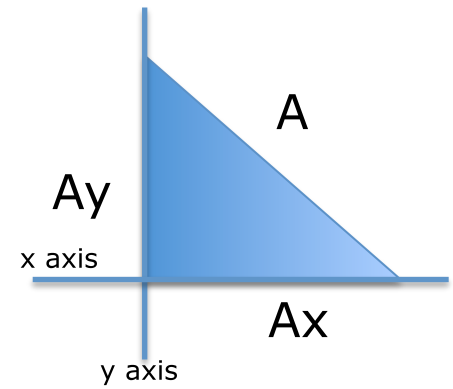
Review and Remember from Exam 1

Units

- How to convert units (Get the 1 the right way up)
- Always carry units around in problems!
- **Your answer to a question should always include units!**
- **Use dimensional analysis to make sure you've solved a problem correctly – do the units make sense?**
- **Distance = meters (m), Time = seconds (s), Mass = kilograms (kg) ALWAYS!!!**
- Know multipliers: kilo = 10^3, milli = 10^{-3}, etc. See lecture 2nd day of class for more multipliers

Vectors

- Have magnitude (numerical value) and direction
- Add by graphical method: put tail of B at head of A, draw sum from tail of A to head of B
- **Component method**
  - YOU MUST REMEMBER YOUR TRIG!!
    - **sin θ = Ax / A, cos θ = Ay / A**
    - **$A^2 = Ax^2 + Ay^2$**
  - **Choose your coordinate system wisely, helps to draw your problem with coordinate system**
  - Vital for figuring out how things move using Newton's laws



Review and Remember from Exam 2

Conservation of Energy

- E can be transformed from PE to KE
- Can transfer E from one object to another
  - ex: slingshot and rock

- Total Energy Conservation: Energy is never created or destroyed, only transformed from one type to another
  - Total E initial = Total E final
  - $(\text{all KE} + \text{all PE})_{initial} = (\text{all KE} + \text{all PE})_{final}$

Relating Work and Energy

- Net work done on a body is the change in kinetic energy of that body

- $W_{NET} = KE_{final} – KE_{initial}$
  - $= 1/2 * m * (v^2_{final} – v^2_{initial})$

- Power: rate work is done or energy is transformed
  - Power = Work / time = (F * d) / t = F * v

New for Exam 3

Pressure

- P, units of Pascal (Pa)
- $P = F/A$
- $P = \rho g h$

- 1 atm = 101, 325 Pa
- 1 kPa = 760 mm Hg

Density

- $\rho = m / V$

- ρ of water = 1 g/cm^3 = 1000 kg/m^3

Buoyant Force

- Buoyant force = weight of fluid displaced by body
- $F_{buoyant} = \rho g V$
  - V = volume of displaced fluid, ρ = density of displaced fluid

- You must know how to calculate buoyant force of an object partially and fully submerged – we spent almost a whole class calculating an example

Fluid Flow

- For a fluid flowing smoothly in a continuous tube, the flow rate must remain constant
  - (A of tube * v of tube) point 1 = (A of tube * v of tube) point 2
- Pressure is inversely related to velocity for overall motion of liquid
  - Bernoulli's Principle

Ideal Gas Law

- Valid for individual molecular motion
- PV = nkT, T in Kelvin
- If P held constant, as V increases T increases
- If V held constant, as P increases T increases
- If T held constant, as P increases V decrease
  - As P decreases V increases

- T is proportional to the average KE of the molecules in the gas (1/2 m v^2)

Temperature Scales

- $°C = (°F – 32) * (5/9)$
- $°F = (°C * (9/5)) + 32$
- $K = °C + 273.15$

Heat

- Energy transferred from one object to another due to difference in temperature
- Flows from higher T to lower T object
- Units: Calories
- 1 Cal = 4.18 Joules

Heat

- $Q = c * m * (T_f – T_i)$
  - Q = Heat required to change temperature of an object from T_i to T_f. Units Cal or Joules
  - c = specific heat, amount of heat per mass required to raise the temperature 1 degree. Units kcal/kg °C, J/kg °C
  - Specific heat of water = 1.0 kcal/kg °C

Changes of State

- Solid to liquid, T = melting point
- Liquid to solid, T = freezing point
- Gas to liquid, T = condensation point
- Liquid to gas, T = boiling point

- Latent Heat: total heat/energy required to cause a change of state, added to a substances and does not cause a change in temperature

Heat

- Heat is transferred via
  - conduction: collision of molecules, requires a change in temperature. Rate depends on temperature difference, material of object, size and shape of object
  - convection: mass movement of molecules (ex: draft of air)
  - radiation: doesn't require matter, transfer of heat via waves of energy. All objects absorb and radiate energy. Darker objects absorb and emit more radiation

Oscillating Systems

- Restoring Force F = k x
  - k = spring constant, x = distance displaced from equilibrium

- Direction of restoring force always points towards equilibrium position
- Direction of restoring force changes position!

Oscillating Systems

- Displacement: distance object from equilibrium point
- Amplitude (A): max/min displacement
- Cycle: time to complete one back and forth motion
- Period (T): time in seconds to complete one cycle
- Frequency: number of cycles per second, $f = 1/T$, in Hertz

Conservation of Energy

- Total Energy = $\frac{1}{2} k A^2 = \frac{1}{2} k x^2 + \frac{1}{2} m v^2$
  - $x = 0$ at equilibrium position, so v is max
- $v_{max} = \pm A \sqrt{(k/m)}$
- period of simple harmonic oscillator
  - $T = 2\pi \sqrt{(m/k)}$

Waves

- types of waves
  - Transverse: displacement of material is perpendicular to direction of travel of wave
  - Longitudinal: displacement of material is along the same direction of travel as wave

Waves

- Superposition: when multiple waves pass through the same region of space at the same time, at the overlap points there results a wave whose amplitude = sum of individual amplitudes
  - Beat frequency = change in frequency
- Standing wave: interference of propagating and reflected wave results in a large amplitude wave that appears to be standing still
  - happens at multiple frequencies: f = (n*v) / (2*L)
  - v = velocity of wave, L = length of transmitting medium (string, length of pool, etc)

Waves

- Mechanical waves require some material substance to travel (ex: sound)

- Medium itself does not travel, particles move back and forth about eqiulibrium
- E propagates with wave

- Wave velocity $v = \lambda f$

Sound Waves

- Sound: longitudinal waves
- Speed of sound $v = 331\ m/s + (0.6\ m/s * T)$, T in Celsius
- Intensity of sound = rate at which E is carried across a unit area, in W/m^2
  - Intensity level in decibels, β (in dB) = $10 \log (I / I_o)$
  - For human hearing, $I_o = 10^{-12}\ W/m^2$
- audible range of sound for humans in intensity: $10^{-12}\ W/m^2$ to $1\ W/m^2$ (0 to 120 dB)

Sound Waves

- Doppler effect: $f = f_o \left((v + v_r) / (v + v_s) \right)$
- f = observed frequency
- v = velocity of waves in medium
- v_r = velocity of receiver/observer
  - $v_r > 0$ if observer moving toward source
  - < 0 if moving away from source
- v_s = velocity of source
  - $v_s < 0$ if source moving toward observer
  - > 0 if moving away from observer

Know Your Powers of 10!

- 10^{-2} = centi (c)
- 10^{-3} = milli (m)
- 10^{-6} = micro (µ)
- 10^{-9} = nano (n)
- 10^{-12} = pico (p)

Charge

- q, units of Columbs, C
- Positive and negative
- Likes repel, opposites attract
- Quantized: every stable and independent object has a charge of an integer multiple of the elementary charge, e
  - $e = 1.6 \times 10^{-19}$ C
  - Electrons = -e, protons = +e

Charge

- Create charge objects by
  - Rubbing: 2 neutral objects, transfer of electrons based on property of electron affinity
  - Conduction: touch charged object to a neutral object
  - Induction: hold a charged object near a neutral object
- Remove charge by grounding
- Prevent charge occurring via shielding

Electricity

- Electric Force $$F_{ele} = k \bullet \frac{q_1 \bullet q_2}{d^2}$$
  - $k = 9 \times 10^9\ N\ m^2/C^2$
- Electric field, E = F/q (vector!) $$E_{ele} = \frac{k \bullet q}{d^2}$$
  - Points away from a + charge, toward a – charge
- Volt = electric potential

Electricity

- Movement of charge = electric current
  - I = total charge / time = n * q / t
  - Units of Amperes, or Amps
- Current flows from + to -, opposite to the direction of electron flow

Electricity

- 2 types of current
  - AC: alternating current, sine wave (V as a function of time varies), from wall sockets
  - DC: direct current, single V value over all time, stays constant, from batteries

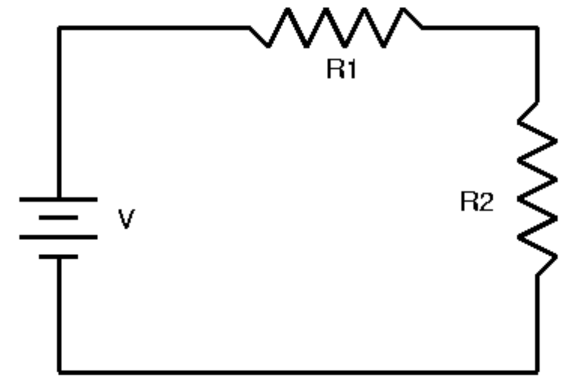
Electricity

- Ability to conduct charge (or prevent charge from moving through objects) is Resistance, R, units Ohms (Ω)

- Ohms Law: $V = I*R$
  - $V_{total} = I_{total} * R_{total}$

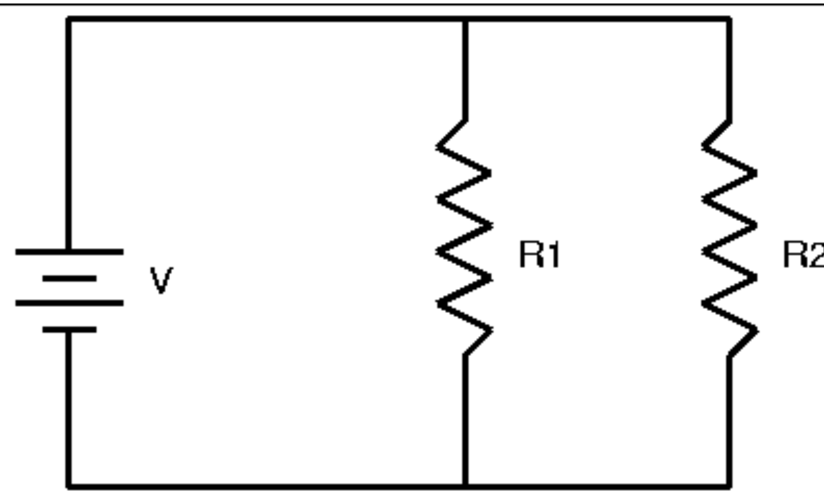
Summing Resistances

- Resistors in series
  - $R_{total} = (R_1 + R_2 + R_3 + \ldots)$



- Resistors in parallel

$$R_{total} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \ldots.}$$



Example Problems Done In Class

- Density of an object
- Buoyant Force
- Pressure at a depth
- Ideal gas law
- Convert J into Calories
- Work done eating an amount of calories
- Heat capacity of an object
- Difference between convection, conduction, radiation methods of heat transfer

Example Problems Done In Class

- Restoring force
- Frequency and period relationship
- Maximum velocity of oscillating object displaced from equilibrium
- Period of simple harmonic oscillator

Example Problems Done In Class

- Wavelength of sound wave
- Speed of sound
- Doppler effect

Example Problems Done In Class

- Net electric force
- Electric Force
- Net electric field
- Current flowing and charge
- Ohm's Law V = I R
- Series circuits & adding R in series
- Parallel circuits & adding R in parallel