

The nature of chemistry

Nature of Chemistry

Chemistry	Study of substances that make up the world and the changes they undergo
Pseudoscience	Process inv. the collection of info that is supported by belief or opinion
Science	Process inv. the collection of info that is supported by evidence

Science is systematic, inv. collection of info and ideas, inv. obs. and experimentation, supp. by evidence

Science	Pseudoscience
relies on process, is objective, is updated constantly	lacks process, is subject, is resistant to new info (i.e. flat earths..)

Scientific inquiry is the process of using obs, investigations, and exp. to learn about natural phenomena -> any testable questions about obs., importance on creativity

Formulating Scientific Questions

Scientific question	Based on obs. and is testable
Most Q are based on obs.	What is that? Why? How does it work? I wonder why..
A good one	narrow focus, unknown answer, addresses gap in knowledge, leads to a hypothesis that can be tested
Non scientific question	based on supernatural, opinion, rely on moral or social values

Scientific methods

Dependent variable	Variable that is changed by another variable
Independent variable	The variable that you change
Qualitative	Obs/data that is not measured on numbers/precise measurements
Quantitative	Obs/data based on numbers/precise measurements
Sc. Inquiry	Process of using obs, inv., and exp. to learn about natural phenomena
Conclusion	Summary of the results

Scientific methods (cont)

Controlled exp.	an exp. in which one variable is changed
Control sample	Sample in a controlled exp. with variables that don't change
Exp. sample	sample in a controlled exp. in which one variable changes
Models	Simple, idea, picture, equation, method, diagram -> visualizing exp. results
Writing a lab report	Question/Hypothesis -> materials -> procedure -> results/data -> analysis -> conclusion

Research in Science

Skepticism	Open minded knowledge in a certain area may be uncertain
Bias	Point of view influenced by opinion
Scientific census	General agreement along scientists on an idea

Research in Science (cont)

How to develop sc. census?	Communication! Publications (peer-reviewed), meetings/conferences, discuss findings (person/online)
Databases	Pubmed, NCBI, NHI, Google scholar

Hypothesis, Theory, and Law

Hypothesis	Testable expl. of a sc. problem based on research and obs. (if/then). Must be testable, supported/refuted by data
Theory	Hypothesis or a group of rel. hypothesis as true based on obs. and repetitive exp., must be testable, req. many exp. and confirmed data to overturn/-modify, can be used for predictions or explanations



Hypothesis, Theory, and Law (cont)		Hypothesis, Theory, and Law (cont)		Safety in Science (cont)		Safety in Science (cont)	
Law	Statement of facts generally accepted to be true, describes relationships in nature, but does not prov. explanation; can be used to predict events/exp. results, support. by all obs. and data, doesn't	Dalton's Atomic Theory	all matter is comp. of atoms, atoms cannot be made/destroyed during chemical reactions, all atoms of an element are identical, different elements have diff. kinds of atoms, chemical reactions occur through rearrangement of atoms	General safety practices	Avoid lose clothes/hair, wear long sleeves/close toed shoes, do not drink/eat/chew gum, no jewelry, avoid contacts if possible, avoid clutter in lab	Handling glass ware	check for breaks/chips, use tongs/holders
How to work with a Hypothesis?	Attempt to explain an obs. or answer a Q -> test it -> if support, then data will agree with it -> if refute, then data will not agree, redo procedure or hypothesis -> continue evaluating data	Atomic Theory	Explains law of conservation of mass	Handling chemicals/equipment	Use tongs/mitts for hot objects, label all containers, inspect equipment before use, dispose of all substances appropriately	Heating devices	Bunsen burner/alcohol burner, hot plate
		Reproducibility leads to reliability	Theory must be supported by all evidence, other scientists should get similar results, all experiment must be reproducible	PPE (personal protective equipment)	Eyes/face: safety goggles/shield, skin/clothing: lab coat/apron, hands: gloves	Use of chemicals	Use clear/accurate labels, do not taste/smell/touch chemicals, use pipettes to transfer liquids, do not put liquids back into storage container, refer to MSDS for storage/disposal/handling
		Safety in Science		Emergency equipment	Fire extinguisher, eye wash, safety shower, first-aid kit	Accident	Stay calm, report, avoid danger, spill kit, help injured
		MSDS (material safety data sheet)	Describes properties, handling, and emergency procedures of a substance	Chemistry glass ware	Beaker, flask, test tubes, graduated cylinder	Cuts from broken glassware	apply pressure/flush
						Chemical burns/irritations/heat burns	remove heat source/put out fire
						Inhalation of toxic chemicals	Get fresh air/report
						Chemicals in eyes	Eye wash (10-15 mins), report



Tools and Technology in chem

Balance	Measure mass
Beaker	Holds liquids
Buret	Used to deliver specific volume, i.e. titrate volumes
Degrees Celsius	Fahrenheit - 30 : 2 = ~ x C
Graduated cylinder	Measure volume of liquid
SI	International system of units, standard set of units used by all scientists
Kelvin	SI unit for temperature in science, 0 C = -273.15 K
Kilogram	SI Unit for mass
Liter	SI unit for volume
Meter	SI unit for distance

Metric system

The Metric System is Base 10

Prefix	Symbol	Multiplier	Prefix	Symbol	Multiplier
tera-	T	1,000,000,000,000	centi-	c	0.01
giga-	G	1,000,000,000	milli-	m	0.001
mega-	M	1,000,000	micro-	μ	0.000001
kilo-	k	1,000	nano-	n	0.000000001

Common SI units

Common SI Units and Units Used with SI

Prefix	Distance	Volume	Mass	Time
kilo-	kilometer (km)	kiloliter (kL)	kilogram (kg)	kilosecond (ks)
(none)	meter (m)	liter (L)	gram (g)	second (s)
centi-	centimeter (cm)	centiliter (cL)	centigram (cg)	centisecond (cs)
milli-	millimeter (mm)	milliliter (mL)	milligram (mg)	millisecond (ms)
micro-	micrometer (μm)	microliter (μL)	microgram (μg)	microsecond (μs)
nano-	nanometer (nm)	nanoliter (nL)	nanogram (ng)	nanosecond (ns)

Temperature: degree Celsius (°C), kelvin (K)
Time: minute (min)

Metric conversion example

Metric Conversions

- Convert 5.97 cm to millimeters.
 - 1 cm = 10 $\frac{\text{mm}}{\text{cm}}$
 - 5.97 cm = (5.97)(10) = 59.7 mm
- Convert 25.0 mL to liters.
 - 1 $\frac{\text{mL}}{\text{L}}$ = 0.001 L
 - 25.0 mL = (25.0)(0.001) = 0.025 L
- Convert 0.0453 kg to grams.
 - 1 kg = 1,000 g
 - 0.0453 kg = (0.0453)(1,000) = 45.3 g

Collecting and organizing data

inference logical conclusion made from observation

Qualitative data non-numerical, descriptive - describes categories or characteristics of things

Quantitative data numerical data that can be measured, data that is easy to analyze over graph or table, has units, always numbers

Charts Used for qualitative data

Tables Used for numerical data set in columns and rows

Graphs Bar/line/pie, display data for analysis

Labels for all parts of charts, tables, and graphs