Lesson activity: GCSE to A-level progression (Chemistry) answer booklet

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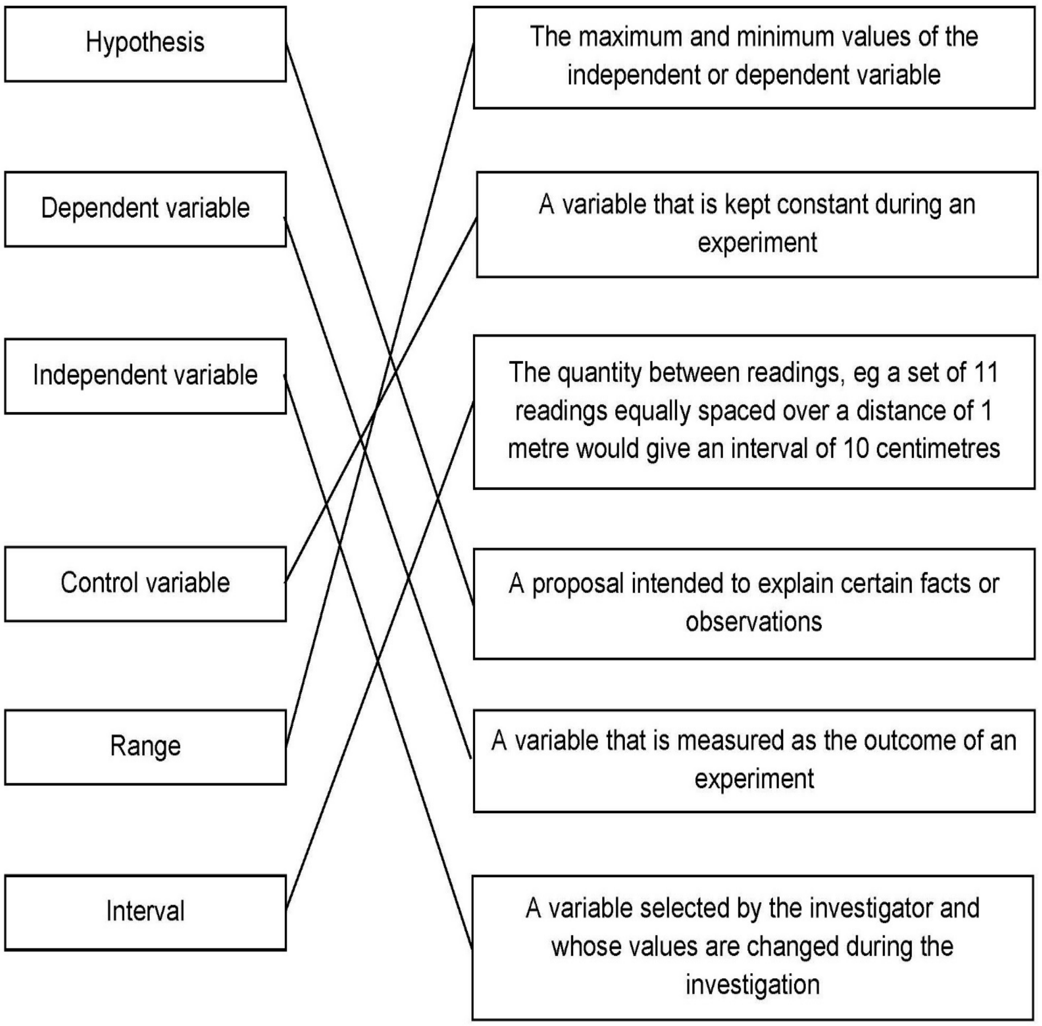
Activity 1 Scientific vocabulary: Designing an investigation



Activity 2 Scientific vocabulary: Making measurements

Term	Definition
True value	The value that would be obtained in an ideal measurement where there were no errors of any kind
Accurate	A measurement that is close to the true value
Resolution	The smallest change that can be measured using the measuring instrument that gives a readable change in the reading
Precise	Repeated measurements that are very similar to the calculated mean value
Uncertainty	The range within which you would expect the true value to lie

Activity 3 Scientific vocabulary: Errors

Term	Definition
Random error	Causes readings to be spread about the true value, due to results varying in an unpredictable way from one measurement to the next
Systematic error	Causes readings to differ from the true value by a consistent amount each time a measurement is made
Zero error	When there is an indication that a measuring system gives a false reading when the true value of a measured quantity is zero

Activity 4 SI units and prefixes
1. a. Kg - As the mass of water will be much less than a kilogram it could be expressed using power of ten (eg 1 gram would be written as 1x 10^{-3} kg. b. cm^3 - Volume is a derived SI unit, and is measured in cubic meters written as m^3. The volume in a burette is small and so the centi prefix is used to express a volume as centimeters cubed, written as cm^3. c. s d. picometres – length is measured in metres but as the length is so small the prefix pico is used. e. mol f. Kelvin
2. a. 500 cm^3 b. 300 s (seconds) c. 293.1 K - d. 294.261K – To convert Fahrenheit to kelvin (F − 32) × 5 ÷ 9 + 273.15 e. 1 x 10^{-5} m^3 f. 5 500 kg g. 9.64 x 10^{-8} m^3 - SI units 1 μl = 1 x 10-9 m^3
3. The flow rate of the critical chemical was reported as 0.24 kg per 60 seconds (4 x 10^{-3} kg per second) at a temperature of 293.1 K.

Activity 5 Converting data
1. 100mm
2. 10mm
3. 1.04 x 10^{-5} g
4. 1120.2 m or 1.1202 x 10^3
5. 7 000 ml or 7.0 x 10^3 ml
6. 7 liters
7. 0.01 cm^3 or 1 x10^{-2}
8. 2.14 kPa

Activity 6 Using the delta symbol
1. D
2. C
3. The reactions is **exothermic** and therefore ΔH is **negative.**

Activity 7 Electrolysis
1. The hypothesis describes the relationship between the amount of time the current flows and how much copper is deposited on the electrode, include a comment about the proportionality. For example: There is a linear relationship between the time a current flow and the amount of copper being deposited.
2. The longer the current flows the more copper will be deposited on the electrode and this relationship is linear.
3. a. the length of time the current flows b. the amount of copper deposited. c. strength of the current and the concentration of copper sulphate.
4. Reproducible – A measurement is reproducible if the investigation is repeated by another person, or by using different equipment or techniques and the same result is found. Repeatable – A measurement is repeatable if the original experimenter repeats the investigation using the same method and equipment and obtains the same results.
5. Most school balances have a resolution of 0.01 g.
6. Take more measurements and calculating a new mean. Also remember, when you are calculating a mean you need to disregard any anomalous readings.
7. Random errors are present when any measurement is made. Random errors cause uncertainty in the results. You can reduce the effect of random errors by taking more measurements and calculating a new mean. By reducing random errors you can make your results closer to the true value so more accurate.
8. 2 mins. 0.63 g (value of 0.45 is anomalous) 4 mins 0.85 g 6 mins 0.99 g 8 mins 1.06 g 10 mins 1.11 g

Activity 8 Using Maths skills

1.
   a. 4×10^3
   b. 1×10^6

2. 5.51368×10^5

3.
   a. 5.77×10^4
   b. 4.53×10^{-1}

4. The relative molecular mass of NaF is 42.0
   Mass NaF in 1 g = $2.88 \times 10^{-5} \times 42.0 = 1.210$ (or 1.2096) $\times 10^{-3}$ g

   Mass NaF in 1 kg = 1.210 (or 1.2096) g (Mass in mg = 1210 (or 1209.6) mg)

   Concentration of NaF = 1.21×10^3 ppm

Activity 9 Atoms

1.
   a. 76
   b. 82
   c. 11
   d. 17

2.
   a. 4
   b. 223
   c. 137.3
   d. 16

3.
   a. 10
   b. 5
   c. 118

Activity 10 Formulae of common compounds

1. CH^4
2. H_2SO_4
3. $KMnO_4$
4. H_2O

Activity 11 Ions and ionic compounds
1. $MgBr_2$
2. BaO
3. $ZnCl_2$
4. NH_4Cl
5. $(NH4)_2CO_3$
6. $AlBr_3$
7. $Ca(NO_3)_2$
8. $FeSO_4$
9. $Fe_2(SO4)_3$

Activity 12 Empirical formula

1. $C_3H_6O_1$
   Explanation:

Element	Carbon	Hydrogen	Oxygen
mass / relative atomic mass	0.360 / 12	0.060 / 1	0.16 / 16
Amount in moles	0.03	0.06	0.01
Divide by smallest value	0.03/0.01	0.06/0.01	0.01/0.01
Ratio	3	6	1

2. $Ti_2C_3O_9$
   Explanation:

Element	Titanium	Carbon	Oxygen
mass / relative atomic mass	0.479 / 47.9	0.18 / 12	0.72 / 16
Amount in moles	0.010	0.015	0.045
Divide by smallest value	0.010 /0.010	0.015 / 0.010	0.045 / 0.010
Ratio	1	1.5	4.5

The calculation lead to the proportions being 1: 1.5: 4.5.
However, ratios in empirical formulae must be whole numbers. If the number is too far to round, then multiply to get whole numbers i.e. 2: 3: 9 leading to the empirical formula $Ti_2C_3O_9$.

3. $C_2H_6O_2$
Explanation:
Firstly, calculate the mass of oxygen (monatomic O):
300 – (145.9 + 24.32) = 129.78 g

Element	Carbon	Hydrogen	Oxygen
mass / relative atomic mass	145.90/ 12	24.32 / 1	129.78 / 16
Amount in moles	12.16 (rounded to 2 dp)	24.32	8.11
Divide by smallest value	12.16 / 8.11	24.32 / 8.11	8.11/8.11
Ratio	1.50 (rounded to 2 dp)	3.00 (rounded to 2 dp)	1.00

The proportions are is 1.5: 3: 1. However, ratios can only be whole numbers, leading to $C_2H_6O_2$. This is the most likely empirical formula for ethane-1,2-diol (ethylene glycol).

4. CH_2O
Explanation:
calculate the percentage carbon and oxygen, which are equal:

100 – 5.99 = 94.01 ÷ 2 = 47.01% (2 dp) each for carbon and oxygen.

Element	Carbon	Hydrogen	Oxygen
% / relative atomic mass	47.01 / 12	5.99 / 1	47.01 / 16
Amount in moles	3.92 (rounded to 2 dp)	5.99	2.94 (rounded to 2 dp)
Divide by smallest value	3.92 / 2.94	5.99 / 2.94	2.94 / 2.94
Ratio	1.33 (rounded to 2 dp)	2.04 (rounded to 2 dp)	1.00

The proportions are 1.33: 2.04: 1. These can be rounded to give the ratio 1:2:1.

Activity 13 Balancing equations

1.
   a. $4Al + 3O_2 \rightarrow 2Al_2O_3$

   b. $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

   c. $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$

2.
   Stage 1: $4CuFeS_2 + 9\frac{1}{2} O2 + 4SiO_2 \rightarrow Cu_2S + 2Cu_2O + 7SO_2 + 4FeSiO_3 \rightarrow$

   Stage 2: $Cu_2S + 2CuO \rightarrow 4Cu + SO_2$

Activity 14 Moles

Substance	Mass of substance in grams	Amount in moles	Number of particles
Helium	**12.04**	**3.01** (rounded to 2 dp)	18.12×10^{23}
Chlorine (Cl)	14.2	**504.1**	**3.034682×10^{26}**
Methane	**64**	4	**2.408×10^{24}**
Sulfuric acid	4.905	**481.18** (rounded to 2 dp)	**2.8967036×10^{26}**

Activity 15 Isotopes and calculating relative atomic mass

1. 80

2. 20.18 divide each percentages by 100.
   multiply the result for each isotope by the relative atomic mass
   add the results together
   express to 4 significant figures

3. ^{63}Cu = 69.17% ^{65}Cu = 30.83%

Activity 16 Extended writing: Types of bonding

The command word is 'compare'. The answer could written in bullet points, prose or presented in a table with clear heading and a brief explanation of what you have done. The answer needs to consider both similarities and differences of the bonds between all three types of bonds.

Similarities

- They all have the electrostatic force of attraction, making strong bonds.
- They hold one atom to another atom.
- The bonding between the atoms results in to forming a stable compound.
- All three types of bonding give different properties, than the original elements.

Differences

These are some points to consider.

Covalent

- A single covalent bond contains a shared pair of electrons.
- Bonds between atoms are strong.
- Multiple bonds contain multiple pairs of electrons.
- Occur in most non metallic elements and in compounds of non- metals.
- A co-ordinate (dative covalent) bond contains a shared pair of electrons with both electrons supplied by one atom.

Metallic

- During metallic bonding the particles are atoms which share delocalised electrons.
- They occur in metallic elements and alloys.
- The attraction between delocalised electrons and positive ions arranged in a regular lattice structure.
- The sharing of delocalized electrons gives rise to strong metallic bonds.

Ionic

- Electrons in the outer shell of the metal atom are transferred.
- Ionic bonding involves electrostatic attraction between oppositely charged ions in a lattice.
- There is strong electrostatic forces of attraction between oppositely charged ions.
- Occurs in compounds formed from metals combined with non – metals.