**Unit 6: Measurement**

**Measurement and Units**

**Qualitative** measurement involves the use of descriptive words that are non-numeric e.g. the reaction produced a white solid.

Quantitativemeasurement involves numbers and values e.g. The reaction took 20 seconds to produce a white solid.

**Basic *Systeme International* (SI) Units**

In the 18th century the French invented a metric system which they based on a more consistent, systematic and carefully set of defined standards that were never previously used before.

**Seven base units**

|  |  |  |
| --- | --- | --- |
| **Type of measurement** | **Base Unit** | **Abbreviation** |
| Length | meter | m |
| Mass | Kilograms | kg |
| Time | Second | s |
| Temperature | Kelvin | K |
| Amount of substance | Mole | mol |
| Electric current | ampere | A |
| Luminous intensity | Candela | cd |

We can derive other units from the 7 base units we have here. For example weight is measured in SI units of force, which is Newtons (N), where Force=mass x gravitational force. Having a mass of 60kg means your weight will approximately be 60 x 10 = 600N. This is because a mass of l kg weighs almost 10N.

**Temperature scales**

In degrees Celsius the temperature at which water **freezes** is defined as **0** degrees Celsius and the point at which it **boils** is **100** degrees Celsius.

In Fahrenheit the temperature at which water **freezes** is **32** degrees Fahrenheit and where water **boils** is **212** degrees Fahrenheit.

**Formulas**

**Kelvin**

**Conversion of SI Units(Metric System)**

|  |  |  |  |
| --- | --- | --- | --- |
| **Prefix** | **Abbreviation** | **Meaning** | **Example** |
| **Giga** | ***G*** |  | **1 gigameter (Gm) = 1 \* m** |
| **Mega** | **M** |  | **1 megameter (Mm) = 1 \*** |
| **Kilo** | **k** |  | **1 kilometer (km) = 1 \*** |
| **Deci** | **d** |  | **1 decimeter (dm) = 1 \*** |
| **Centi** | **c** |  | **1 centimeter (cm) = 1 \*** |
| **Milli** | **m** |  | **1 millimeter (mm) = 1 \*** |
| **Micro** | **µ** |  | **1 micrometer (µm) = 1 \*** |
| **Nano** | **n** |  | **1 nanometer (nm) = 1 \*** |
| **Pico** | **p** |  | **1 picometer (pm) = 1 \*** |
| **Femto** | **f** |  | **1 femtometer (fm) = 1 \*** |

**Precision and accuracy**

**Precision** sees how closely a series of measurements made on the same object resemble each other. The closer the measurements are to each other the higher the precision.

**Accuracy** describes a property’s “True” value by seeing how closely the measured value approaches it.

**Significant Figures**

Significant figures are all numbers in a measurement that are measured accurately, plus a last estimated digit. Significant figures indicate the precision of the value.

**Rules of significant figures**

1. **All non-zero digits are significant.**

Example:

2.5 and 25 both have **two** significant figures.

1. **Zeros between two non-zero digits are always significant.**

Example:

9001 has **four** significant figures.

200.69 has **five** significant figures.

1. **Leading zeros are not significant**

Example:

0005.68 has **three** significant figures.

0.901 has **three** significant figures.

1. **Terminal zeros after the decimal point are always significant**

Example:

55.000 has **six** significant figures.

1.000 has **four** significant figures.

**5. In a decimal number with no decimal point the trailing zeros after non-zero digits are not necessarily significant.**

Example:

602 000 has **at least three** significant figures.

A method to avoid this ambiguity is expressing it in scientific notation.

**Scientific notation**

A notation used to make enormous or extremely tiny numbers easily readable for humans.

Example:

9.5

Where **9.5** is the **Coefficient**, **10** is the **base** and **6** is the **exponent**.

If **n**, which is **6** in this case, is **positive** then the original decimal point will be to the right of standard position.

If **n** is **negative** then the decimal point will be to the left standard postion.

**Multiplication and division**

Multiplying or dividing two numbers written in scientific notation can be done using certain rules.

**Multiplication:**

( = (

**Division:**

( =

**Rounding of numbers**

Rounding of means making the value of a number simpler, but keeping it’s accuracy as close as possible to the True value.

**Rules**

1. When the number dropped is **< 5** then the preceding number is unchanged.

Example:

**2d.p:** 1.543 will be **1.54** the dropped number is **3**.

1. When the number dropped is **> 5** then 1 is added to the preceding number.

Example:

**4s.f:** 65646 will be **6565** the dropped number is **6**.

1. When the number dropped == 5, if the preceding number is **even** then it remains unchanged, if it is **odd** then 1 is added to it.

**Rules for determining significant figures in calculations**

**Addition and subtraction**

Answer may contain only as many ***decimal places*** as the ***least precise value*** i.e. ***fewer*** decimal places.

* 5.2208 + 0.1 = 5.3208
* **5.3** -> value is adjusted to **5.3** since **0.1** is the least precise value.

**Division and Multiplication**

Answer may contain only as many ***total digits*** as the ***least accurate value*** used i.e. ***fewer*** significant figures.

* 49.600 / 47.40 = 1.0464135
* **1.046** -> value is adjusted is **1.046** since **49.600** is least accurate value.