0 | |
| water | 0 | 0 | |

Carry out appropriate calculations to fill in the blanks in the table.

Use figures from the table to work out a value for the equilibrium constant, $K_c$, of the reaction in **equation 33.1**.

$K_c$ = ..... **[4]**

**(c)** Another ester is the monomer for the polymer polymethyl methacrylate or PMMA. PMMA is often used to make lightweight transparent materials as a replacement for glass.
The monomer has the structure shown below.



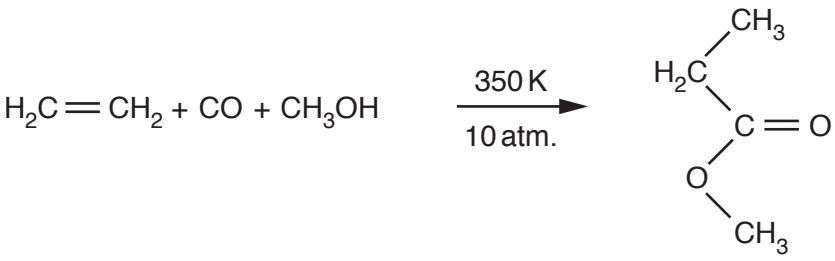
Draw the structural formula for **one** repeating unit of the polymer.

**[1]**

**(d)** The monomer can be made in the following reaction sequence.

Give the systematic names of two of the compounds on the dotted lines below their structures.

**Stage 1:**



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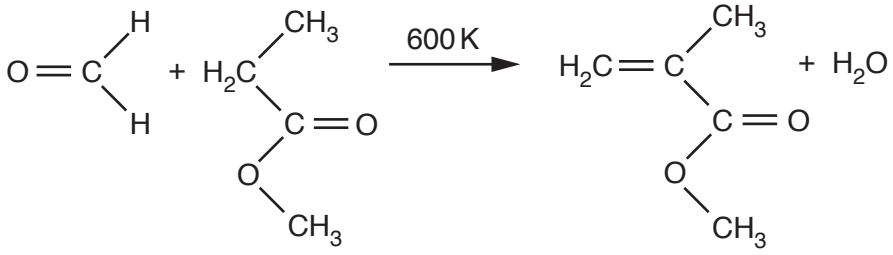
**Stage 2:**



.....

**[1]**

**(e)** The ethene used in **stage 1** comes from thermal cracking of long chain alkanes from crude oil in the presence of steam.
One such reaction is shown below.

$C_{10}H_{22}(g) \rightleftharpoons C_8H_{18}(g) + C_2H_4(g) \quad \Delta_r H = +103\,kJ\,mol^{-1}$ **Equation 33.2**

| Substance | Entropy / J mol$^{-1}$ K$^{1}$ |
|---|---|
| $C_{10}H_{22}$ | +425.9 |
| $C_8H_{18}$ | +361.1 |
| $C_2H_4$ | +219.5 |

Use the entropy values given to find the minimum temperature needed for the forward reaction to be feasible.
Give your answer to an **appropriate** number of significant figures.

minimum temperature = ..... *K* **[3]**

**(f)** Give the effects that the following changes have on the value of $K_c$ for the reaction in **equation 33.2**.

| Change | Increased temperature | Increased pressure | Use of a catalyst |
|---|---|---|---|
| Effect on $K_c$ | | | |

**[2]**

$C_{10}H_{22}(g) \rightleftharpoons C_8H_{18}(g) + C_2H_4(g) \quad \Delta_r H = +103\,kJ\,mol^{-1}$ **Equation 33.2**

**(g)** The yield of the reaction in **equation 33.2** is typically 50%.

Calculate the volume (in $dm^3$) of ethene produced when 25.0 kg of decane are cracked at 900 K and a pressure of 150 kPa.

volume of ethene = ..... $dm^3$ **[3]**

**(h)** An alternative method of obtaining ethene is catalytic cracking using zeolite catalysts.

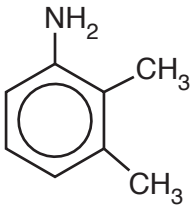
Explain the advantage to the environment of this method over steam cracking.

.....

..... **[1]**

**34** Coal tar provides the raw materials for many painkilling drugs and dyestuffs. One such drug, 'mefenamic acid', is also being investigated as a possible treatment for Alzheimer's disease. Mefenamic acid is made from 2,3-dimethylphenylamine.

**(a)** Distillation is used to separate the compound 2,3-dimethylphenylamine from coal tar.




**2,3-dimethylphenylamine**

**(i)** Draw a labelled diagram to show how distillation can be carried out in a laboratory to remove the more volatile component from a mixture.
Explain how the products are separated.

.....

..... **[3]**

**(ii)** The 2,3-dimethylphenylamine is contaminated with phenols. The mixture is shaken with hydrochloric acid in a separating funnel.

Give the equation for the reaction of 2,3-dimethylphenylamine with hydrochloric acid.

**[1]**

**(iii)** The aqueous layer is then run off.

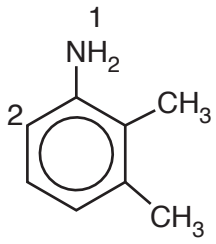
Suggest how the 2,3-dimethylphenylamine can be obtained from the solution.

.....

.....

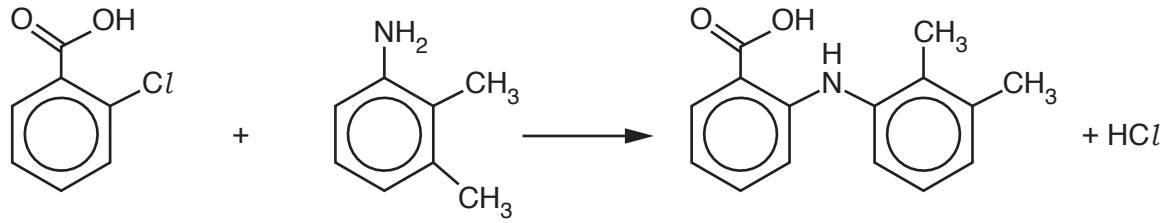
..... **[2]**

**(b)** Indicate the number of peaks in the proton NMR spectrum for 2,3-dimethylphenylamine.
Use numbers for each proton environment on the structure below.
Some numbers have been added already.




**[2]**

**(c)** The reaction to form mefenamic acid is shown below.




**2-chlorobenzoic acid** **2,3-dimethylphenylamine** **mefenamic acid**

The yield of the reaction is 52%.

Calculate the mass of 2-chlorobenzoic acid (in kg) needed to produce 15.0 kg of mefenamic acid.

mass = ..... kg **[3]**

**(d)*** The structure of mefenamic acid can be investigated by a combination of spectroscopic techniques.

Describe and explain the appearance of the infrared spectrum and mass spectrum, and how they could be used to identify mefenamic acid.

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..... **[6]**

**35** Some students want to investigate the relative reactivities of calcium and barium with water.

**(a)*** Describe an experiment (involving gas collection) they could do to **measure** the rate of the reaction between each metal and water and explain the expected observations.

You may include a diagram as part of your answer.

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..... **[6]**

**(b)** The students decide to investigate the solubility of calcium hydroxide by shaking solid calcium hydroxide with deionised water and filtering the mixture to remove undissolved solid. They then titrate the dissolved hydroxide ions with hydrochloric acid.

**(i)** They titrate $25.0\,cm^3$ of their saturated solution of calcium hydroxide with $0.0400\,mol\,dm^{-3}$ HC*l*.

Their results are shown below.

| | **Trial** | **Repeat 1** | **Repeat 2** | **Repeat 3** | **Repeat 4** |
|---|---|---|---|---|---|
| **Titre / $cm^3$** | 15.00 | 13.80 | 13.90 | 14.00 | 14.60 |

Use their results to find the solubility product of calcium hydroxide.

solubility product of calcium hydroxide = .....

units ..... **[4]**

**(ii)** Describe and explain what difference they would see in their titre if they repeated their titration with saturated magnesium hydroxide solution.

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..... **[1]**

**(c)** 15.0 g of calcium chloride are dissolved in water.

Use the information below to find the temperature rise of the solution.
You may assume the mass of the solution is 100 g and its specific heat capacity is $4.18\,J\,k^{-1}\,g^{-1}$.

| | **Enthalpy change / kJ mol$^{-1}$** |
|---|---|
| $\Delta_{LE}H\ CaCl_2$ | −2258 |
| $\Delta_{hyd}H\ Cl^-$ | −364 |
| $\Delta_{hyd}H\ Ca^{2+}$ | −1650 |

temperature rise = ..... °C **[3]**

**END OF QUESTION PAPER**

## ADDITIONAL ANSWER SPACE

If additional space is required, you should use the following lined page(s). The question number(s) must be clearly shown in the margin(s).