Essential Pre-Uni Chemistry B6.4

GCSE C C C A Level P P P

Calculate the volume of $0.50\,\text{mol}\,\text{dm}^{-3}$ H_2SO_4 required to neutralize each of the following. Give your answer in cm^3 unless otherwise specified.

Part A **(a)**

$25.0\,\text{cm}^3$ of $1.0\,\text{mol}\,\text{dm}^{-3}$ $NaOH$

Part B **(b)**

$3.0\,\text{g}$ $CaCO_3$

Part C **(c)**

$1.25\,\text{g}$ $ZnCO_3$

Part D **(d)**

$4.03\,\text{kg}$ MgO. Give your answer in dm^3.

Part E **(e)**

$100\,\text{cm}^3$ of $0.2\,\text{mol}\,\text{dm}^{-3}$ $NH_3\,(aq)$

Step and overall yield

A Level

A synthesis from phenol to give **G** ($C_8H_8O_2$) was carried out as shown below.

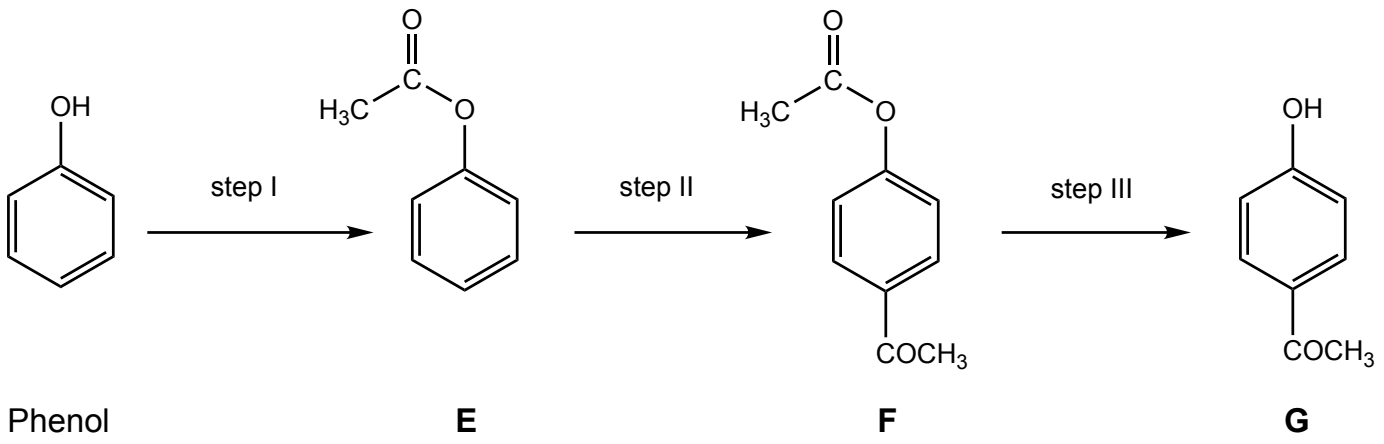

Figure 1: Three-step synthesis starting from phenol.

Part A Overall yield

$47.0\,\text{g}$ of phenol gave $44.5\,\text{g}$ of the final product **G** ($C_8H_8O_2$). What is the overall percentage yield of **G** from phenol? Give your answer to the nearest integer.

Part B Step II yield

The yield for step I, for the conversion of phenol to **E** ($C_8H_8O_2$), was $75\,\%$, and the yield for the hydrolysis of **F** ($C_{10}H_{10}O_3$) to **G** ($C_8H_8O_2$) in step II was $100\,\%$. What is the percentage yield for step II? Give your answer to the nearest integer.

Adapted with permission from OCR, A Level Chemistry, June 1999, Further Organic Paper, Question 4

Essential Pre-Uni Chemistry B3.2

GCSE P P P A Level P P P

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}$.

Part A (a)

Calculate the amount of gas (at RTP) in $4.8\,\mathrm{dm}^3$.

Part B (b)

Calculate the amount of gas (at RTP) in $12\,\mathrm{m}^3$.

Part C (c)

Calculate the amount of gas (at RTP) in $400\,\mathrm{cm}^3$. Give your answer to 2 significant figures.

Part D (d)

Calculate the amount of gas (at RTP) in $18\,\mathrm{ml}$.

Essential Pre-Uni Chemistry B3.1

GCSE C C C A Level P P P

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}\,\mathrm{mol}^{-1}$.

Part A (a)

Calculate the volume occupied by $4.0\,\mathrm{moles}$ of gas at RTP.

Part B (b)

Calculate the volume occupied by $0.030\,\mathrm{moles}$ of gas at RTP.

Part C (c)

Calculate the volume occupied by 5.0×10^{18} atoms of helium gas at RTP.

Part D (d)

Calculate the volume occupied by 1.2×10^{24} molecules of ozone at RTP.

Part E (e)

Calculate the volume occupied by $8.0\,\mathrm{g}$ of O_2 at RTP.

Part F **(f)**

Calculate the volume occupied by $1.1\ \mathrm{kg}$ of carbon dioxide at RTP.

Oxidation Yield

A Level

Oxidation of phenylethene ($12.0\,\text{g}$, C_8H_8) gave benzoic acid ($\text{C}_7\text{H}_6\text{O}_2$), which needed $100\,\text{cm}^3$ of $1.00\,\text{mol}\,\text{dm}^{-3}$ aqueous NaOH for neutralisation. The benzoic acid only has one acidic group and so reacts with the hydroxide in a $1:1$ molar ratio.

Calculate the percentage yield of benzoic acid from phenylethene in this reaction rounding to the nearest integer.

Adapted with permission from UCLES, A Level Chemistry, November 1999, General and Organic Paper, Question 6

Essential Pre-Uni Chemistry B3.4

GCSE C C C A Level P P P

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}$.

Part A (a)

Calculate the number of **atoms** (at RTP) in $60\,\mathrm{cm}^3$ of argon.

Part B (b)

Calculate the number of **atoms** (at RTP) in $1.2\,\mathrm{dm}^3$ of N_2.

Part C (c)

Calculate the number of **atoms** (at RTP) in $8.0\,\mathrm{m}^3$ of carbon dioxide.

Part D (d)

Calculate the number of **atoms** (at RTP) in $420\,\mathrm{cm}^3$ of ethene. Give your answer to 2 significant figures.

Essential Pre-Uni Chemistry B3.5

GCSE C C C A Level P P P

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}$.

Part A (a)

Calculate the the mass of $1.0\,\mathrm{m}^3$ of neon at RTP.

Part B (b)

Calculate the the mass of $20\,\mathrm{cm}^3$ of $(\mathrm{CH_3})_2\mathrm{O}$ at RTP.

Part C (c)

Calculate the the mass of $420\,\mathrm{cm}^3$ of ammonia at RTP. Give your answer to 2 significant figures.

Yield vs Atom Economy

A Level

Identify the correct statements about percentage yield and atom economy.

1. Both percentage yield and atom economy can theoretically range from $0\,\%$ to $100\,\%$.
2. The percentage yield of a reaction is always less than or equal to its atom economy.
3. The atom economy of a reaction will always be increased by adding a catalyst.

- **1** only
- **2** only
- **3** only
- **1** and **2**
- **1** and **3**
- **2** and **3**
- None of the above
- All of the above

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Essential Pre-Uni Chemistry B6.4

GCSE - Challenge (C3)
A Level - Practice (P1)

Calculate the volume of $0.50\,\text{mol}\,\text{dm}^{-3}$ H_2SO_4 required to neutralize each of the following. Give your answer in cm^3 unless otherwise specified.

Part A **(a)**

$25.0\,\text{cm}^3$ of $1.0\,\text{mol}\,\text{dm}^{-3}$ $NaOH$

Part B **(b)**

$3.0\,\text{g}$ $CaCO_3$

Part C **(c)**

$1.25\,\text{g}$ $ZnCO_3$

Part D **(d)**

$4.03\,\text{kg}$ MgO. Give your answer in dm^3.

Part E **(e)**

$100\,\text{cm}^3$ of $0.2\,\text{mol}\,\text{dm}^{-3}$ $NH_3\,(aq)$

Step and overall yield

A Level - Practice (P1)

A synthesis from phenol to give **G** ($C_8H_8O_2$) was carried out as shown below.

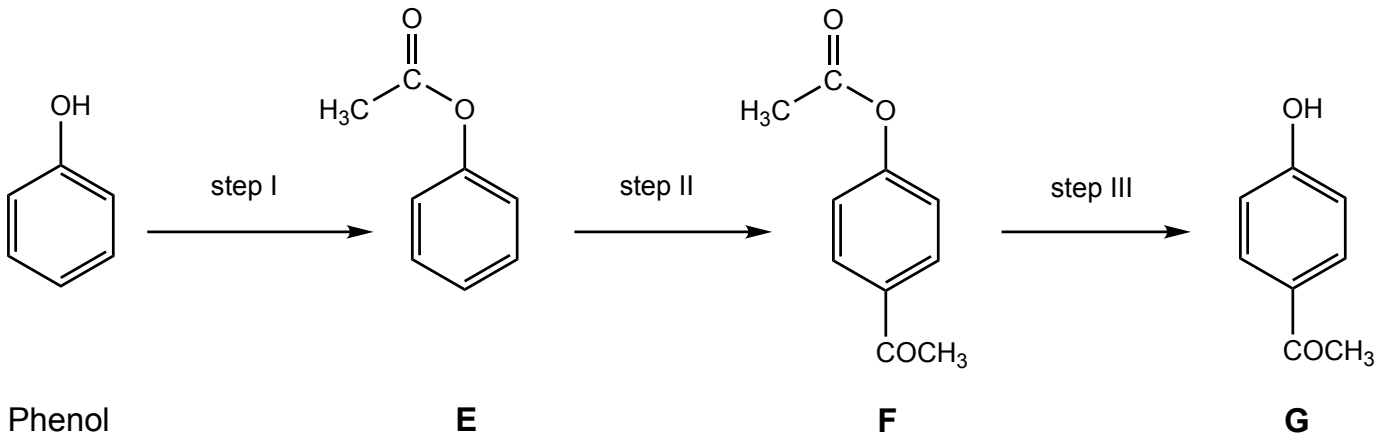

Figure 1: Three-step synthesis starting from phenol.

Part A Overall yield

$47.0\,\text{g}$ of phenol gave $44.5\,\text{g}$ of the final product **G** ($C_8H_8O_2$). What is the overall percentage yield of **G** from phenol? Give your answer to the nearest integer.

Part B Step II yield

The yield for step I, for the conversion of phenol to **E** ($C_8H_8O_2$), was $75\,\%$, and the yield for the hydrolysis of **F** ($C_{10}H_{10}O_3$) to **G** ($C_8H_8O_2$) in step II was $100\,\%$. What is the percentage yield for step II? Give your answer to the nearest integer.

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Essential Pre-Uni Chemistry B3.2

GCSE - Practice (P2)
A Level - Practice (P1)

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}$.

Part A **(a)**

Calculate the amount of gas (at RTP) in $4.8\,\mathrm{dm}^3$.

Part B **(b)**

Calculate the amount of gas (at RTP) in $12\,\mathrm{m}^3$.

Part C **(c)**

Calculate the amount of gas (at RTP) in $400\,\mathrm{cm}^3$. Give your answer to 2 significant figures.

Part D **(d)**

Calculate the amount of gas (at RTP) in $18\,\mathrm{ml}$.

Essential Pre-Uni Chemistry B3.1

GCSE - Challenge (C2)
A Level - Practice (P1)

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}\,\mathrm{mol}^{-1}$.

Part A **(a)**

Calculate the volume occupied by $4.0\,\mathrm{moles}$ of gas at RTP.

Part B **(b)**

Calculate the volume occupied by $0.030\,\mathrm{moles}$ of gas at RTP.

Part C **(c)**

Calculate the volume occupied by 5.0×10^{18} atoms of helium gas at RTP.

Part D **(d)**

Calculate the volume occupied by 1.2×10^{24} molecules of ozone at RTP.

Part E **(e)**

Calculate the volume occupied by $8.0\,\mathrm{g}$ of O_2 at RTP.

Part F **(f)**

Calculate the volume occupied by $1.1\,\mathrm{kg}$ of carbon dioxide at RTP.

Oxidation Yield

A Level - Practice (P1)

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Calculate the percentage yield of benzoic acid from phenylethene in this reaction rounding to the nearest integer.

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Essential Pre-Uni Chemistry B3.4

GCSE - Challenge (C2)
A Level - Practice (P1)

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Part A **(a)**

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Part B **(b)**

Calculate the number of **atoms** (at RTP) in $1.2\,\mathrm{dm}^3$ of N_2.

Part C **(c)**

Calculate the number of **atoms** (at RTP) in $8.0\,\mathrm{m}^3$ of carbon dioxide.

Part D **(d)**

Calculate the number of **atoms** (at RTP) in $420\,\mathrm{cm}^3$ of ethene. Give your answer to 2 significant figures.

Essential Pre-Uni Chemistry B3.5

GCSE - Challenge (C2)
A Level - Practice (P1)

RTP = room temperature and pressure.

Any gas occupies $24\,\mathrm{dm}^3$ per mole at RTP.

Avogadro's number, $N_\mathrm{A} = 6.02 \times 10^{23}$.

Part A **(a)**

Calculate the the mass of $1.0\,\mathrm{m}^3$ of neon at RTP.

Part B **(b)**

Calculate the the mass of $20\,\mathrm{cm}^3$ of $(\mathrm{CH_3})_2\mathrm{O}$ at RTP.

Part C **(c)**

Calculate the the mass of $420\,\mathrm{cm}^3$ of ammonia at RTP. Give your answer to 2 significant figures.

Yield vs Atom Economy

Identify the correct statements about percentage yield and atom economy.

1. Both percentage yield and atom economy can theoretically range from $0\,\%$ to $100\,\%$.
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- **1** only
- **2** only
- **3** only
- **1** and **2**
- **1** and **3**
- **2** and **3**
- None of the above
- All of the above

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Smelting

A Level - Practice (P1)

Smelting of metal ores is often carried out with carbon monoxide. The metal ore is reduced by the carbon monoxide gas, which is itself oxidised to carbon dioxide (a waste product) in the process.

Consider the above occurring for the reduction of CuO and $\mathrm{Fe_2O_3}$ to the respective metals: copper and iron. Calculate the atom economy for each of these two reactions, giving your answer as a percentage rounded to the nearest integer.

Part A CuO

Calculate the atom economy for the reduction of CuO.

Part B $\mathrm{Fe_2O_3}$

Calculate the atom economy for the reduction of $\mathrm{Fe_2O_3}$.

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Alcohol Oxidation Efficiency

A Level - Practice (P1)

A student was given the following instructions for the preparation and identification of a carbonyl compound:

To $100\,\mathrm{cm}^3$ *of water in a flask, carefully add* $30\,\mathrm{cm}^3$ *of concentrated sulfuric acid and set up the apparatus for distillation.*

Make up a solution containing $28.0\,\mathrm{g}$ *of sodium dichromate(VI),* $\mathrm{Na_2Cr_2O_7}$ *in* $15.0\,\mathrm{cm}^3$ *of water; add* $18.0\,\mathrm{g}$ *of the alcohol,* $\mathrm{C_3H_8O}$*, and pour the solution into a dropping funnel connected to the flask.*

Boil the acid in the flask. Add the mixture containing the alcohol at such a rate that the product is collected slowly.

Re-distil the crude product and collect the fraction that boils between $48\,^\circ\mathrm{C}$ *and* $50\,^\circ\mathrm{C}$*.*

The balanced equation for the process taking place is shown below:

$$3\,\mathrm{C_3H_8O} + \mathrm{Na_2Cr_2O_7} + 4\,\mathrm{H_2SO_4} \longrightarrow 3\,\mathrm{C_3H_6O} + \mathrm{Na_2SO_4} + \mathrm{Cr_2(SO_4)_3} + 7\,\mathrm{H_2O}$$

The student obtained $7.20\,\mathrm{g}$ of the carbonyl compound, $\mathrm{C_3H_6O}$.

Part A Atom economy

Calculate the atom economy for this process, treating only the carbonyl compound as a useful product. Give your answer expressed as a percentage and rounded to the nearest integer.

Part B Moles of dichromate

Calculate how many moles of $\mathrm{Na_2Cr_2O_7}$ were used.

Part C Limiting reagent

Identify which reagent was limiting and fill in its molecular formula. Assume that concentrated sulfuric acid has a concentration of $18.4\,\mathrm{mol\,dm^{-3}}$.

Part D Percentage yield

Calculate the percentage yield obtained by the student. Give your answer rounded to the nearest integer.

Adapted with permission from UCLES, A Level Science (Modular), June 1997, Chains and Rings Paper, Question 3

Smelting

A Level

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