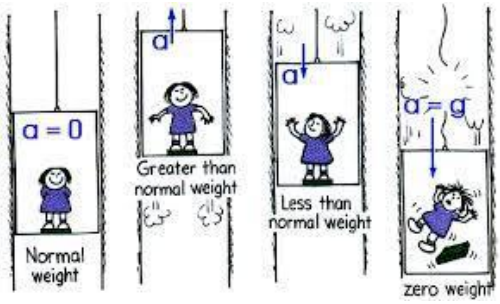
Review of 9th Grade Accelerated Physics and Chemistry

A. About Science – Chapter 1
   a. The Scientific Hypothesis
      i. Falsifiable - Capable of being tested and proven wrong (but hasn't been proved wrong yet)
      ii. Experiments can support or disprove a hypothesis, but they can't prove it
   b. The Scientific Experiment
      i. Remain objective and observe what happens rather than what you want to have happen
      ii. Have one independent variable that you are changing on purpose to see the effect, if any, on the dependent variable

B. Describing Motion – Chapter 2
   a. Mass is a measure of inertia
      i. It is a resistance to change in motion and measured in kilograms
   b. Net Force
      i. A push or a pull that causes acceleration
      ii. Weight is a force and measured in newtons



   c. Density = mass divided by volume
      i. Denser objects sink below less dense objects when allowed to move freely
   d. Equilibrium = Net force equals zero, so acceleration equals zero
      i. Velocity is constant in equilibrium. It could be zero, but it doesn't have to be.
   e. Support Force (Normal Force) = The force of a surface keeping you from going though it
      i. It acts perpendicular (normal) to the surface
      ii. It is a produce of the electrostatic forces between molecules
   f. Friction – opposes motion in direction
      i. Air resistance is an example of friction
      ii. It is dependent on velocity and the surface area and shape of the objects involved
   g. Speed and Velocity
      i. Speed is distance divided by time. It is a scalar.
      ii. Velocity is speed with direction. It is a vector.
   h. Acceleration
      i. Change in velocity over time
      ii. Can be solely a change in direction, as with circular motion

C. Newton's Laws of Motion – Chapter 3
   a. 1st Law – Law of Inertia – Objects maintain their state of motion unless acted upon by an unbalanced force
   b. 2nd Law – Force = mass times acceleration (Force = change in momentum over time) F=ma
   c. 3rd Law – Forces occur in equal but opposite pairs
   d. Vectors – magnitude and direction

D. Momentum and Energy – Chapter 4
   a. Momentum = mass x velocity
   b. Collisions
      i. Elastic – bounce
      ii. Inelastic – stick together
   c. Impulse = change in momentum over time
   d. Conservation of momentum – Unless an outside force (like friction) acts on a system, the momentum at the beginning and end is the same

$P = mv$ $\quad Ft = mv_2 - mv_1$ $\quad m_1v_1 = -m_2v_2$

$m_1v_1 + m_2v_2 = m_1v_3 + m_2v_4$ $\quad m_1v_1 + m_2v_2 = (m_1 + m_2)\,v_3$

e. Energy – measured in joules
f. Power = Work divided by time – measured in watts
g. Potential Energy – stored
    i. Gravitational = (mass) times (10 m/s^2) times (change in height)
h. Kinetic Energy – motion
    i. Kinetic energy = (1/2) times (mass) times (velocity squared)
i. Work-Energy Theorem
    i. Work done on an object increases its kinetic energy
    ii. W = Fd = (1/2) times (mass) times (velocity squared)

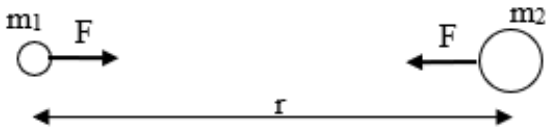
$W = Fd$ $P = W/t$ $F = ma$

$PE_g = mgh$ $KE = (1/2)mv^2$ $W_T = \Delta KE$

j. Conservation of Energy
    i. In the absence of external work input or output, the energy of a system remains unchanged.
    ii. Energy cannot be created or destroyed. It can only be transformed (and one form is mass).
k. Machines – Generally lessen force needed to do the same work by increasing the distance
    i. Pulleys
    ii. Levers
l. Efficiency = (work done) divided by (energy used)

E. Gravity – Chapter 5
a. Newton's Law of Universal Gravitation $F = GMm/r^2$
b. Acceleration due to gravity on the surface of Earth is about 10 m/s^2
c. Weight = What the support force balances when you are not falling
d. Projectile Motion
    i. horizontal and vertical motion are separate
    ii. gravity only affects vertical motion
    iii. drag slows projectiles and shortens range
    iv. Air resistance is affected by velocity squared and frontal surface area
    v. When the force due to gravity is balanced by the force due to air resistance while falling, you have reached terminal velocity and no longer accelerate
    vi. Complementary launch angles produce the same range (angles that add to 90 °)
    vii. Kinematic equations for linear motion with constant acceleration (formulas will be on the test)
        1. Find time
        2. Find range
        3. Find maximum height
        4. Including non-zero angles

$$F = G\frac{m_1 m_2}{r^2}$$



$G = 6.67 \times 10^{-11}\ N\ m^2 / kg^2$

Variable	Symbol
t	time taken
s	distance travelled
u	initial velocity
v	final velocity
a	acceleration

Table 1.2.1 - Variables used in uniformly accelerated motion equations

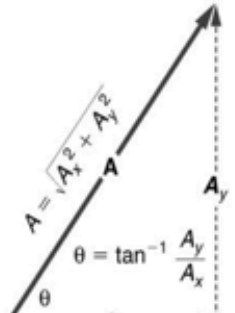
$v = u + at$

$s = \left(\frac{u+v}{2}\right)t$

$v^2 = u^2 + 2as$

$s = ut + \frac{1}{2}at^2$

$s = vt - \frac{1}{2}at^2$



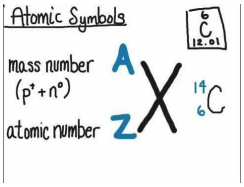
e. Satellites fall around the object they orbit, parallel to its surface
    i. Circular orbits have a constant speed
    ii. Elliptical orbits have a varying speed
    iii. All round orbits have a centripetal acceleration pulling them inward and they stay in orbit with their continual tangential velocity
    iv. Orbital speed for Earth is between ~8,000 and 11,200 m/s

F. Heat – Chapter 6
    a. Heat – The thermal energy that flows from a substance of higher temperature to a substance of lower temperature, commonly measured in calories, Calories (kilocalories), or joules
    b. Thermodynamics – The entropy (disorder) of a system will always increase
    c. Temperature: Kelvin is an absolute measurement of temperature, and reaching absolute zero degrees Kelvin is not possible
    d. Specific Heat Capacity – The quantity of heat required to raise the temperature of a unit mass of a substance by one degree Celsius or Kelvin
        i. Water has a very high one compared to most substances, meaning it holds a lot of heat before changing state and the boiling and freezing points are far apart
    e. Heat Transfer
        i. Occurs because of a temperature differences
            1. Conduction – Touching – Transfer by molecular and electronic collisions
            2. Convection – Material exchange - Flowing currents in fluids
            3. Radiation – Not Touching - Transfer by electromagnetic waves

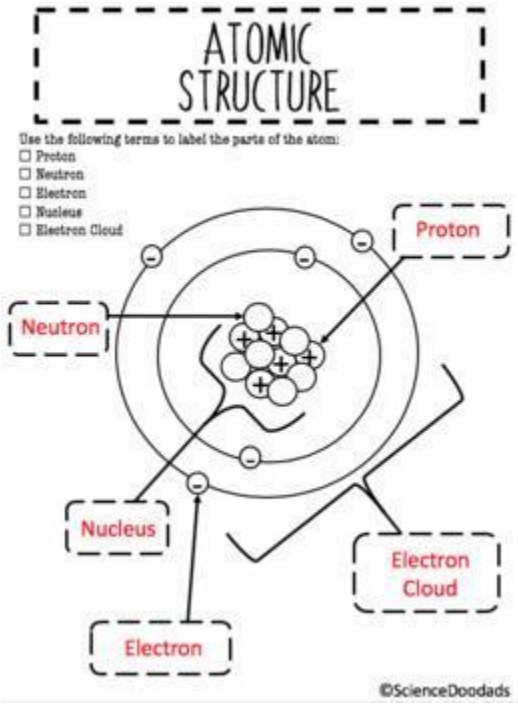
G. Electricity and Magnetism – Chapter 7
    a. Electrical Force and Charge
        i. Charged particles produce electromagnetic fields
        ii. Opposite charges attract (positive to negative), like charges repel
    b. Coulomb's Law: $F = kq_1q2/r^2$
        i. Strength of electrostatic force is inversely proportional to the distance between the charges squared
        ii. It depends on the charges involved
        iii. Negative force implies attraction, positive implies repulsion
        iv. It is much stronger than gravitational force comparatively
    c. Conductors and Insulators
        i. Conductors easily transfer energy
            1. Metals are all good conductors
        ii. Insulators are poor conductions
            1. Plastics tend to be poor conductors
    d. Ohm's Law: V = IR
        i. Current: I flow of charges over time
        ii. Voltage: V
        iii. Resistance: R
    e. Power: P=IV
    f. Circuits
        i. Series
        ii. Parallel
    g. Magnetic Force
        i. Field goes from north to south
        ii. Like poles repel, unlike poles attract
    h. Electromagnetic Induction

i. An electrical current produces a magnetic field and a force that can be transferred into motion: a motor
ii. A changing magnetic field produces an electrical current: a generator

H. Waves – Sounds and Light – Chapter 8
   a. Transverse
      i. Perpendicular to wave motion
      ii. Light
   b. Longitudinal
      i. Parallel to wave motion
      ii. Sound
   c. Reflection – Bouncing waves
   d. Refraction – Bending waves through a prism
   e. Diffraction – Bending waves around an obstacle
   f. Interference – Waves build each other up or cancel each other out depending on their relative phases
   g. Wave-Particle Duality
      i. Light can act like a wave and a particle



I. Atoms and the Periodic Table – Chapter 9
   a. Elements – Specific types of atoms
   b. Atoms – know how to read the periodic table symbols for mass number, atomic number, atomic symbol, neutrons, electrons, and ionization
   c.



      i. Nucleus includes nucleons – Mass Number
         1. Protons
            a. Positive charge
            b. Atomic Number
            c. Relative mass of ~1 amu
            d. Produce strong force and electromagnetic force
         2. Neutrons
            a. Neutral
            b. Relative mass of ~1 amu
            c. Produce strong force
            d. Find by taking the atomic mass – the atomic number
            e. Numbers vary by isotope
            f. Having too many or too few makes the nucleus unstable and leads to radioactive decay via the weak force
      ii. Orbital Shell
         1. Electrons
            a. Negative charge
            b. Equals the Atomic Number unless ionized, relative mass of ~0 amu
            c. Can be gained, lost, or shared in chemical reactions
            d. Produce electromagnetic force
         2. s orbitals hold 2 electrons each
         3. p orbitals hold 6 electrons each (2 in each direction x, y, and z), d and f hold more, but most atoms commonly found try to have eight valence electrons like a noble gas, filling up the outer s and p orbitals

d. Ions – Charged atoms that have gained (-) or lost electrons (+)
e. Isotopes – elements with the same number of protons but different numbers of neutrons
f. Periodic Table
    i. Alkali Metals – Group 1 – Very reactive
    ii. Alkali Earth Metals – Group 2 – Very reactive
    iii. Halogens – Group 17 – Very reactive
    iv. Noble Gasses – Group 18 – Mostly Inert and don't react
        1. Atoms want to have electron shells like these do naturally – Octet Rule
    v. Metals – On the left and in the middle
    vi. Nonmetals – In the top right corner
g. Spectroscope
    i. Used to identify elements by analyzing the light they emit when they are made to glow by passing electricity through them and then using a combination of a slit and a prism in a spectroscope to separate out the resultant light
    ii. The resultant pattern is the atomic spectrum

J. The Atomic Nucleus and Radioactivity – Chapter 10
a. Radioactivity – lowers the energy level of the nucleus from an unstable state
    i. Alpha Decay
        1. a Helium nucleus, so fairly large and easy to stop
        2. positively charged by 2, so quite able to damage DNA
        3. lowers the mass number by 4 and atomic number by 2, resulting in a new element
    ii. Beta Decay
        1. An electron or a positron, so more difficult to stop
        2. Negatively or positively charged by 1, so able to damage DNA
        3. Changes the atomic number by 1, resulting in a new element
    iii. Gamma Decay
        1. A high-energy photon, so very difficult to stop
        2. Able to damage DNA
        3. Doesn't change the atomic number or mass number
b. Strong Nuclear Force
        1. Produced by nucleons
        2. Only attractive
        3. Extremely short range
        4. Holds the nucleus together, combating the electromagnetic repulsion of the protons to each other
c. Half-Life
    i. The time it takes half of an amount of a radioactive substance to decay
    ii. Used to tell how long objects have been decaying and estimating age
    iii. Exponential
d. Nuclear Fission
    i. Splitting the nucleus into smaller daughter nuclei and usually some other neutrons, usually by hitting it with a neutron
    ii. The neutrons produced can hit other nuclei, causing a chain reaction when substance is over the critical mass of fissionable material
    iii. Releases energy when done on elements higher in atomic number than iron
e. Mass-Energy Equivalence
    i. $E = mc^2$
f. Nuclear Fusion
    i. Combining nuclei smaller than iron to release energy

K. Investigating Matter – Chapter 11
    a. Phase Changes
        i. Physical – change the arrangement of the molecules but not the molecules themselves
        ii. Solid <-> Liquid <-> Gas
        iii. Ex. Melting ice
    b. Chemical Changes
        i. Reactions make new substances by changing the molecular bonds between atoms
        ii. Ex. Mixing baking soda and vinegar
    c. Compounds
        i. Made of multiple atoms
        ii. Named by their relative positions on the periodic table and their number
    d. Chemical Bonds and Mixtures – Chapter 12
        i. Electron-Dot Structures
            1. Display valence electrons and suggest bonding types and configurations
            2. Valence electrons are the outer shell and determine reactivity
            3. Most elements want a noble gas like configuration because it is lower in energy, so they gain, lose, or share electrons
        ii. Ionic Bonds
            1. Electromagnetic attractions between ions
                a. Anions – negative, gained electrons
                b. Cations – positive, lost electrons
            2. Predictable based on position on the periodic table
            3. Ex. Table Salt $Na^{+1}Cl^{-1}$
        iii. Covalent Bonds
            1. Atoms sharing electrons
            2. Polarity is affected proportionally which atom gets the electrons the most due to their relative electronegativities
            3. Ex. Water H_2O
    e. Water is weird
        i. Specific heat capacity is high
        ii. Density is lower as a solid than a liquid (except between 0 and 4 degrees C), so most ice floats
        iii. Exists in 3 phases naturally here on Earth
        iv. Is polar and so a good solvent
        v. Exhibits hydrogen bonding between molecules and so has surface tension, adhesion, and cohesion (it's sticky and wet and clumps into droplets)
L. Chemical Reactions – Chapter 13
    a. Chemical Equations
        i. Reactants -> Products
        ii. Need to be balanced due to conservation of mass
            1. Exothermic – give off heat (and feel hot)
            2. Endothermic – take in heat (and feel cold)