AP Physics B Review --- ASHWIN JACOB

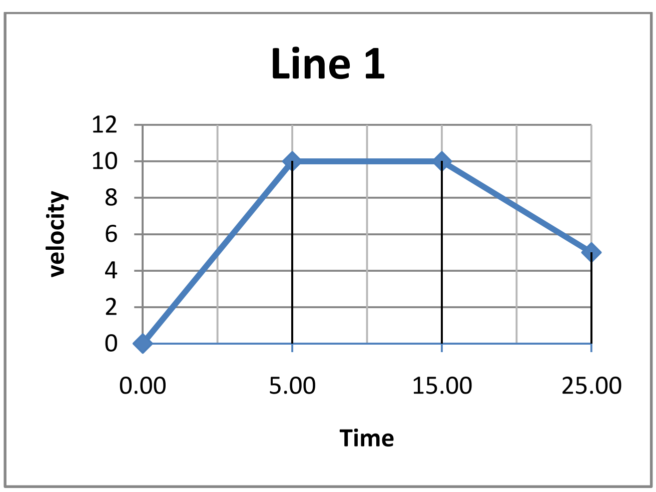
Exam 1

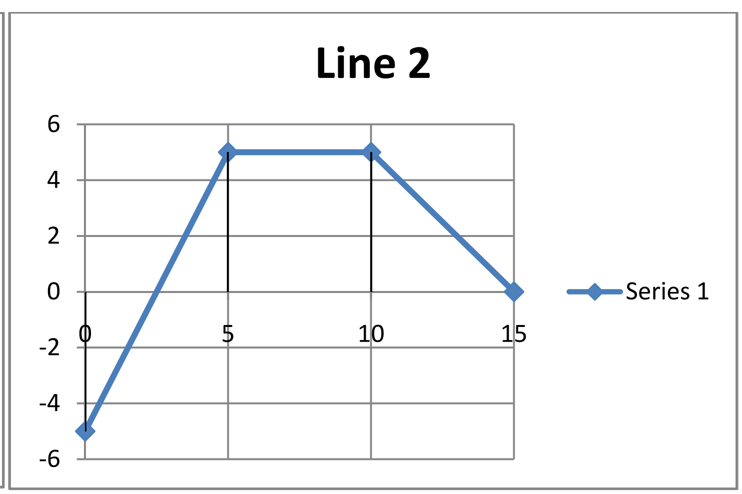
Kinematics

- Definition: The <u>Description</u> of Motion
- Projectile- an object that's influenced by gravity and in motion
    - Horizontal and vertical components are independent
    - The horizontal component of the velocity remain constant
    - The vertical component has a constant acceleration of "g" or 9.8 m/s^2
    - **Only** the vertical component of velocity, at its maximum height, is equal to zero
- Kinematic Formulas

1) $\bar{v} = \frac{\Delta d}{\Delta t}$
2) $\bar{v} = \frac{V_f + v_i}{2}$
3) $\alpha = \frac{\Delta \mathrm{v}}{\Delta \mathrm{t}} = \frac{V_f - v_i}{t}$
4) $x_f = x_i + v_i t + 1/2\, a t^2$
5) $v_f{}^2 = v_i{}^2 + 2a\Delta x$

- Acceleration(α) is the rate that velocity change
    - Occurs when there is a change of speed or change of motion
- When doing projectile problems, it is your choice on what direction is positive and what direction is negative
- Shortcut for velocity of free-falling object $v = \sqrt{2g\Delta y}$
- Analyzing Graphs
    - Area of Graph is the distance
    - Graph B
        - From A(1st point) to x-axis, it has a negative velocity(backward) and since below x-axis it is negative distance

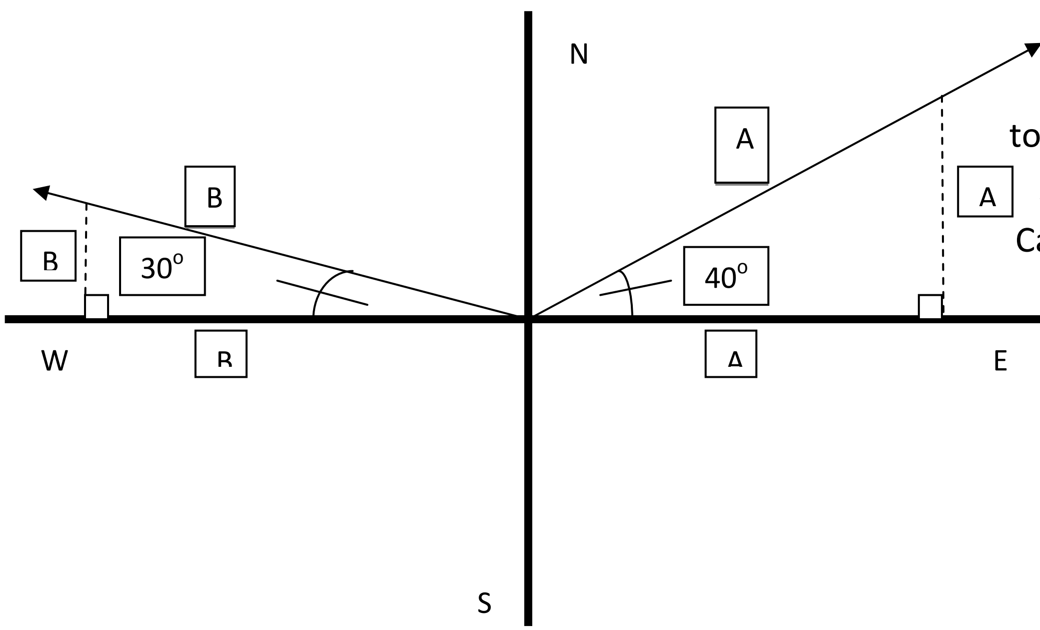




Exam 2

Vectors ****Degree Mode****

- Vectors- Quantities that require both size(magnitude) and direction
  - Velocity, Displacement, and Force
- Scalars-Magnitude Only
  - Volume, Mass, Distance, Speed
- Vector Equations
  - $x = R \times \cos\theta$
  - $y = R \times \sin\theta$
  - $\sum x = A_x - B_x$
  - $\vec{R} = \sqrt{\sum x^2 + \sum y^2}$
  - $\theta = \tan^{-1}(\frac{\sum y}{\sum x})$
- Vector Example
  - $\underset{A}{\rightarrow}$ =50m @ 40^{o}N of E
  - $\underset{B}{\rightarrow} = 20m \ @ \ 30^o N \ of \ W$



Plug in the values into the 1st and 2nd equations to get the x and y values of A and B. From there, you Can solve for anything you Want

- Vector Rules
  - If the two X's or Y's are going in the same direction, then add the x-vectors or y-vectors vector
  - If the two X's or Y's are going in the opposite direction, subtract the bigger x-value or y-value from the smaller x-value or y-value(the direction it will be heading is the big value's direction)
  - Subtracting Vectors
    - $\vec{A} - \vec{B} = \vec{A} + (-\vec{B})$
    - Just the opposite of B = Same Angle, Same Meter, Different Direction

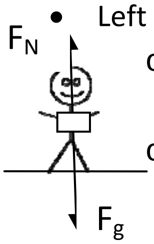
Two-Dimension Kinematics

- The horizontal and vertical motions of a projectile are independent of one another

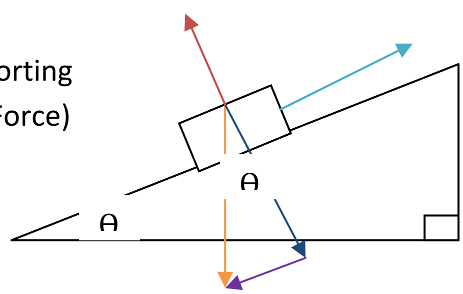
- Changed Equations
  - $y_f = y_i + v_i t + {}^1/_2 at^2$
  - $x = \bar{v}t$
  - Still Need to consider the angles

Newton's First Law (Law of Inertia)

- Inertia- tendency of an object to resist change in their motion
  - Depends on the amount of mass(kg)
- Newton's First Law
  - An object at rest will remain at rest
  - An object in motion will remain in motion in a **straight line** at a **constant speed** unless acted upon a **Net External Force**(push or pull)
- Newton's Second Law
  - $\vec{F}_{net} = m\vec{a}$
  - Two things to Remember
    - Vector Equation
    - Net Force and Acceleration **MUST** have the same direction!!!
  - $\vec{F} = mg$ (Definition of Weight)
- Force is measured in kg*m/s^2 or Newton
- Elevator Problem
  - If accelerating upwards, you feel heavier
  - If accelerating downwards, you feel lighter



- Left Picture
  - F_N is your supporting Force(Normal Force)
  - F_G=F_N



- Right Picture(Color Coded)
  - F_g(Weight)
  - $F_\perp$(Perpendicular to Inline)= mgcosϴ
  - $F_f = \mu F_N (\mu = Coefficant\ of\ Friction)$
    - Friction opposes Motion
  - F_N=$F_\perp$
  - F_P=mgsinϴ (parallel to incline; always goes down hill)
- Object at rest or moving at constant Velocity have a Net force of **ZERO**

Exam 3

Circular Motion

- Centripetal Force: Inward Force Needed to maintain circular motion
  - $F_c = \frac{mv^2}{r}$
- Centripetal Acceleration: The change in direction produced by a central force

- $\frac{v^2}{r}$

- The centripetal force is not a special kind of force; therefore never label a force on a free-body-diagram as 'centripetal'. The centripetal force is provided by the component of the force that is directed towards the center of the circular path e.g. friction, tension, gravity, normal, etc.
- Minimum Speed to go around once
  - $v = \sqrt{rg}$
- Vertical Circle
  - Top=Light
  - Bottom=Heavy

Work

- Definition: The product of the displacement and the component of the force in the direction of the displacement.(Units-Joules)
  - $W = \vec{F} \times \vec{x}$
  - The "F" is the Sum of the Forces
  - "F" and "x" must go in the same direction
- Work and Energy and Scalar Quantities
- Work/ Energy Theorem
  - $W = \Delta E$
- Graph of Force and Distance
  - Area underneath is the work done
- Spring Force
  - $F_s = kx$
  - K=Spring Constant
  - X=distance stretched

Potential Energy	Kinetic Energy
$U_e = {}^1/_2\, kx^2$---**Spring** Stretched	$K = {}^1/_2\, mv^2$
$U_g = mg\Delta y$---Vertical	

- Pendulum Problem
  - $cos\theta = \frac{\ell - \Delta y}{\ell}$
- Positive and Negative Work
  - Force acting on an object has the same direction as displacement = + W
  - Force acting on an object has the opposite direction as displacement = -W
- Mechanical Energy= Constant!!
  - If object is above the zero line of Potential Energy, then include Potential Energy
  - If object is in motion at the point, then include kinetic Energy
  - If object is a spring, then use only equations related to spring
    - $w_F = F_f * x$
- DO NOT NEED MASS ALL THE TIME

Power

- Definition: The rate at which work is done
- $P = \frac{W}{t}$

Exam 4

Newton's Universal Law of Energy

$$F_g = G(\frac{m_1 m_2}{r^2})$$

- r = distance apart from the center(m_1 and m_2)
- Gravity= Force between objects
- Every mass attracts other masses
- G=6.67*10^{-11} $Nm^2/(kg)^2$

Kepler's Law

- First Law
  - Planets Revolve around the sun in ellipsis's
- Second Law
  - "Law of equal areas"
  - Speeds of the planets in their orbits
- Third Law
  - $g = \frac{GM}{r^2}$
    - g = acceleration on any planet
    - M= Mass of object in "?"
  - $v = \sqrt{\frac{Gm}{r}}$
    - v = orbital speed
    - m= mass of "stationary object"
  - $T^2 = \frac{4\pi^2 r^3}{GM}$
    - T=Period(Sec.)
    - r = meters
    - M= stationary object
    - Solar System Constant = $\frac{4\pi^2}{GM}$

Momentum

- $\vec{P} = m\vec{v}$
  - P=momentum= kg(m/s)
  - Write Positive or Negative Sign to show specific direction because it is a vector
- $\overrightarrow{F_{net}} = \frac{\Delta P}{t}$
  - A force is the rate momentum changes
  - Force get bigger when time gets smaller

Energy	Momentum
$W = \Delta E$	$Impulse = \Delta P$
$W = \vec{F} \times \vec{x}$	$I = \vec{F}t$
Area under graph for Force-Displacement is work	Area under Force-Time Graph is Implulse

Newton's Third Law

- "For every action, there is an equal and opposite reaction"
- How to formulate the Construction of Momentum
  - $\overrightarrow{F_1} = -\overrightarrow{F_2}$
  - $\Delta P_1 = -\Delta P_2$
  - $\Delta P_1 + \Delta P_2$=0
  - $\boxed{\sum P_i = \sum P_f}$
- **Inelastic** Collision-Any collision where K_i>K_f
- **Elastic** Collision- A collision that conserves Kinetic Energy --- NEVER ASSUME
- Momentum is conserved in all collision systems. Kinetic energy is conserved only in elastic collisions.

Ballistic Pendulum

- K'=U_g
- Find v'
- Plug into the Construction of Momentum to find mass of bullet
- This is one example of the many they can give you

Elastic Collision

- $v_2' = \left(\frac{2m_1}{m_1+m_2}\right) v_1'$
- $v_1' = \left(\frac{m_1-m_2}{m_1+m_2}\right) v_1$
- One that is moving=m_1
- One that is not=m_2

Exam 5

Fluid

- $P = \frac{F}{A} = \frac{N}{m^2} = Pa$---**Not** a Vector. It is a scalar quantity.
- $PV = nRT$ --- Can only use two units
  - Pa & m^3
  - Atm & L
- $P_f = \varrho_f gh$ --- Pressure of a fluid
  - Fluid pressure is independent of the shape or area of the container
- Density $\varrho = \frac{m}{V}$
- Gauge Pressure = P_f --- Pressure only by fluid
- Absolute pressure is equal to the gauge pressure plus the atmospheric pressure
- Buoyant Force is upwards(against gravity) $\overrightarrow{F_B} = \varrho_f g V_s$
  - V_S= Volume of Object Submerged
  - It is a vector

- Definition: **Weight** of Fluid displaced by Object

- Please Note that you can think of $F_g = \varrho_o g V_T$
  - ϱ_o= density of object

Dynamic Fluids

- $A_1 v_1 = A_2 v_2$ --- Equation of Continuity
  - Flow Rate
    - $A_1 v_1$
    - $m^2 * {}^{m}/_{s}$
    - $\frac{m^3}{s}$
    - $\boxed{{}^{V}/_{s}}$

- Bernoulli's Equation: The net work done on a fluid is equal to the changes in kinetic and potential energy of the fluid in terms of quantities per volume.
  - $P_1 + {}^{1}/_{2}\,\varrho {v_1}^2 + \varrho g y_1 = P_2 + {}^{1}/_{2}\,\varrho {v_2}^2 + \varrho g y_2$
  - Any Time fluid is exposed to air the Pressure = 1 atm
  - If the distances between the two fluids are very close, then they can be set to zero
  - If water is leaking then you can find velocity using …. $v = \sqrt{2gy}$

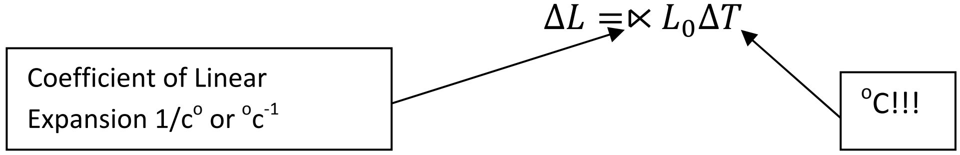
Exam 6-ThermoDynamics

Thermo expansion

- Increase of a temperature on object
- Expanding of metals at a rate

Linear Expansion

$$\Delta L = \propto L_0 \Delta T$$



Ideal Gas Law

1. $PV = nRT$
   a. n=moles
   b. Value of R
      i. 8.31 J/(mol*K)
      ii. 0.0821 (atm*L)/(mol*K)
   c. T --- Always use Kelvin for temp Scale
      i. ___°K=___°C+273
2. $n * N_A = N$

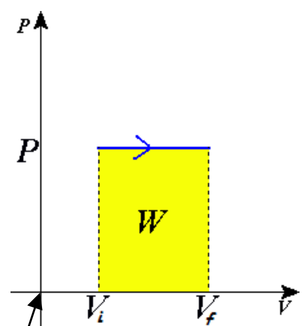
a. n = # of moles
b. N_A = Avogadro's # = 6.022 *10^{23}
c. N = # of Molecules

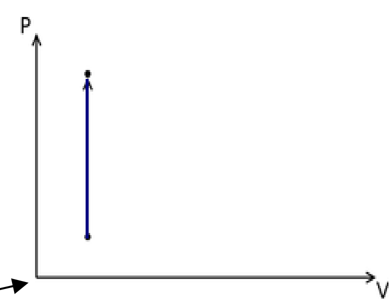
3. $PV = N\mathcal{k}T$
   a. $\mathcal{k}$ = Boltzmann's Constant = 1.38 * 10^{-23} J/K

Kinetic Theory

- Kinetic theory relates the average kinetic energy of the molecules in a gas to the temperature of the gas in Kelvin
- $P = \frac{1}{3}\frac{N}{V}[m\bar{v}^2]$ same as $P = \frac{2}{3}\frac{N}{V}\bar{K}$
- $\bar{K} = {}^{3}/_{2}\,\mathcal{k}T$
- $v_{rms} = \sqrt{\frac{3\mathcal{k}T}{m}}$
  - m = mass of single molecule
  - r.m.s= root mean square
  - i.e. O_2 = 16 g/mol (Periodic Table) * 2(diatomic) = 21 g/mol → Then divide by 1000 → then divide by N_A → Changed to Kg which is the value you need for "m"

Thermal Energy/ Law of Thermodynamics

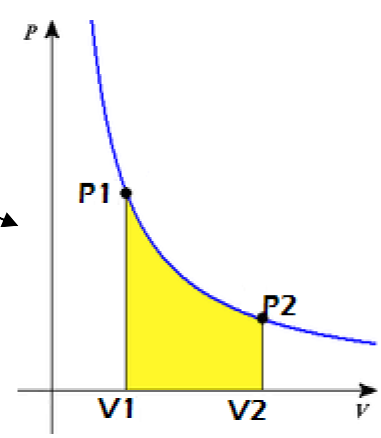




- $\Delta U = {}^{3}/_{2}\,N\mathcal{k}\Delta T$
  - Internal Energy of Gas
- First Law of Thermodynamics
  - $\Delta U = \Delta Q - W$
  - Work is done ON the System
  - $W = P\Delta V$
- The Sign is Important so always put a "+" or "-"

P-V Diagrams

(1) Isobaric Process- Process when Pressure is constant
(2) Isometric(Isochoric) Process – Occurs at Constant Volume
   a. $\Delta U = \Delta Q$
(3) Isothermal Process – Constant Temperature
   a. Everywhere, $V_1P_1=P_2V_2$
   b. $W = nRT\ln\left(\frac{V_f}{V_i}\right)$
   c. $W = PV\ln\left({}^{V_f}/_{V_i}\right)$ --- Same as above
   d. $\Delta Q = W$



(4) Adiabatic Pressure

a. $\Delta Q = 0$

b. $\Delta U = -W$

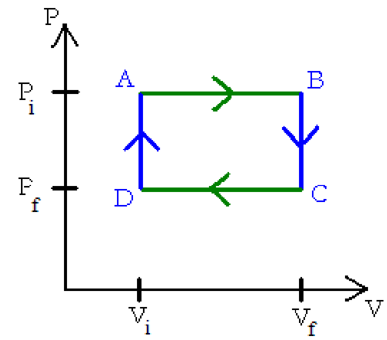
(5) Complete Cycle

a. Total for delta U = 0

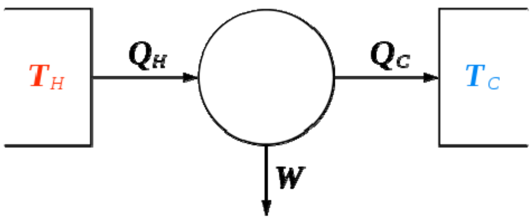
b. Total for delta Q = W

c. Total for W= "+"

d. Pay Attention to Direction

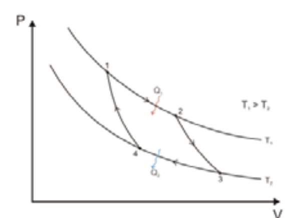


Carnot Engine



$$Q_h = Q_c + W$$

- Carnot cycles involve only isothermal and adiabatic processes. To determine the efficiency use the Kelvin temperatures of the reservoirs.
- Carnot Engine = The "Perfect" Cycle
- Efficiency of any engine $\varepsilon = \frac{W}{Q_h} = 1 - \frac{Q_c}{Q_h}$
- Efficiency of Carnot (maximum Efficiency) $\varepsilon = 1 - \frac{T_c}{T_h}$



1Carnot Cycle-Only Adiabatic and Isothermal

Watt = (J/S) = Energy/Time = P (Didn't know where to put this)

Negative Work (Gas Does the Work)

(1) $W = -(P\Delta V)$

(2) $\Delta U = \Delta Q + W$

(3) $\mathrm{W} = -\mathrm{nRT}\ln\left({}^{\mathrm{V_f}}/{}_{\mathrm{V_i}}\right)$

Entropy

- Basic measure of "disorder"
- Entropy of the universe is always "+"
- $\Delta s = \frac{\Delta Q}{T}$
  - s = entropy
  - Q= change in entropy
  - T= Kelvin
- $\frac{Q_C}{T_C} = \frac{Q_H}{T_H}$