AS BRIDGING WORK

1) Complete all questions, remember to show all working.
2) Using the markscheme and a green pen, self mark and correct your work.
3) Write 3 targets – which calculations will you need to practice?

PART 1: MEASURING AMOUNT OF SUBSTANCE

MASS **VOLUME** **MOLAR MASS** **AVOGADRO**

CONCENTRATION **ATOM** **ION** **MOLECULE**

MEASUREMENTS IN CHEMISTRY

Mass

Convert the following into grams:

a) 0.25 kg
b) 15 kg
c) 100 tonnes
d) 2 tonnes

Volume

Convert the following into dm^3:

a) 100 cm^3
b) 25 cm^3
c) 50 m^3
d) 50000 cm^3

Tip – always use standard form for very large and very small numbers!

What is a mole?

Atoms and molecules are very small – far too small to count individually!

It is important to know how much of something we have, but we count particles in MOLES because you get simpler numbers

$$1 \text{ mole} = 6.02 \times 10^{23} \text{ particles}$$

$(6.02 \times 10^{23}$ is known as Avogadro's number)

a) If you have 2.5×10^{21} atoms of magnesium, how many moles do you have?

b) If you have 0.25 moles of carbon dioxide, how many molecules do you have?

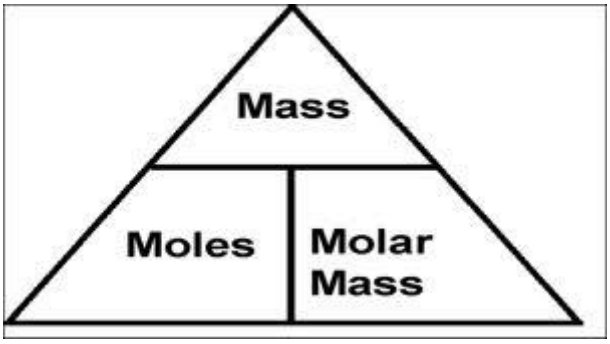
How can you work out how many moles you have?

a) From a measurement of **MASS**:

You can find the number of moles of a substance if you are given its **mass** and you know its **molar mass**:

number of moles = mass/molar mass

$n = m/m_r$



Mass MUST be measured in grams!

Molar mass has units of $gmol^{-1}$

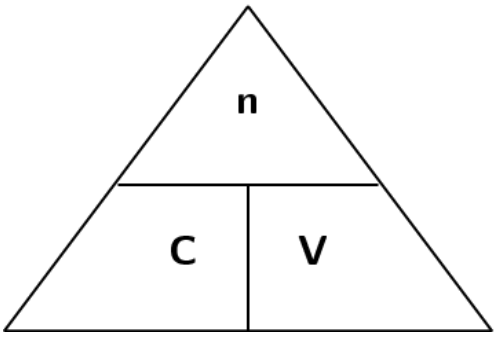
1. Calculate the number of moles present in:	2. Calculate the mass of:	3. Calculate the molar mass of the following substances:
a) 2.3 g of Na	a) 0.05 moles of Cl_2	a) 0.015 moles, 0.42 g
b) 2.5 g of O_2	b) 0.125 moles of KBr	b) 0.0125 moles, 0.50 g
c) 240 kg of CO_2	c) 0.075 moles of $Ca(OH)_2$	c) 0.55 moles, 88 g
d) 12.5 g of $Al(OH)_3$	d) 250 moles of Fe_2O_3	d) 2.25 moles, 63 g
e) 5.2 g of PbO_2	e) 0.02 moles of $Al_2(SO_4)_3$	e) 0.00125 moles, 0.312 g

b) From a measurement of AQUEOUS VOLUME:

You can find the number of moles of a substance dissolved in water (aqueous) if you are given the **volume** of solution and you know its **molar concentration**:

number of moles = aqueous volume x molar concentration

n = V x C



Aqueous volume MUST be measured in dm^3!

concentration has units of $moldm^{-3}$

If you know the molar mass of the substance, you can convert the molar concentration into a mass concentration:

Molar concentration ($moldm^{-3}$) x m_r = mass concentration (gdm^{-3})

1. Calculate the number of moles of substance present in each of the following solutions:	2. Calculate the molar concentration and the mass concentration of the following solutions:	3. Calculate the molar concentration and the mass concentration of the following solutions:
a) 25 cm^3 of 0.1 $moldm^{-3}$ HCl	a) 0.05 moles of HCl in 20 cm^3	a) 35 g of NaCl in 100 cm^3
b) 40 cm^3 of 0.2 $moldm^{-3}$ HNO_3	b) 0.01 moles of NaOH in 25 cm^3	b) 20 g of $CuSO_4$ in 200 cm^3
c) 10 cm^3 of 1.5 $moldm^{-3}$ NaCl	c) 0.002 moles of H_2SO_4 in 16.5 cm^3	c) 5 g of HCl in 50 cm^3
d) 5 cm^3 of 0.5 $moldm^{-3}$ $AgNO_3$	d) 0.02 moles of $CuSO_4$ in 200 cm^3	d) 8 g of NaOH in 250 cm^3
e) 50 cm^3 of 0.1 $moldm^{-3}$ H_2SO_4	e) 0.1 moles of NH_3 in 50 cm^3	e) 2.5 g of NH_3 in 50 cm^3

c) From a measurement of GASEOUS VOLUME:

You can find the number of moles of a gas if you are given the **volume** of the gas and its **pressure** (in kPa) and **absolute temperature (in K)**:

$$\textbf{number of moles} = \frac{\textbf{pressure x volume}}{\textbf{R x temperature}} = \textbf{PV/RT}$$

Volume of gas must be in m^3

Pressure must be in Pa

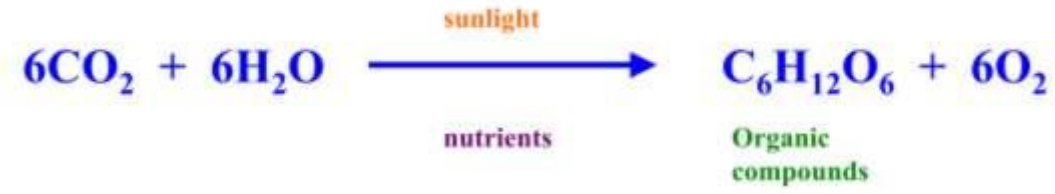
Temperature must be in K

R is the molar gas constant ($8.31\ Jmol^{-1}K^{-1}$)

1. Calculate the number of moles present in:	2. Calculate the volume of gas occupied by:	3. Calculate the mass of the following gas samples:
a) 48 dm^3 of O_2 at 298 K and 100 kPa	a) 0.05 moles of Cl_2 at 298 K and 100 kPa	a) 48 dm^3 of O_2 at 298 K and 100 kPa
b) 1.2 dm^3 of CO_2 at 298 K and 100 kPa	b) 0.25 moles of CO_2 at 298 K and 100 kPa	b) 1.2 dm^3 of CO_2 at 298 K and 100 kPa
c) 200 cm^3 of N_2 at 273 K and 250 kPa	c) 28 g of N_2 at 273 K and 250 kPa	c) 200 cm^3 of N_2 at 273 K and 250 kPa
d) 100 dm^3 of Cl_2 at 30 ^oC at 100 kPa	d) 3.2 g of O_2 at 30 ^oC at 100 kPa	d) 100 dm^3 of Cl_2 at 30 ^oC at 100 kPa
e) 60 cm^3 of NO_2 at 25 ^oC and 100 kPa	e) 20 g of NO_2 at 25 ^oC and 100 kPa	e) 60 cm^3 of NO_2 at 25 ^oC and 100 kPa

PART 2: USING CHEMICAL EQUATIONS

MASS **AQUEOUS VOLUME** ` **MOLAR MASS**



GASEOUS VOLUME **MOLES** **CONCENTRATION**

REVISION FROM TASK 1

How many moles?

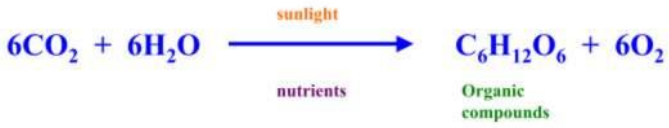
1) Erder weighs a sample of $CaCO_3$ and records a mass of 5.0 g. How many moles of calcium carbonate are present?

2) Aishah measures out 50 cm^3 of 0.1 $moldm^{-3}$ hydrochloric acid. How many moles of hydrochloric acid are present?

3) Humaira collects 48 cm^3 of carbon dioxide in a gas syringe at 298 K and 100 kPa. How many moles of carbon dioxide are present?

Using Chemical Equations

Chemical Equations show the ratio in which different species react in a chemical equation.



This equation shows that **6** moles carbon dioxide of react with **6** mole of water to make **1** mole of glucose and **6** moles of oxygen.

6: 6: 1: 6

a) How many moles of water are needed to react with 0.03 moles of carbon dioxide?
b) How many moles of glucose can you make from 0.03 moles of carbon dioxide?
c) How many moles of oxygen can you make from 0.03 moles of carbon dioxide?

Equation 1: $Mg + 2\,HCl \rightarrow MgCl_2 + H_2$

a) How many moles of magnesium would be needed to react with 0.01 moles of hydrochloric acid?
b) How many moles of hydrogen could be produced from 0.01 moles of hydrochloric acid?

Equation 2: $2\,H_2S + 3\,O_2 \rightarrow 2\,SO_2 + 2\,H_2O$

a) How many moles of oxygen are needed to react with 0.5 moles of hydrogen sulphide?
b) How many moles of sulphur dioxide can be made from 0.5 moles of hydrogen sulphide?

Equation 3: $4\,K + O_2 \rightarrow 2\,K_2O$

a) How many moles of oxygen are needed to react with 0.05 moles of potassium?
b) How many moles of potassium oxide can be made from 0.05 moles of potassium?

Calculating Reacting Quantities from Chemical Equations

You perform these calculations in three steps:

- **calculate the number of moles of one of the substances (you will either be given the mass, or the aqueous volume and the concentration, or the gaseous volume)**
- **use the equation to work out the number of moles of the other substance**
- **use one of the mole relationships to work out the quantity you need**

1) What volume (in dm^3) of hydrogen is produced at 298 K and 100 kPa when 194 g of magnesium is reacted with hydrochloric acid?

$$Mg + 2\,HCl \rightarrow MgCl_2 + H_2$$ (3)

2) What volume (in cm^3) of 0.5 $moldm^{-3}$ hydrochloric acid is required to react completely with 1.94 g of magnesium?

$$Mg + 2\,HCl \rightarrow MgCl_2 + H_2$$ (3)

3) What volume (in dm^3) of oxygen at 298 K and 100 kPa is needed to react with 8.5 g of hydrogen sulphide (H_2S)?

$$2\,H_2S + 3\,O_2 \rightarrow 2\,SO_2 + 2\,H_2O$$ (3)

4) What mass of potassium oxide is formed when 7.8 g of potassium is burned in excess oxygen?

$$4\,K + O_2 \rightarrow 2\,K_2O$$ (3)

5) What volume of oxygen (in dm^3) at 298 K and 100 kPa is required to oxidise 10 g of ammonia to NO?

$$4\,NH_3 + 5\,O_2 \rightarrow 4\,NO + 6\,H_2O$$ (3)

6) What mass of aluminium oxide is produced when 135 g of aluminium is burned in oxygen?

$$2\ Al + 3\ O_2 \rightarrow Al_2O_3$$ (3)

7) What mass of iodine is produced when 2.4 dm^3 of chlorine gas reacts with excess potassium iodide at 298 K and 100 kPa?

$$Cl_2 + 2\ KI \rightarrow 2\ KCl + I_2$$ (3)

8) What volume (in dm^3) of hydrogen is needed to react with 32 g of copper oxide at 200 ^oC and 100 kPa?

$$CuO + H_2 \rightarrow Cu + H_2O$$ (3)

9) What volume of oxygen is formed at 398 K and 100 kPa when 735 g of potassium chlorate decomposes?

$$2\ KClO_3 \rightarrow 2\ KCl + 3\ O_2$$ (3)

10) What volume of hydrogen is produced when 195 g of potassium is added to water at 298 K and 100 kPa?

$$2\ K + 2\ H_2O \rightarrow 2\ KOH + H_2$$ (3)

11) What mass of calcium carbonate is required to produce 1.2 dm^3 of carbon dioxide at 398 K and 100 kPa?

$$CaCO_3 \rightarrow CaO + CO_2$$ (3)

12) What mass of magnesium oxide is formed when magnesium reacts with 6 dm^3 of oxygen at 298 K and 100 kPa?

$$2\ Mg\ +\ O_2\ \rightarrow\ 2\ MgO$$ (3)

13) What volume of carbon dioxide (in dm^3) is produced when 5.6 g of butene (C_4H_8) is burnt at 298 K and 100 kPa?

$$C_4H_8\ +\ 6\ O_2\ \rightarrow\ 4\ CO_2\ +\ 4\ H_2O$$ (3)

14) The pollutant sulphur dioxide can be removed from the air by reaction with calcium carbonate in the presence of oxygen. What mass of calcium carbonate is needed to remove 480 dm^3 of sulphur dioxide at 298 K and 100 kPa?

$$2\ CaCO_3\ +\ 2\ SO_2\ +\ O_2\ \rightarrow\ 2\ CaSO_4\ +\ 2\ CO_2$$ (3)

15) 25 cm^3 of a solution of sodium hydroxide reacts with 15 cm^3 of 0.1 mol/dm^3 HCl. What is the molar concentration of the sodium hydroxide solution?

$$HCl + NaOH \rightarrow NaCl + H_2O$$ (3)

FIVE AS-LEVEL QUESTIONS

1. Which one of the following contains the smallest number of moles of carbon dioxide gas?

A 2.65 g
B 0.0150 m^3 at 1000 K and 33.0 kPa
C 1.50 dm^3 at 327 °C and 200 kPa
D 1500 cm^3 at 300 K and 100 kPa

(Total 1 mark)

2. Which one of the following samples of gas, when sealed into a vessel of volume 0.10 m^3, is at the highest pressure?

A 1.6 g of helium (He) at 100 K
B 1.6 g of methane (CH_4) at 100 K
C 1.6 g of oxygen (O_2) at 600 K
D 1.6 g of sulphur dioxide (SO_2) at 1200 K

(Total 1 mark)

3. Which one of the following samples of gas occupies the largest volume?

A 1.0 g of ozone (O_3) at l00 kPa and 300 K
B 1.0 g of oxygen (O_2) at 100 kPa and 300 K
C 1.0 g of water vapour (H_2O) at 250 kPa and 450 K
D 1.0 g of methane (CH_4) at 333 kPa and 500 K

(Total 1 mark)

4. Which one of the following contains the greatest number of moles of methanol?
(The Avogadro number (L) is 6.02×10^{23}, the relative molecular mass (M_r) of methanol is 32.)

A 6.6×10^{22} molecules of methanol
B 3.3 g of methanol
C 2.5×10^{-3} m^3 of methanol vapour at 300 K and 100 kPa
D 70 cm^3 of 1.5 M aqueous methanol

(Total 1 mark)

5. What is the volume occupied by 10.8 g of the freon CCl_2F_2 at 100 kPa and 273 K?

A 2.02 dm^3
B 2.05 dm^3
C 2.02 cm^3
D 2.05 cm^3

(Total 1 mark)

ANSWERS TO TRANSITION EXERCISES

MEASUREMENTS IN CHEMISTRY

Mass

e) 0.25 x 1000 = 250 g
f) 15 x 1000 = 15000 g
g) $100 \times 10^6 = 1 \times 10^8$ g
h) 2×10^6 g

Volume

e) 100/100 = 0.1 dm^3
f) 25/1000 = 0.025 dm^3
g) 50 x 1000 = 50000 dm^3
h) 50000/1000 = 50 dm^3

What is a mole?

c) $(2.5 \times 10^{21})/(6.02 \times 10^{23}) = 4.15 \times 10^{-3}$
d) $0.25 \times 6.02 \times 10^{23} = 1.51 \times 10^{23}$

How can you work out how many moles you have?

d) From a measurement of **MASS**:

1.	a) 0.10	b) 0.078	c) 5500	d) 0.16	e) 0.022
2.	a) 3.6 g	b) 14.9 g	c) 5.6 g	d) 39.9 kg	e) 6.8 g
3.	a) 28	b) 40	c) 160	d) 28	e) 249.6

e) From a measurement of AQUEOUS VOLUME:

1. a) 2.5×10^{-3} b) 8×10^{-3} c) 0.015 d) 2.5×10^{-3} e) 5×10^{-3}
2. a) 2.5 $moldm^{-3}$, 91.3 gdm^{-3} b) 0.4 $moldm^{-3}$, 16 gdm^{-3}
   c) 0.121 $moldm^{-3}$, 11.9 gdm^{-3} d) 0.1 $moldm^{-3}$, 16.0 gdm^{-3}
   e) 2 $moldm^{-3}$, 34 gdm^{-3}
3. a) 350 gdm^{-3}, 5.98 $moldm^{-3}$ b) 100 gdm^{-3}, 0.627 $moldm^{-3}$
   c) 100 gdm^{-3}, 2.74 $moldm^{-3}$ d) 32 gdm^{-3}, 0.8 $moldm^{-3}$
   e) 50 gdm^{-3}, 1.47 $moldm^{-3}$

f) From a measurement of GASEOUS VOLUME:

1. a) 2 b) 0.05 c) 0.022 d) 4.0 e) 2.5
2. a) 1.2 dm^3 b) 6 dm^3 c) 9.1 dm^3 d) 2.5 dm^3 e) 10.4 dm^3
3. a) 64 g b) 2.2 g c) 0.62 g d) 282 g e) 0.115 g

TRANSITION COURSE – END OF PART 1!

How many moles?

1) 0.05
2) 5×10^{-3}
3) 2×10^{-3}

Using Chemical Equations

Equation 0: a) 0.03 b) 0.005 c) 0.03

Equation 1: a) 0.005 b) 0.005

Equation 2: a) 0.75 b) 0.5

Equation 3: a) 0.0125 b) 0.025

Calculating Reacting Quantities from Chemical Equations

1. moles (Mg) = 194/24.3 = 8.0
   moles (H_2) = 8.0 x 1 = 8.0
   volume (H_2) = 8.0 x 8.31 x 298/100000 x 1000 = 200 Answer: 200 dm^3

2. moles (Mg) = 1.94/24.3 = 0.08
   moles (HCl) = 0.08 x 2 = 0.16
   volume (HCl) = 0.16/0.5 x 1000 = 320 Answer: 320 cm^3

3. moles (H_2S) = 8.5/34 = 0.25
   moles (O_2) = 0.25 x 1.5 = 0.375
   mass (O_2) = 0.375 x 8.31 x 298/100000 x 1000 = 9.3 Answer: 9.3 dm^3

4. moles (K) = 7.8/39.1 = 0.2
   moles (K_2O) = 0.2 / 2 = 0.1
   mass (K_2O) = 0.1 x 94 = 9.4 Answer: 9.4 g

5. moles (NH_3) = 10/17 = 0.588
   moles (O_2) = 0.588 x 5/4 = 0.735
   mass (H_2) = 0.735 x 8.31 x 298/100000 x 1000 = 18.2 Answer: 18 dm^3

6. moles (Al) = 135/27 = 5
   moles (Al_2O_3) = 5/2 = 2.5
   mass (Al_2O_3) = 2.5 x 102 = 255 g Answer: 255 g

7. moles (Cl_2) = 100000 x 0.0024/(8.31 x 298) = 0.097
   moles (I_2) = 0.0197 x 1 = 0.097
   mass (I_2) = 0.097 x 253.8 = 24.6 g Answer: 24.6 g

8. moles (CuO) = 32/79.6 = 0.402
   moles (H_2) = 0.4 x 1 = 0.402
   volume (H_2) = 0.402 x 8.31 x 473/100000 x 1000 = 15.8 dm^3 Answer: 15.8 dm^3

9. moles ($KClO_3$) = 735/122.6 = 6.00
   moles (O_2) = 6.00 x 1.5 = 8.99
   volume (O_2) = 8.99 x 8.31 x 398/100000 x 1000 = 297 dm^3 Answer: 297 dm^3

10. moles (K) = 195/39.1 = 4.99
    moles (H_2) = 4.99 / 2 = 2.49
    volume (H_2) = 2.49 x 8.31 x 298/100000 x 1000 = 61.8 dm^3 Answer: 61.8 dm^3

11. moles (CO_2) = 0.0012 x 100000/(8.31 x 398) = 0.036
    moles ($CaCO_3$) = 0.036 x 1 = 0.036
    mass ($CaCO_3$) = 0.036 x 100.1 = 3.6 g Answer: 3.6 g

12. moles (O_2) = 0.006 x 100000/(8.31 x 298) = 0.24
    moles (MgO) = 0.24 x 2 = 0.48
    mass (MgO) = 0.48 x 19.5 = 19.5 g Answer: 19.5 g

13. moles (C_4H_8) = 5.6/56 = 0.1
    moles (CO_2) = 0.1 x 4 = 0.4
    volume (CO_2) = 0.4 x 8.31 x 298/100000 x 1000 = 9.9 Answer: 9.9 dm^3

14. moles (SO_2) = 0.480 x 100000/(298 x 8.31) = 19.4
    moles ($CaCO_3$) = 19.4 x 1 = 19.4
    mass ($CaCO_3$) = 19.4 x 100.1 = 1940 g Answer: 1940 g

15. moles (HCl) = (15/1000) x 0.1 = 0.0015
    moles (NaOH) = 0.0015 x 1 = 0.0015
    molar concentration (NaOH) = 0.0015 / (25/1000) = 0.06 mol/dm^3
    Answer: 0.06 mol/dm^3

AS Questions:

Answers: B, A, D, A, A