# Metric System

**SI *Base* Units of Measurement**

- Meter (m) - length
- Liter - volume
- Kilogram - mass
- Seconds/minutes/hours - time
- Ampere (A) - electric current
- Kelvin - temperature
- Candela (cd) - luminous intensity
- Mole (mol) - amount of substance at a molecular level

*Starts with a **base unit** and increases or decreases in units of 10*

Prefix + base unit: indicates amount

For example: deci + meter = decimeter, which is 1/10th of a meter

Nano + meter = nanometer, which is 1 billionth of a meter

7:32.67 = 7 minutes, 32 seconds and 67 one-hundredths of a second

**Prefixes**

| Metric prefixes in everyday use | | |
|---|---|---|
| **Text** | **Symbol** | **Factor** |
| tera | T | 1 000 000 000 000 |
| giga | G | 1 000 000 000 |
| mega | M | 1 000 000 |
| kilo | k | 1 000 |
| hecto | h | 100 |
| deca | da | 10 |
| (none) | (none) | 1 |
| deci | d | 0.1 |
| centi | c | 0.01 |
| milli | m | 0.001 |
| micro | μ | 0.000 001 |
| nano | n | 0.000 000 001 |
| pico | p | 0.000 000 000 001 |
| V•T•E | | |

Rules:

- Prefix symbols greater than 10^3 are capitalized
- Abbreviations don't need periods

# Lab Glassware

**Lab Glassware**
*Measures volume*

| | |
|---|---|
| Erlenmeyer flasks + beakers | - For mixing, transporting, reacting<br>- Can measure liquids, but not for accurate measurements |
| Graduated cylinders | ● Intermediate amount of precision<br>○ More precise than beakers/Erlenmeyer flasks, not as precise as **volumetric flask**s / **pipettes**<br>● Made of **polypropylene** (shatter-resistant and resistant to chemicals - can't be heated)<br>○ Or **polymethylpentene** (known for clarity - lighter to ship, less fragile than glass)<br>● To read<br>○ Flat surface, eye level, surface forms a lens-shaped curve - take bottom of curve |
| Pipette | - Accurately measures small amounts of liquid<br>- Measurement read exactly at **meniscus**<br>- **Pipette**<br>- Hand-operated pump that dispenses solutions |
| Burette/buret | ● Accurately dispenses liquid<br>○ include s stopcock and tip |

**Beakers/Erlenmeyer < Graduated cylinder < Volumetric flask/Pipette < Burette (in order of dispensing precision).**

# Balances

**Balances**
*Measure mass and force*

Most to least accurate:

1. Electronic balance
2. Triple-beam balance
3. Spring balance

**Triple-beam balance**

- Has a plate - where item to be weighed is placed
- x 3 **beams** - textbook makes no sense
    - Front beam - measures weights from 0 to 10 grams
    - Middle beam - measures weights in 100-gram increments
    - Far beam - weights in 10-gram increments
- Sum of the beams = total weight of object
- **Set screw**
    - Calibrates equipment
- Mark indicating the object and counterweights are in balance

Analytical balances are accurate to within 0.0001 g

# Scientific Explanations

**Scientific Explanations**

**Data Collection FROM EXPERIMENTS**

- Valid experiment must be measurable
- Data should be repeatable, reproducible, and accurate
    - Procedure for data collection should be reliable and consistent
- Practice tests should be done to **calibrate** all equipment

**Scientific process skills**

- **Observation**
    - Scientists need to take data from experiments/nature without bias
- **Hypothesizing**
    - Combining theory knowledge and other experimental results to determine what should occur in their own tests
- **Data-analysis process**
    - Ordering/categorizing
        - Gathered data must be arranged to be readable with key results
    - Comparing
        - Should be able to compare one's own results with other published results
    - Infer
        - Drawing logical conclusions from your results
    - Apply
        - Knowledge of theory and results to create logical experimental designs and determine cases of special behavior
    - Communicate
        - One's results and conclusions
        - *Greatest scientific progress is made when scientists review and test one another's work and offer advice/suggestions*

**Scientific Statements**

- **Hypotheses**
    - Educated guesses about what is likely to occur
    - Starting point for designing an experiment
    - Can be based on results of previous experiments of theory or follow logically from both
- **Assumptions**
    - Statements take to be fact without proof for purpose of performing an experiment
    - Can be true or true only for given set of conditions under which experiment is conducted
    - *Necessary* to simplify experiments
        - Huh
- Scientific models
    - Mathematical statements that describe physical behavior
        - Only as good as our knowledge of the actual system

        - Never perfectly represent an actual system
        - Good for simplifying it for better understand of its behavior
- Scientific laws
    - Statements about natural behavior that produce accurate/repeatable results in all testing
- Theory
    - Statement of behavior that consolidates all current observations
    - More susceptible to being proven wrong
    - Can become laws if they resist scrutiny/testing

**Scientific Method**

1. First step: formulating the problem that is to be addressed
    a. Define the limits of what's to be observed
2. Hypothesis
    a. Educated guess should be a possible solution
3. Experimentation
    a. Test the hypothesis
    b. Can be quantitative - when a numeric measurement is taken
    c. Qualitative - something is evaluated based on feeling or preference
4. Drawing conclusions or making generalizations intended to predict future results
    a. If they support hypothesis, experiment is complete
    b. Results will be published to allow others to test it by repeating experiment
    c. If don't
        i. Results used to develop new hypothesis
        ii. New experiment

**Experimental Design**

- should be **controlled** so that all conditions except ones being manipulated (independent variables) are **constant**
    - Prevents results from being skewed by unintended consequences of shifting conditions
    - Ex. a placebo group
    - A **control group**
        - **Positive controls**
        - **Negative control groups**

My notes made no sense so i just highlighted the key vocabulary above

- Data collection must be kept in mind
    - Ex. checking data collected periodically for obvious errors
- **Analyzing** collected data

**Variables**

- **Independent variable** - the one purposely changed and tested

- **Dependent variable** - is observed and recorded
- All other variables = **constants**

**Events**

- **Cause** = act or event that makes something happen, **effect** if what happens
    - Single cause can have multiple effects
    - Single effect can have multiple causes
    - An effect can be the cause of another effect
        - **Cause-and-effect chain**

**Extra: IF YOU WANT TO MEASURE THE VOLUME OF AN IRREGULARLY SHAPED OBJECT LIKE A ROCK**

**MEASURE HOW MUCH WATER IT DISPLACES WHEN DROPPED INTO A CONTAINER FILLED TO THE BRIM WITH WATER**

- **ACCORDING TO TEAS PRACTICE TEST VER. A**