Partial Vocabulary List for Science-1A

(These are simplifications of formal definitions.)

Mechanics

Scientific Notation	Writing numbers in the form of 6.022×10^{23} .
(Standard) Units	Agreed basic sizes like meters (m), kilograms (kg), seconds (s), newtons (N), joules (J), …
Unit Prefixes	Letters placed in front of units to indicate powers of 10 multipliers like G (giga 10^9, k (kilo 10^3), c (centi 10^{-2}), m (milli 10^{-3}), μ (micro 10^{-6}), …
Formula	A recipe for combining numbers like $A=\pi r^2$, $F=ma$, $F=G\frac{m_1 m_2}{d^2}$, …
Universal Constant	A value like $\pi=3.14159\ldots$, $G=6.67\times10^{-11}\frac{\mathrm{N\cdot m^2}}{\mathrm{kg^2}}$, $c\approx3.00\times10^8\,\mathrm{m/s}$, …
Mass	The amount of stuff that makes something harder to shake. My mass is 100 kg.
Inertia	The tendency of objects to resist changes in their motion. It is proportional to their mass.
Density	Mass of an object divided by its volume.
Force	The amount of push or pull. Lifting 100 kg requires 980 N of force at the Earth's surface.
Net force	The sum of all forces on an object taking into account their different signs and directions.
Weight	The force caused by local gravity. On the Moon, 100 kg has a weight of 162 N.
Pressure	Force on an area divided by that area
Freefall	Falling under the pull of gravity, but without any resisting force (no parachute).
Weightless	When an object is in freefall, it is weightless even though it has mass and is being accelerated by a gravitational force.
Speed	How fast you are moving in any direction.
Velocity	Speed together with direction of motion.
Acceleration	How velocity is changing because of its speed and/or direction of motion are changing.
Centripetal Force	The sideways force causing an object to change direction.
Centrifugal Force	The imagined force felt when your direction is being changed by a centripetal force. It is simply the sensation of your inertia resisting the direction change.
Newton's 2nd law	The proportionality between net force on an object and its acceleration with the proportionality constant being the object's mass. $F=ma$
Newton's 1st law	Just his 2nd law with F=0 so that the acceleration is also zero.
Newton's 3rd law	The idea that forces always come in equal, but opposite pairs. A push on B = B push on A.
Frequency	The rate of repetition of a periodically varying quantity.
Period	The time between repetitions of a periodically varying quantity.
Gravitational constant	Constant $G=6.67\times10^{-11}\frac{\mathrm{N\cdot m^2}}{\mathrm{kg^2}}$ often called "big G" that describes the strength of gravitational effects. It is the same value throughout the universe.
Gravitational acceleration	How things accelerate when falling in response to a gravitational force. This is often called "little g". It depends on the gravity of nearby masses.
Synchronous Orbit	A satellite orbit where the satellite revolves around the Earth every 24 hours so that it is always above the same part of the Earth as the Earth rotates.
Inverse square law	How gravitation, electric and nuclear effects from a single source weaken as 1/(distance)^2.
Torque	A twisting force such as applied by a wrench or screwdriver.
(Linear) momentum	A very useful quantity with a value equal to mass multiplied by velocity, $p=mv$. Momentum, like velocity, has direction.
Angular momentum	The analog of linear momentum for spinning objects. It also has a direction.
Conservation law	A rule for how certain quantities like total energy or total momentum can stay the same while other quantities like speed and mass might change.

Energy, Work and Momentum

Energy	The stuff that can be transferred from one object to make other things move or get hot. Examples are light energy, heat energy, mechanical energy, electrical energy, … There is no true zero of energy; only changes in energy are important.
Power	Energy change per unit time.
Work	A change of energy from one form to another. This must not be confused with the common use of the word work. Holding a 100 kg barbell at a fixed height does not do any physics work even though the weight lifter's muscles are getting tired.

Waves

Wave	A periodically varying physical quantity moving like an ocean wave, sound wave, …
Wave amplitude	The maximum extent of a wave's action – pressure for sound, electric field for electromagnetic wave, displacement for earthquake waves, ...
Wavelength	The distance between crests (high points) of a wave.
Wave velocity	The rate of apparent motion of the crests of a wave in a particular direction.
Longitudinal wave	A compression wave. Sound waves are longitudinal waves.
Transverse wave	A wave with a sideways component to the direction of the wave. Electromagnetic waves (light, radio,…) are transverse waves.
Resonance	The matching of the natural frequency of an object with a driving force that leads to increased motion of the object. A child pumps a swing in resonance with its natural swinging frequency.
Standing wave	A wave combined with its reflection in a manner that enhances its effect (resonance). All musical instruments generate standing waves.
Traveling wave	A wave carrying energy in a particular direction.
Node	A point or points in a standing wave which appear to not be changing.
Tsunami (tidal wave)	A large mass of water spreading out from an undersea earthquake.
Ultrasound scan	The use of ultrasonic waves to make images of the insides of a living person.

Thermodynamics

Temperature	A measure of heat energy content of an object.
Absolute zero	The lowest temperature possible, 0 K, -273.15 ^{o}C, -459.67 ^{o}F.
Latent heat	Heat involved in a phase change like from liquid to gas or solid to liquid.
Heat capacity	Heat involved in changing the temperature of a substance.
Thermal conductivity	The ability of an object to transport heat energy throughout its material.
Entropy	A measure of the disorder of a system of particles. A confined gas at a particular temperature will have a lower entropy than the same gas at the same temperature in a larger volume. Living creatures are organized energy machines, but they need food to maintain that lower entropy. Upon death, their entropy rises.
Thermodynamic Laws	Rules governing the effects of temperature which balance energy minimization and entropy increase.
Blackbody radiation	The heat given off or absorbed by any object. Its magnitude varies as the 4th power of the temperature of the object and is greater for "black" objects than for "shiny", reflective objects.

Electricity, Magnetism, and Electromagnetic Waves

Electron (e^-)	The tiny particles that are negatively charged and surround atoms.
Electric charge	The quantity causing electric effects. It can be positive or negative.
Static electricity	The study of electric charge effects when the charges are not moving.
Electric current	The flow of electric charges, usually electrons or ions.
Direct current (DC)	An electric current that flows in one direction from positive to negative. Batteries and solar panels provide DC current.
Alternating current (AC)	An electric current that smoothly reverses its direction at a particular frequency. Our house outlet electricity here in the United States alternates at a frequency of 60 Hz.
Electric voltage	The driving force causing electric currents to flow.
Electricity	The study of electric currents and voltages.
Conductor	A material through which electricity easily passes, usually a metal.
Insulator	The opposite of a conductor. Insulators prevent electricity from flowing through them and going to unintended places.
Semiconductor	A material which conducts electricity poorly. Semiconductors often have impurity atoms intentionally added to change their properties into useful devices like transistors and solar cells.
Magnetism	A source of energy and forces related to moving electric currents.
Magnetic dipole moment	A source of magnetism from spinning or paired electrical charges.

Magnetic domain	A region of a magnetic material that has a large number of aligned dipole moments.
Electromagnetic waves	Waves of energy carried by changing electric and magnetic fields pulling each other along. Different frequencies of electromagnetic waves are called radio, microwaves, infra-red, visible light, ultra-violet rays, X-rays, and gamma rays.
Electromagnetic radiation	Energy carried by electromagnetic waves.
Light polarization	The direction of the electric field for a light beam. It is usually spoken of as being horizontal or vertical.
Reflection	The redirection of electromagnetic waves by a metal or mirror. Angle in = angle out.
Refraction	The bending of electromagnetic waves passing through a boundary between substances. Light going between air and water is refracted.
Diffraction	The interference between different parts of an electromagnetic wave. A laser going through a small hole produces concentric rings of diffracted light.
Electrical transformer	A pair of wire coils sharing a magnetic field. A transformer can alter voltages and currents, but the electric power (current multiplied by voltage) will not be increased.
Ohm's Law	The rule for many electrical objects that the current through them is proportional to the voltage placed across them. Many types of devices do NOT obey Ohm's law.
Series circuit	A circuit where each component follows another like the links of a chain. Connecting one hose after another to make a longer hose is a series water "circuit".
Parallel circuit	A circuit where each component is connected side-to-side. A multi-lane highway is like a parallel circuit for cars.
Short circuit	An unintentional connection between electrical conductors.
Open circuit	An unintentional break in the path of an electric current.

Quantum Theory

Quantum	A tiny chunk of energy or angular momentum.
Photon	An isolated "chunk" of light wave containing and energy proportional to its frequency.
Quantum mechanics	The rules governing atoms and photons that are needed to replace Newtonian mechanics.
Planck's constant	The proportionality constant $h = 6.63 \times 10^{-34}\,\mathrm{J \cdot s}$ relating photon frequency to photon energy.
Photoelectric effect	How light causes electrons to be emitted from a metal. One photon per electron.
Uncertainty principle	The fact that simultaneous perfect measurements of velocity and position of a particle or the energy and time of a quantum of event is limited by a relation involving Planck's constant.

Atoms and Molecules

Periodic Table of Elements	An arrangement of all types of atoms which emphasizes their chemical similarities.
Mole	A measure used for counting atoms and molecules. 6.022×10^{23} things It is used in a manner similar to the use of "dozen." When written as a unit, the final "e" is left off: 3 mols of water molecules contain $18.066 \times 10^{23}\,\mathrm{H_2O}$ molecules with $36.132 \times 10^{23}\,\mathrm{H}$ atoms and $18.066 \times 10^{23}\,\mathrm{O}$ atoms .
Atomic mass (weight)	The mass in grams of 1 mol of the specified atom or molecule. Also, the mass in atomic mass units (amu) of a single atom of the specified type.
Atomic number	The number of protons in a specified atom.
Atomic symbol	The abbreviation for an atom. The atomic symbol for helium is He.
Atom	The smallest unit of matter that determines the characteristics seen in large chunks of matter. Atoms have a small, heavy nucleus with a positive charge surrounded by a cloud of electrons with a negative charge.
Neutral atom	An atom where the charges are balanced (equal number of protons and electrons), leaving it with no net charge.
Ion	An atom with unbalanced charges. It can be a negative ion or a positive ion.
Element	The simplest kind of matter consisting of identical atoms.
Energy shells	The discrete layers of the electron cloud surrounding an atomic nucleus. Each shell has electrons with similar energies. The rows of the Periodic Table of Elements correspond to the different energy shells. Light is emitted or absorbed when electrons go from one energy shell to another.

Molecules	Bound groups of atoms forming a larger unit of matter like H_2, H_2O, CO_2, fatty acids, amino acids, sugars, caffeine, enzymes, proteins, …
Compounds	Mixed groups of different atoms and/or molecules.
Reactants	The substances at the left side of a reaction equation.
Products	The substances at the right side of a reaction equation.
Chemical equilibrium	The balance attained in a reaction of an isolated chemical system after the amount of its products and reactants have stopped changing.
Rate of reaction	A measure of how long it takes a reaction to reach its equilibrium state.
Acid	A molecule that easily releases a hydrogen atom in a water solution.
Base	A molecule that tends to acquire a hydrogen atom in a water solution.
Salt	The result of combining an acid with a base to produce a neutral molecule.
Functional group	A group of atoms that often are involved in reactions in biochemistry.
Fatty acid	A hydrogen-carbon chain with a –COOH functional group at one end.
Amino acid	A biochemical with a NH_2-C-COOH group at one end and having its central C connected to other biochemicals. The NH_2 of one amino acid connects to the COOH group of an adjacent amino acid to form a peptide bond.
Polypeptide	A short chain of amino acid units. For example oxytocin.
Protein	A long, folded chain of amino acid units usually forming biological structures.
Catalyst	A chemical compound that reduces the energy barrier in chemical reactions without itself being consumed.
Enzyme	A long, folded chain of amino acid units used to catalyze chemical reactions.
Combustion	The reaction with oxygen that produces energy, H_2O, and either CO_2 or CO.
Condensation reaction	A chemical reaction where water is released from the merging functional groups.
Addition reaction	A chemical reaction where a double bond is broken to connect molecules together.
Hydrocarbon	Molecules made with just carbon and hydrogen atoms.
Carbohydrate	Molecules made from carbon, hydrogen and oxygen atoms, usually with twice as many hydrogens as oxygens, $C_m(H_2O)_n$.
Sugar	A class of carbohydrates with the general formula $C_n(H_2O)_n$.
Starch	A chain of sugars with bonding that we can digest.
Cellulose	A chain of sugars with a straight structure that we cannot digest.
Nucleic acid	The basic units of DNA and RNA.
Nucleotides	Nucleic acids combined with a ribose or de-oxyribose sugar.
DNA	Deoxyribonucleic acid. The molecule holding the code for making biological compounds in living organisms.
RNA	Ribonucleic acid. Another molecule used for making biological compounds in living organisms.
Electrochemistry	The study of chemical reactions that involve atoms changing their ionic character.
Electrolyte	A solution with ions that conducts electricity in electrochemical reactions.
Batteries	Devices using the differing electrochemistry of two kinds of metals to produce electricity.
Electroplating	A process where electrochemistry causes ions of one metal to adhere to or replace ions of another metal.
Corrosion	An electrochemical process facilitated by water and oxygen to cause metals to oxidize.
Electrolysis	The electrochemical process that can break apart molecules or purify metals using electrical currents. We used electrolysis to break water into hydrogen and oxygen gasses.

Relativity

Special Relativity	Einstein's improvement on Newton's Laws that is based on the assumptions that the speed of light and the laws governing the motion of objects are always the same no matter how fast different observers are moving past at constant velocities. It predicts that lengths and time depend on the speed of an observer and $E=mc^2$.
General Relativity	An extension of Special Relativity to cases of accelerating observers including those in a gravitational field. It predicts black holes and gravitational waves.
Gravitational waves	Waves in space-time caused by gravitational changes like when black holes collide. They travel at the speed of light.
Time dilation	The fact that time depends on speed. Faster clocks run slower.
Length contraction	The fact that length in the direction of motion depends on the speed in that direction. Faster

objects become shorter.

Mass-energy equivalence The idea that mass is just a different form of energy; $E=mc^2$.

Black hole An astronomical object so massive that light cannot escape from it.

Nuclear Physics

Atomic nucleus The positively charged center of an atom consisting of protons and usually neutrons. The positive charge of a proton is exactly the same size as the negative charge of an electron.

Proton A part of a nucleus that has a positive charge.

Neutron A part of a nucleus that has no charge, but helps hold the nucleus together. A neutron has nearly the same mass as a proton and sometimes decays into a proton and an electron.

Isotope A nucleus where the number of protons is the same, but the number of neutrons is different.

Nuclear glue An attractive force between neutrons and protons. It becomes very weak when the neutrons or protons become separated by as little as a few proton diameters.

Nuclear binding energy The energy associated with nuclear glue. It is the energy source of nuclear bombs.

Nucleon The generic term for protons and neutrons.

Anti-particle Nuclear particles with certain properties like charge that are opposite of normal particles.

Positron The anti-particle of an electron. Positrons have the same mass and magnetic moment as an electron, but have a positive charge.

Half-life The time for a specific nuclear decay to have a 50-50 chance of occurring.

Alpha (α) *particle* A helium nucleus emitted in a nuclear reaction.

Beta (β) *particle* An electron (β^-) or positron (β^+) emitted in a nuclear reaction.

Gamma (γ) *ray* A photon with extremely high energy usually emitted in nuclear reactions.

Nuclear radiation A collective term for alpha-, beta-, gamma-rays, and nuclear fission fragments.

Cosmic ray An energetic particle (usually a proton or gamma ray) striking the earth. Also, the term is applied to other particles caused by primary cosmic rays striking atmospheric nuclei.

Geiger counter A device that can measure alpha-, beta-, and gamma- rays, usually emitting audio beeps.

Nuclear chain reaction A sequence of nuclear reactions that cause additional reactions yielding energy.

Nuclear fission The breaking apart of a large nucleus releasing energy.

Nuclear fusion The joining together of small nuclei releasing energy.

Atom bomb A lousy name for a nuclear fission bomb.

Hydrogen bomb A lousy name for a nuclear fusion bomb.

Nuclear reactor A facility for using a fission reaction to produce electricity.

Nuclear waste The low-grade radioactive materials left over after a nuclear reactor has extracted energy from higher grade uranium or plutonium.

Nuclear medicine The use of radioactive materials to learn about or attempt to cure illnesses.

Carbon Dating The process of using the ${}^{14}_{6}C_8 \Rightarrow {}^{14}_{7}N_7 + e^- + \text{antinutrino}$ nuclear reaction to determine the age of dead plants or animals. With a half-life of 5730±40 years, it is only useful for times between a few hundred and about 50,000 years ago. It works because ${}^{14}_{6}C_8$ is produced in the upper atmosphere at a constant rate by cosmic rays.

MRI scan Magnetic resonance imaging using high magnetic fields to analyze nuclear magnetic magnetic moments in tissue to learn about chemical reactions. It does not require the use of nuclear radioactivity.

CAT scan The use of computer controlled scanning X-ray analysis to produce 3-D images of living tissue.

PET scan The use of positron-electron annihilation from an injected material to produce pairs of gamma rays that can be detected outside of the body to allow the determination of the location of a medical problem.