Honors Physics Study Guide

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Breakdown of Units

**topics discussed may vary between schools. The units in this guide are the main topics discussed in many physics courses.

Unit 1: Kinematics (1D and 2D motion)
Unit 2: Newton's Laws of Motion
Unit 3: Circular Motion
Unit 4: Work and Energy
Unit 5: Electric Currents and Magnetism

<u>1 Dimensional Motion</u>

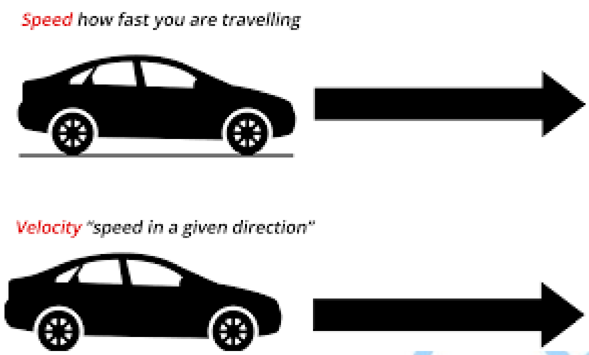
Introduction to Speed and Velocity

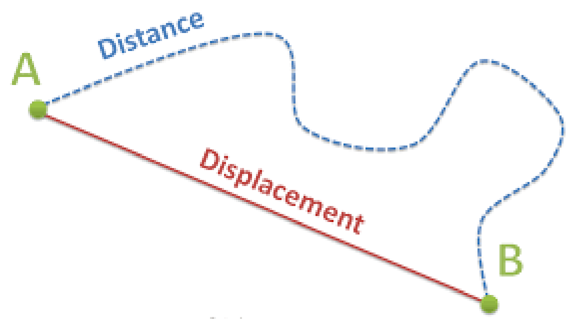
<u>Key Equations:</u>

Average speed = (distance)/(time)

Average velocity = (displacement)/(time)

<u>Velocity</u>: The rate at which position changes (basically speed with direction)
<u>Displacement:</u> Distance and direction from the starting point (ex: 30 meters 10° west)





https://www.coolkidfacts.com/speed-and-velocity/ http://thescienceclassroom.org/physics/motion-in-1-d/distance-and-displacement/

<u>Example Problems:</u>

(1) Finding distance given speed and time

Avg. speed= 70 mi/hr
Time= 14 hours
Distance= ?

<u>How to solve:</u>

Equation: Average speed=(distance)/(time)
Rearrange equation: distance=(avg speed)(time)
Substitute: distance=(70)(14)
Final Answer: distance=<u>980 miles</u>

(2) Finding time given speed and distance

Avg. speed: 75 mi/hr
Distance: 360 mi
time= ?

time=(distance)/(avg. speed)=(360)/(75)= 4.8 hrs

(3) Word problem using travel in 2 directions

You travel at 30 meters per second east for 4 seconds and then 50 m/s west for 3 seconds. What is the average speed? What is the average velocity?

Tip: when tackling word problems underline all the numbers given to you and then write them out with what unit of measurement that number represents. This makes it easier to figure out which equation is best to use. In the case of two different directions using two different colors to differentiate between numbers can also be helpful.

Travel in the East Direction	Travel in the West Direction
Speed=30 m/s	Speed= 50 m/s
Time= 4 seconds	Time= 3 seconds
distance= (30)(4) = 120 meters	distance= (50)(3) = 150 meters

Average speed = (total distance)/(total time)=(120+150)/(7)= 38.57 m/s
Average velocity = (displacement)/(total time)=(120-150)/(7)= -4.3 m/s or 4.3 m/s west

**when finding the displacement think of the east direction as positive and the west direction as negative

(4) Word problem using two objects traveling in different directions

Two trains are 1600 meters apart and heading toward one another. Train A is headed north at 10 km/hr while train B is headed south at 15 km/hr Where and when will they collide?

1 Dimensional Motion

Acceleration

Acceleration: The rate of change of velocity (every second it gains x amount of speed)
Equation: acceleration=(change in velocity)/(time)

Example: 0-60 mi/hr in 4 seconds
acceleration=(change in velocity)/(time)= (60-0)/(4)=15 (mi/hr)/(s)
(every second it gains 15 mi/hr)

Kinematic Equations -have these memorized!

final velocity= initial velocity + (acceleration)(time)

displacement =(initial velocity)(time)+ (½)(acceleration)(time^2)

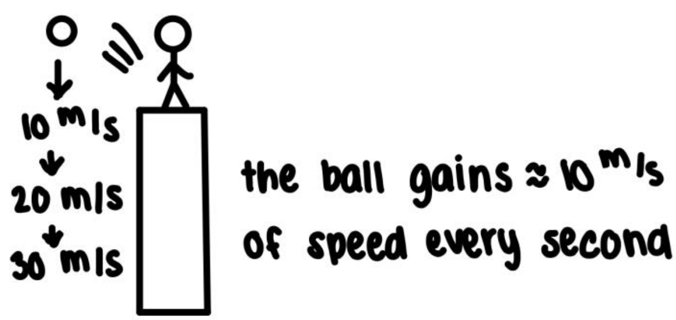
final velocity=initial velocity^2 + (2)(acceleration)(distance)

More pointers about displacement, velocity, and acceleration
1. When displacement is positive, the object is to the right of zero (or above zero)
2. When velocity is positive, the object is heading to the right of zere(or up)
3. If acceleration is positive, the force is to the right or upwards (**force is a push or pull)

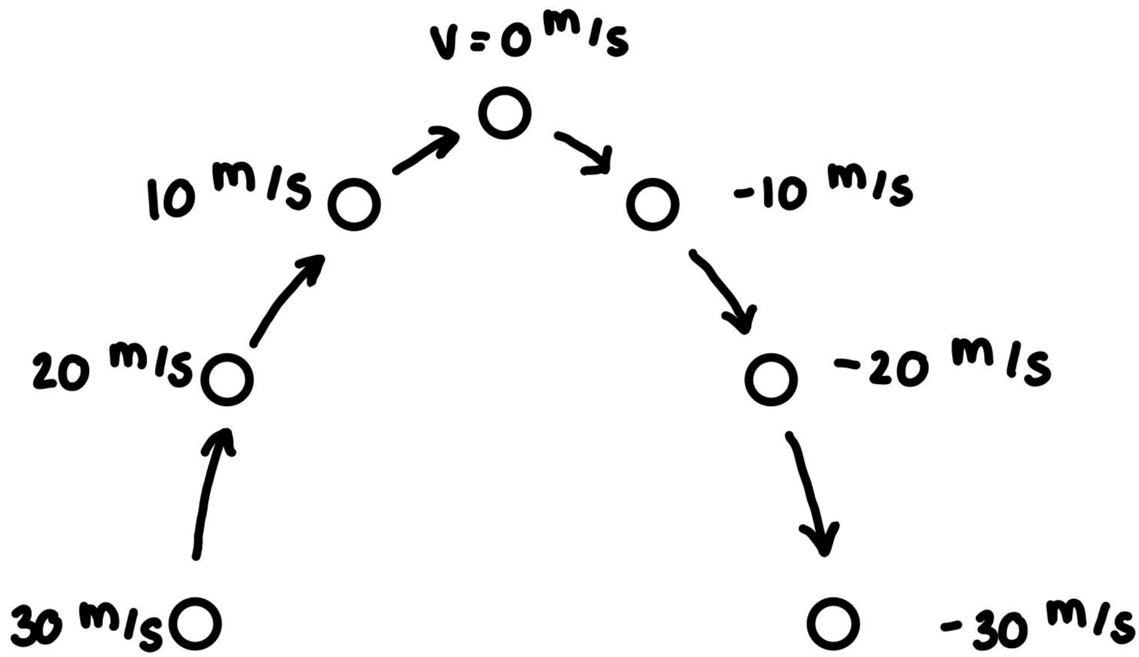
Free Fall

- Objects fall under the influence of gravity alone
- Any object, regardless of weight accelerate at the same rate
- Freefall rate of acceleration: 9.8 m/s^2

Acceleration due to gravity= -9.8 m/s^2



The Ball in the Air Problem



(1) How fast was the ball thrown? (it took 1.8 seconds for the ball to hit the ground after thrown)

Equation: final velocity= initial velocity + (acceleration)(time)

How to go about solving: Cut the time in half so that you can solve using the amount of time it took for the ball to get to the top. At the top, the velocity of the ball is 0, so that can be used as the final velocity.

0=(initial velocity)+(-9.8)(.9) → <u>initial velocity=8.82 m/s</u>

(2) How high did the ball go?

Equation: displacement =(initial velocity)(time)+ (½)(acceleration)(time^2)

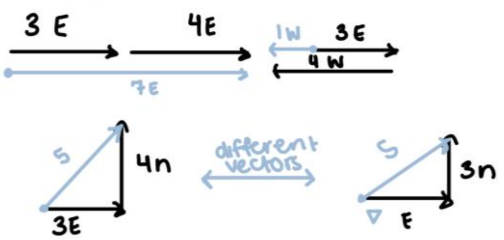
How to go about solving: since we have all of the values needed to plug into the equation we would just have to substitute to solve for the displacement, or in this case; height.

displacement=(8.82)(.9)+(½)(9.8)(.9)^2 → <u>height=3.969 m</u>

2 Dimensional Motion

Vector: magnitude and direction	velocity	displacement	acceleration	force
Scalar: magnitude only	volume	mass	speed	length

m = resultant



$\tan\theta = \frac{4}{3}$
$\theta = \tan^{-1}(\frac{4}{3})$
$\theta = 53°$

$\tan\theta = \frac{3}{4}$
$\theta = \tan^{-1}(\frac{3}{4})$
$\theta = 37°$

* put calculator in degree mode

Equations for Projectiles:

horizontal distance, horizontal velocity, time

$$X = V_x t$$

vertical velocity, initial vertical velocity, -9.8, time

$$V_y = V_{yo} + gt$$

vertical distance, time, -9.8, initial vertical velocity, time

$$y = V_{yo} t + \frac{1}{2} g t^2$$

Vectors

Rules for vector addition:

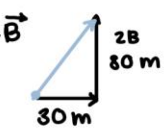
1. Place vectors tail to tip
2. Draw resultant from opent tail to open tip
3. Report magnitude and direction

vector A

$\vec{A} = 30$ m E
$\vec{B} = 40$ m N

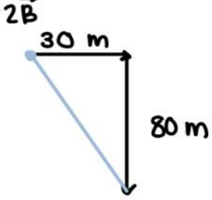
Find $\vec{A} + \vec{B}$ 50 m @ 53°
$\tan^{-1}(\frac{40}{30})$

$\vec{A} + 2\vec{B}$

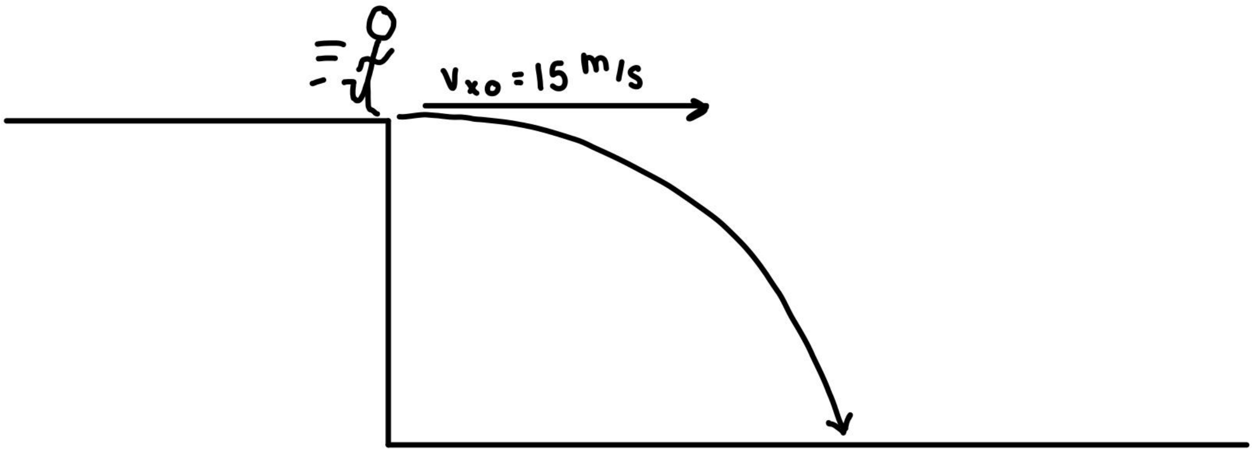


$30^2 + 80^2 = c^2$
$c = 85.44$
$\tan^{-1}(80/30) = 69.4°$

$\vec{A} - 2\vec{B}$



Examples

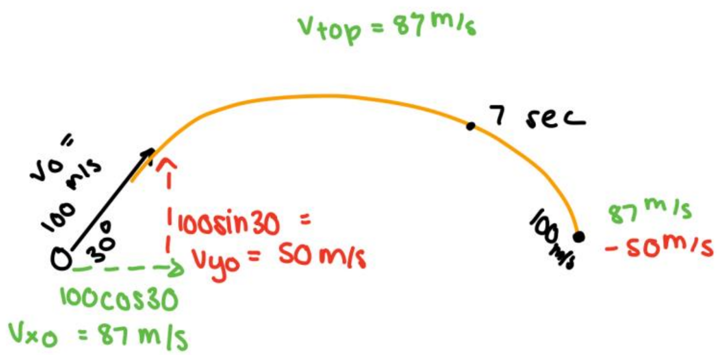


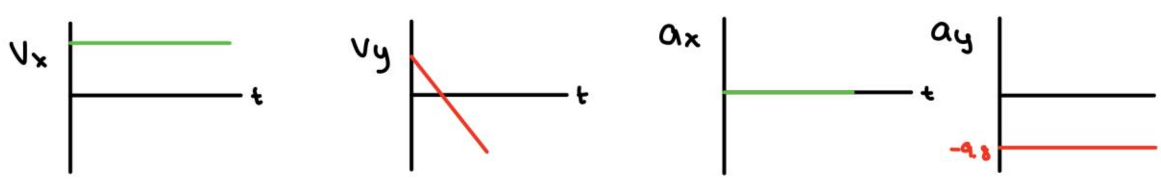
how far from the base of the cliff does he land?

$$y = \frac{1}{2} g t^2 \rightarrow t = \sqrt{\frac{2y}{g}} = \sqrt{\frac{2(-25)}{-9.8}} = 2.26 \text{ sec}$$

$$x = v_x t \rightarrow x = (15 \text{ m/s})(2.26 \text{ sec}) = \boxed{33.9 \text{ m}}$$

Upwardly Launched Projectiles:



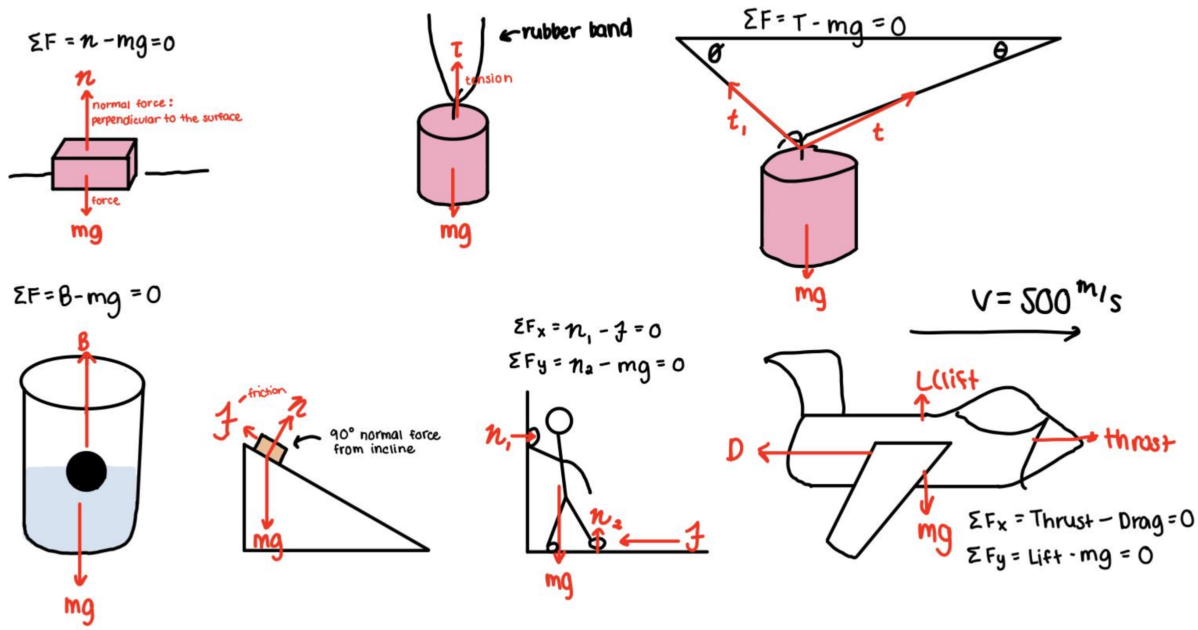


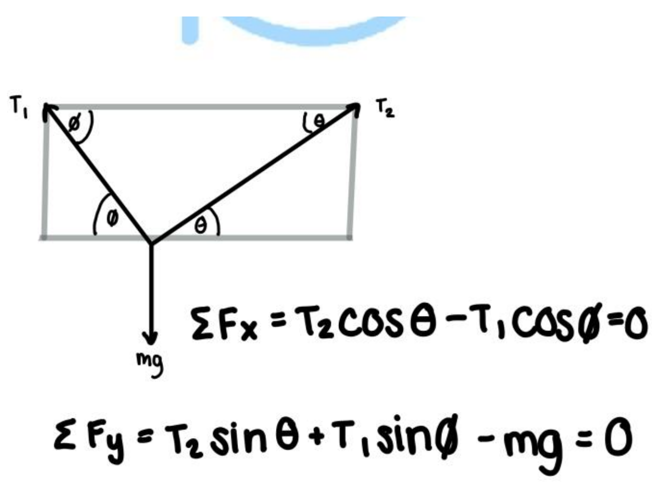
Newton's Laws

Force: push or pull

- Unit: Newtons (N)
  - Mass: amount of matter (kg)
  - Volume: amount of space (m^2)
  - Weight: force due to gravity (N)
    - weight=(mass)(9.8)

Drawing Freebody Diagrams:





Newton's First Law: If the sum of the forces (net force)=0, then the acceleration=0

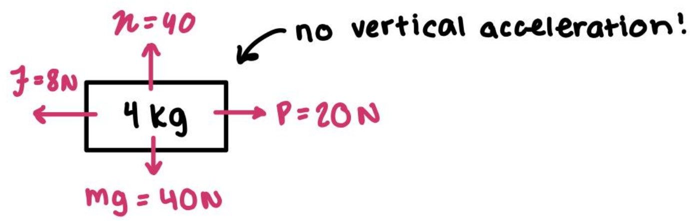
Inertia: Resistance to a change in motion (dependent on mass)

- Larger mass=larger inertia

<u>Newton's Second Law:</u> If the net force doesn't equal zero, the the acceleration doesn't equal zero

$\Sigma F_x = P - f = ma \rightarrow 20 - 8 = 4a \quad a = 3\,m/s^2$

$\Sigma F_y = n - mg = 0 \rightarrow n = mg = 40N$



IF M ↑ THEN A ↓ ($a \propto \frac{1}{m}$)

$a = \frac{\Sigma F}{m}$

$\Sigma F = ma \qquad T - mg = ma$

<u>Newton's Third Law:</u> For every action there is an equal and opposite reaction.

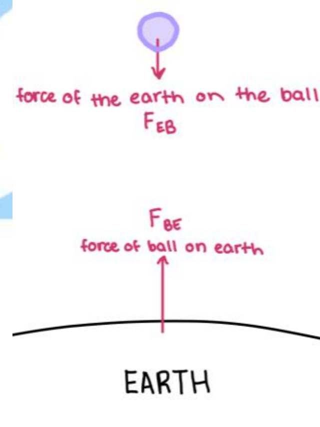
$F_{ab} = -F_{ba}$

force ↵ ↓ a ↳ b   force ↵ ↓ b ↳ a

$\frac{F}{MASS} = a$

$\frac{F}{MASS} = a$

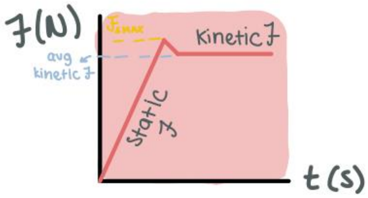
Same force, different acceleration!



$\frac{F}{m} = a$

$\frac{F}{m} = a$

Friction

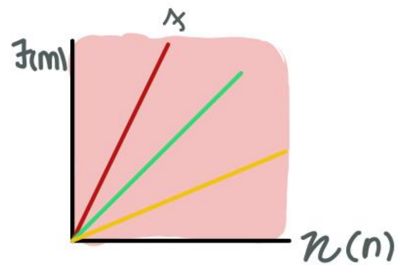


N friction force

N normal force

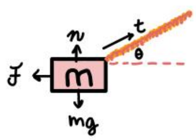
$$\mathcal{F} = \mu n$$

coefficient of friction (percentage)



$$Y = mx$$

Angled Forces



find acceleration:

$$\Sigma F_y = n - mg + T\sin\theta = 0$$

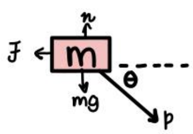
$$\Sigma F_x = T\cos\theta - \mathcal{F}_k = ma$$

$$T\cos\theta - \mu_k n = ma$$

$$n = mg - t\sin\theta$$

$$T\cos\theta - \mu(mg - T\sin\theta) = ma$$

$$m = \frac{T\cos\theta - \mu(mg - T\sin\theta)}{a}$$



find acceleration:

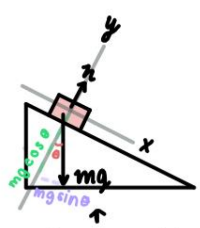
$$\Sigma F_y = n - mg + P\sin\theta = 0$$

$$\Sigma F_x = P\cos\theta - \mathcal{F}_k = ma$$

$$P\cos\theta - \mu n = ma$$

$$P\cos\theta - \mu(mg + P\sin\theta) = ma$$

$$a = \frac{P\cos\theta - \mu(mg + P\sin\theta)}{m}$$

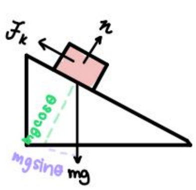


no friction!!

$$\Sigma F_y = n - mg\cos\theta = 0 \rightarrow n = mg\cos\theta$$

$$\Sigma F_x = mg\sin\theta = ma$$

$$a = g\sin\theta$$

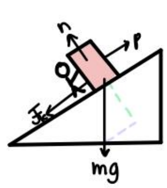


$$\Sigma F_y = n - mg\cos\theta = 0$$

$$\Sigma F_x = mg\sin\theta - \mathcal{F}_k = ma$$

$$m\sin\theta - \mu n = ma$$

$$a = \frac{g\sin\theta - \mu(g\cos\theta)}{m}$$



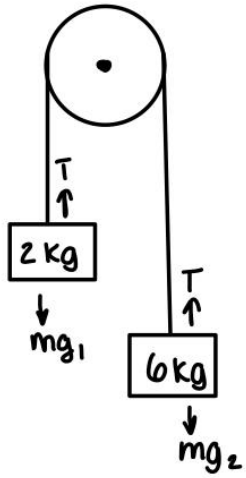
$$\Sigma F_y = n - mg\cos\theta = 0$$

$$\Sigma F_x = F - \mathcal{F}_k - mg\sin\theta = ma$$

$$P - \mu n - mg\sin\theta = ma$$

$$a = \frac{P - \mu mg\cos\theta - mg\sin\theta}{m}$$

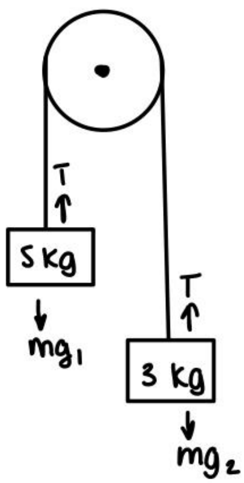
Atwood Machine Examples:



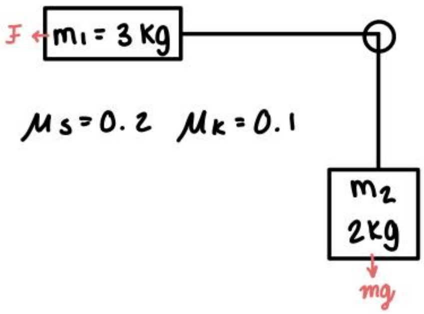
$$\Sigma F_2 = T - mg_1 = ma$$
$$\hookrightarrow T - 20 = 2a$$

$$\Sigma F_6 = mg - T = ma$$
$$\hookrightarrow 60 - T = 6a$$

$$\begin{array}{r} T - 20 = 2a \\ \underline{60 - T = 6a} \\ 40 = 8a \\ a = 5\ m/s^2 \\ T = 30\ N \end{array}$$



$$\Sigma F_{system} = m_5 g - m_3 g = (m_3 + m_5)(a)$$
$$50 - 30 = 8a$$
$$a = 2.5$$



$$\begin{aligned} \Sigma F_1 &= T - F_k = m_1 a \\ &= T - \mu_k n = m_1 a \\ &= T - \mu_k m_1 g = m_1 a \\ &= T - (0.1)(30) = 3a \\ & T - 3 = 3a \end{aligned}$$
$$\Sigma F_2 = 20 - T = 2a$$

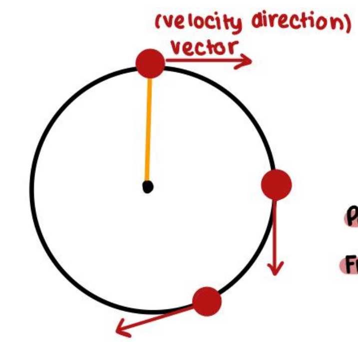
Quick way:

ΣF_{system}: $20 - 3 = 5a$

$$a = 3.4\ m/s^2$$

$$\begin{array}{r} T - 3 = 3a \\ \underline{20 - T = 2a} \\ 17 = 5a \\ a = 3.4\ m/s^2 \\ T = 13.2\ N \end{array}$$

Circular Motion

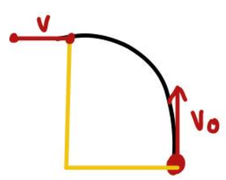


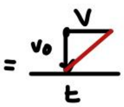
velocity m/s $V = \frac{2\pi r}{T}$ radius; time for 1 circle (sec)

Period: time for 1 circle
Frequency: # of circles per second
} inverse relationship

$T = 1/f$

$f = 1/T$



$a = \frac{\Delta v}{t} = \frac{v - v_0}{t} =$  $=$ acceleration

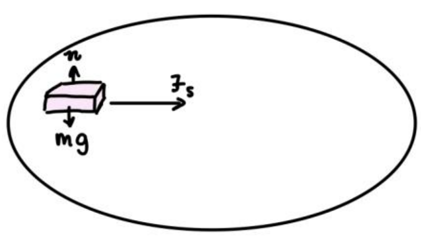
centripical = inward

$a_c = \frac{v^2}{r}$ → amount of acceleration

$F_c = \frac{mv^2}{r}$

$$\boxed{V = \frac{2\pi r}{T} \quad T = 1/f \quad f = 1/t \quad a_c = \frac{v^2}{r} \quad f_c = \frac{mv^2}{r}}$$

Friction during circular motion:



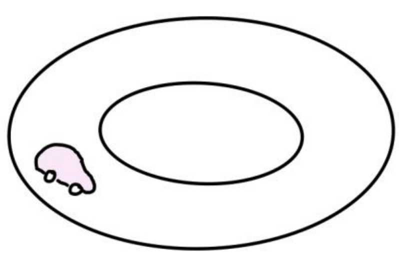
$\Sigma F_y = n - mg = 0 \qquad n = mg$

$\Sigma F_c = F_s = (m)\left(\frac{v^2}{r}\right) \qquad \mu_s n = \frac{mv^2}{r}$

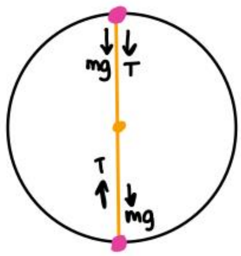
$\mu_s mg = \frac{mv^2}{r} \qquad V = \sqrt{r\mu g}$

↑ max. speed

$v_{max} = \sqrt{r\mu g} \rightarrow \mu = \frac{v^2}{rg}$



Vertical Circles

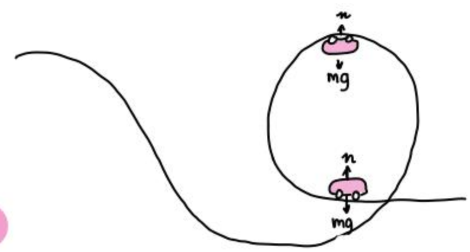


$\Sigma F_c = T + mg = \frac{mv^2}{r}$ $\quad T = \frac{mv^2}{r} - mg$

$\Sigma F_c = T - mg = \frac{mv^2}{r}$ $\quad T = \frac{mv^2}{r} + mg$

$n = \frac{mv^2}{r} = mg$ $\qquad n - mg = \frac{mv^2}{r}$

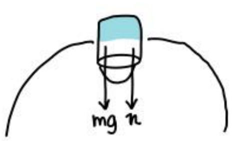
$n = \frac{mv^2}{r} + mg$



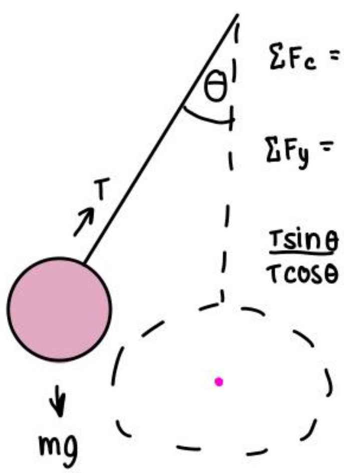
minimum speed to complete a circle (v_{min})

$T + mg = \frac{mv^2}{r}$

@ v_{min} T aproaches zero $\cancel{T} + mg = \frac{mv^2}{r} \rightarrow \boxed{v_{min} = \sqrt{gr}}$



← don't go less than the $\sqrt{gr}$!

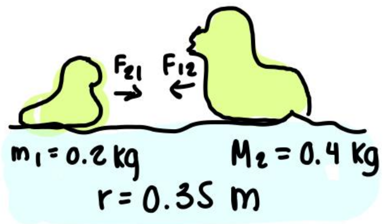


$\Sigma F_c = T\sin\theta = \frac{mv^2}{r} \rightarrow T\sin\theta = mg$

$\Sigma F_y = T\cos\theta - mg = 0$

$\frac{T\sin\theta}{T\cos\theta} = \frac{\frac{mv^2}{r}}{mg}$ $\qquad \tan\theta = \frac{v^2}{rg}$

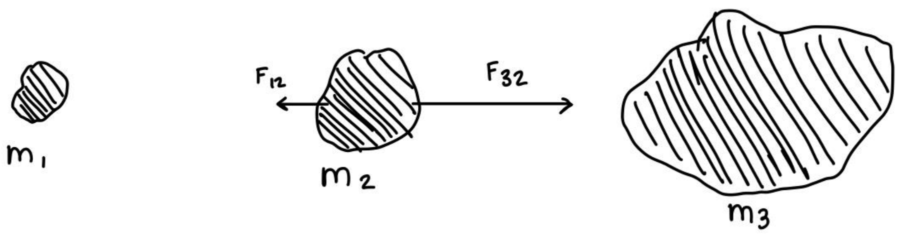
Gravity

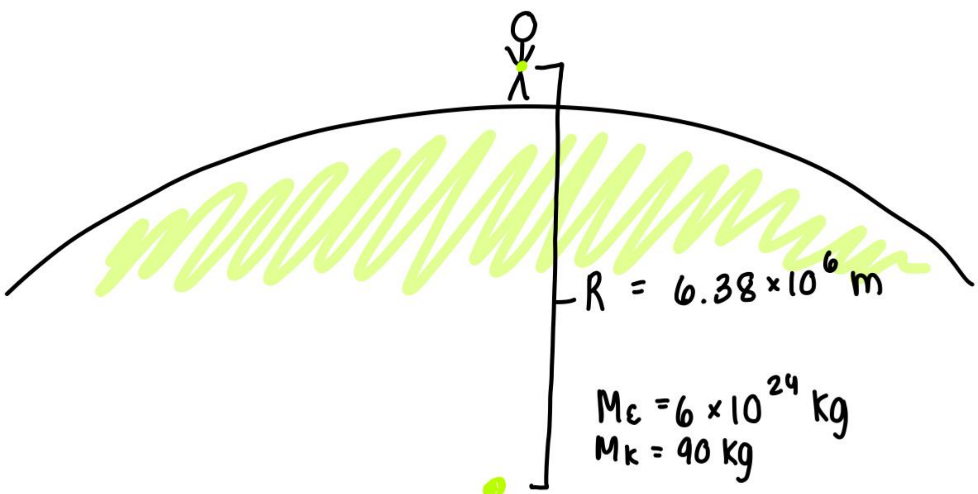


$6.67 \times 10^{-11} \frac{Nm^2}{Kg^2}$

$$F = \frac{GmM}{r^2}$$

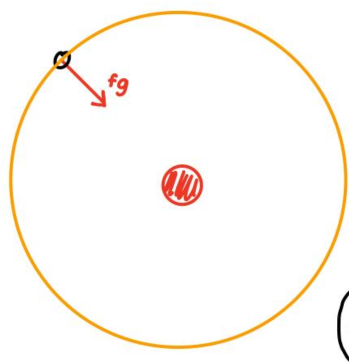
$$= \frac{(6.67 \times 10^{-11})(0.2)(0.4)}{0.35^2} = 4.36 \times 10^{-11} N$$





$$F = \frac{GmM}{r} \Rightarrow \cancel{m}g = \frac{G\cancel{m}M}{r^2} = \frac{(6.67 \times 10^{11})(6 \times 10^{24})}{6.38 \times 10^{6}} = 9.8$$

Kepler's Third Law

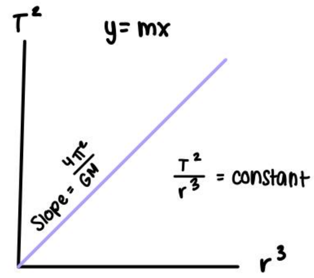


$$\Sigma F_c = \frac{GmM}{r^2} = \frac{mv^2}{r}$$

$$v = \frac{2\pi r}{t}$$

$$\frac{GmM}{r^2} = \frac{m\left(\frac{2\pi r}{t}\right)^2}{r}$$

$$\frac{GmM}{r^2} = \frac{m4\pi^2 r^2}{T^2 r}$$



$$\frac{T^2}{r^3} = \text{constant}$$

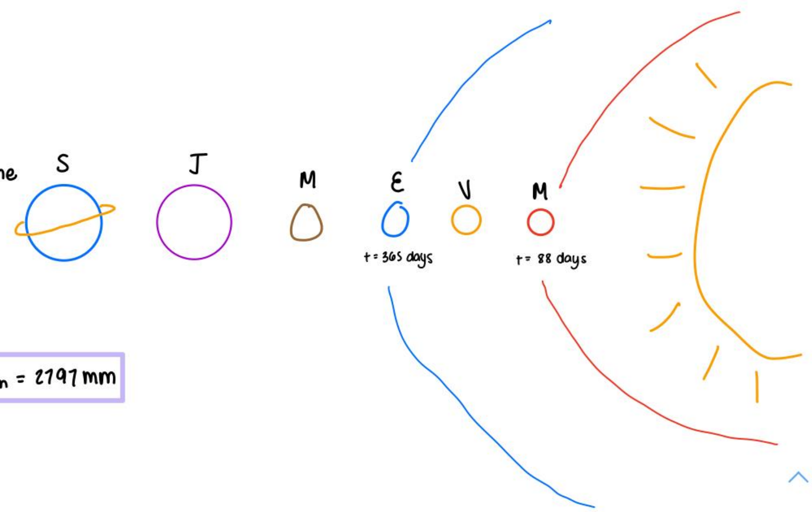
$$\boxed{T^2 - \left(\frac{4\pi^2}{CM}\right) r^3} \longleftarrow \text{kepler's 3rd law}$$

$$\frac{t_e^2}{r_e^3} = \frac{t_m^2}{r_m^3}$$

r=distance from the sun

$$\frac{365^2}{93^3} = \frac{88^2}{r_m^3} \quad \boxed{r_m = 36.03\ \text{mm}}$$

$$\frac{t_e^2}{r_e^3} = \frac{t_n^2}{r_n^3} \qquad \frac{365^2}{93^3} = \frac{60190^2}{r_n^3} \quad \boxed{r_n = 2797\ \text{mm}}$$



Work and Energy

energy: the ability to do work

work: force × distance

$$\boxed{W = Fd\cos\theta}$$

work: newton-meter, joule; force (N); distance (m); θ: angle between f and d

$\Sigma F_x = T\cos\theta - F_k = ma$

$150\cos 30 - (0.2)(317) = 40a$

$a = 1.66\ m/s^2$

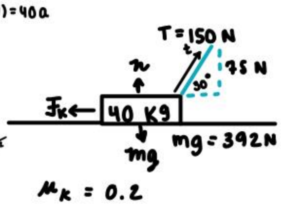
$v^2 = v_0^2 + 2ad$

$v = 4.82\ m/s$

$W = \Delta E$

$495\ J = \frac{1}{2}(40)v^2 - \cancel{\frac{1}{2}(40)0^2}$

$v = 4.82\ m/s$



calculate the work done by each force:

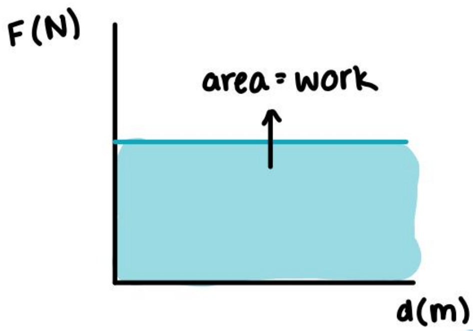
$W_{tension} = Td\cos\theta = (150\ N)(7\ m)\cos 30° = 909\ J$

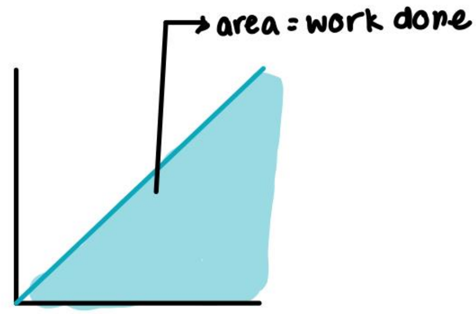
$W_{mg} = (mg)d\cos\theta = (40\ kg)(9.8\ m/s^2)\cos 90° = 0\ J$

$W_F = F_k d\cos\theta = (\mu_k n)d\cos\theta = (0.2)(317\ N)(7\ m)\cos 180 = -444\ J$

$W_n = nd\cancel{\cos\theta} = 0\ J$

$W_{NET} = 909 + 0 + -444 + 0 = 465\ J$





Types of Energy

kinetic energy: the energy of motion

$K_E = \frac{1}{2}mv^2$

kinetic energy (J); mass (kg); speed (m/s)

potential energy (gravitational): energy of position (height)

$P_E = mgh$

J; mass (kg); g: 9.8 m/s²; height (m)

potential energy (elastic): energy of position (stretch)

$P_E = \frac{1}{2}kx^2$

J; spring constant (N/m); stretch (m)

Work Energy Theorem

$$W = \Delta E$$

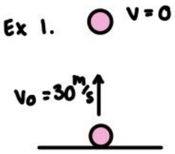
$$w = \tfrac{1}{2}mv^2 - \tfrac{1}{2}mV_0^2 \qquad w = mgh - mgh_0 \qquad w = \tfrac{1}{2}kx^2 - \tfrac{1}{2}kx_0^2$$

Conservation of Energy

$$PE_0 + KE_0 = PE + KE$$

$$U_0 + K_0 = U + K$$

Ex 1.



Find the max height:

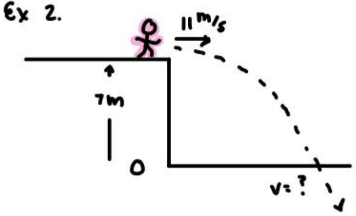
$\cancel{U_0} + K_0 = U + \cancel{K}$

$\tfrac{1}{2}\cancel{m}v^2 = \cancel{m}gh$

$\tfrac{1}{2}(30)^2 = (9.8)h$

$\boxed{h = 45.9\ m}$

Ex 2.



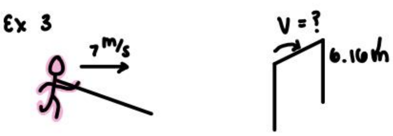
$U_0 + K_0 = \cancel{U} + K$

$\cancel{m}gh_0 + \tfrac{1}{2}\cancel{m}v^2 = \tfrac{1}{2}\cancel{m}v^2$

$(9.8)(7) + \tfrac{1}{2}(11^2) = \tfrac{1}{2}v^2$

$\boxed{v = 16.1\ m/s}$

Ex 3



$\cancel{U_0} + K_0 = U + K$

$\tfrac{1}{2}\cancel{m}v_0^2 = \cancel{m}gh + \tfrac{1}{2}\cancel{m}v^2$

$\tfrac{1}{2}(7^2) = (9.8)(6.16) + (\tfrac{1}{2})(v^2)$

$24.5 = 60.4 + \tfrac{1}{2}v^2$ not possible (too slow)

How fast does he have to run?

$K_0 + \cancel{U_0} = \cancel{K} + U$

$\tfrac{1}{2}\cancel{m}v_0^2 = \cancel{m}gh$

$(\tfrac{1}{2})(v_0^2) = (9.8)(6.16)$

$\boxed{V_0 = 11\ m/s}$

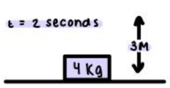
Power

$P = \dfrac{W}{t}$ — work (J); time (sec); power (watt)

* anytime rate is mentioned think POWER $\boxed{R = \dfrac{\text{change of position}}{\text{time}}}$

$$P = \frac{\Delta E}{t} \qquad P = \frac{mgh - mgh_0}{t} \qquad P = \frac{\tfrac{1}{2}mv^2 - \tfrac{1}{2}mv_0^2}{t} \qquad P = \frac{Fd}{t} \qquad P = F\bar{V}$$

avg. speed



$P = \dfrac{W}{t} = \dfrac{Fd\cancel{\cos\theta}}{t} = \dfrac{(40)(3)}{2} = \boxed{6\ \text{watts}}$ (angle = 0)

Efficiency

$$\text{efficiency} = \frac{\text{energy out}}{\text{energy in}} \times 100$$

electrical energy 100 J/s

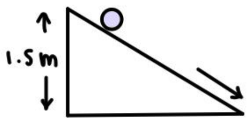
70 J/s of light energy

lightbulb is 70% efficient

30% is heat

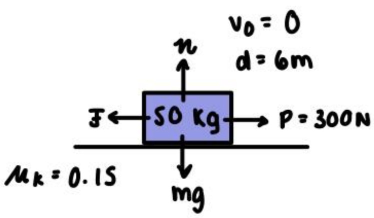
Example: A 3 Kg ball rolls down a 1.5 m high hill, it reaches a speed of 4.3 m/s. What was the efficiency of the energy transfer?

<u>Heat</u>



$$\text{eff} = \frac{\text{energy out}}{\text{energy in}} = \frac{\frac{1}{2}mv^2}{mgh} = \frac{(\frac{1}{2})(3)(4.3)^2}{(3)(9.8)(1.5)} \times 100 = 62.8\% \text{ eff}$$

$|W_{\mathcal{F}}| = \text{heat}$ $\quad$ $\mu n d = \text{heat}$ $\quad$ $W_{\mathcal{F}} + U_0 + K_0 = U + K + \text{heat}$



$W = Fd\cos\theta$

$W_P = (300)(6)\cos 0 = 1800\text{ J}$

$W_{mg} = (490)(6)\cos 90 = 0$

$W_n = 0$

$W_{\mathcal{F}} = (\mu n)d\cos\theta = (0.15)(490)6\cos 180 = -441\text{ J}$

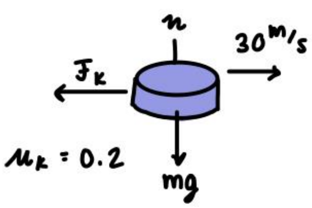
$W_{NET} = 1359\text{ J}$

$W_{\mathcal{F}} + \cancel{U_0}^{0} + \cancel{K_0}^{0} = \cancel{U}^{0} + K + \text{heat}$

$1800 = K + 441$

$K = 1359\text{ J}$

Ex 1:



Question: How far does it slide before coming to rest?

$\cancel{W} + \cancel{U_0} + K_0 = \cancel{U} + \cancel{K} + \text{heat}$

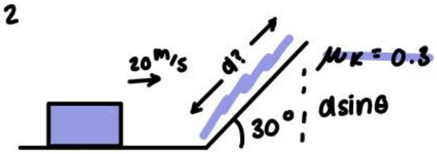
$\frac{1}{2}mv_0^2 = \mu n d$

$\frac{1}{2}\cancel{m}v_0^2 = \mu \cancel{m}gd$

$(\frac{1}{2})(30^2) = (0.2)(9.8)d$

$d = 229.6\text{ m}$

Ex 2



$\cancel{W}^{0} + \cancel{U_0}^{0} + K_0 = U_0 + \cancel{K_0}^{0} + \text{heat}$

$\frac{1}{2}\cancel{m}v_0^2 = \cancel{m}gh + \mu\overbrace{\cancel{m}g\cos\theta}^{n} d$

$(\frac{1}{2})(20^2) = (9.8)(d\sin\theta) + (0.3)(9.8\cos 30)(d)$

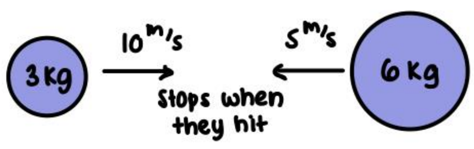
$200 = (9.8)(d\sin\theta) + 2.55d$

$200 = d(9.8\sin 30 + 2.55)$

$d = 26.8\text{ m}$

Ex 3

How much heat is produced?



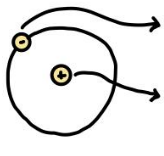
$\cancel{W} + \cancel{U_0} + K_0 = U + K + \text{heat}$

$(\frac{1}{2})(3)(10^2) + (\frac{1}{2})(6)(5^2) = \text{heat}$

$\text{heat} = 225\text{ J}$

Electric Currents and Magnetism

Electricity



$M_{electron} = 9.11 \times 10^{-31}$ kg
$q_e = -1.6 \times 10^{-19}$ C
$M_{proton} = 1.67 \times 10^{-27}$ kg
$q_p = +1.6 \times 10^{-19}$ C

6.25×10^{18} e's $\Rightarrow$ -1 coulomb
6.25×10^{18} p's $\Rightarrow$ $+1$ coulomb
micro coulomb
$1\,\mu C = 1 \times 10^{-6}$ C
$5\,\mu C = 5 \times 10^{-6}$ C

Opposite charges attract

Like charges repel

Coulomb's Law

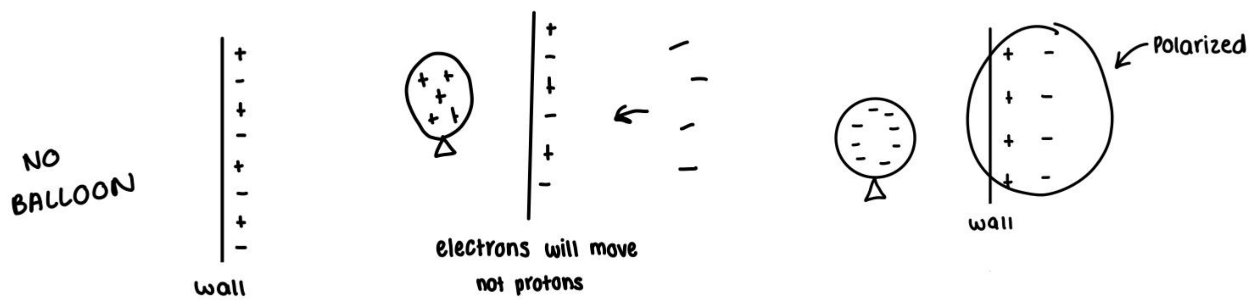
$$F = \left| \frac{K q_1 q_2}{r^2} \right|$$

F = force (N)
$K = 9 \times 10^9 \left(\frac{Nm^2}{C}\right)$
$q_1 =$, $q_2 =$ → charge (C)
r^2 = distance between charges (m)

$q_1 = 3.2 \times 10^{-19}$ C $\qquad$ $q_2 = -1.6 \times 10^{-19}$ C

Find the force q_1 has on q_2

$$F = \left| \frac{K \cdot q_1 \cdot q_2}{r^2} \right| = \left| \frac{(9 \times 10^{9})(3.2 \times 10^{-19})(1.6 \times 10^{-19})}{(0.35)^2} \right| = 3.76 \times 10^{-27}\ N$$

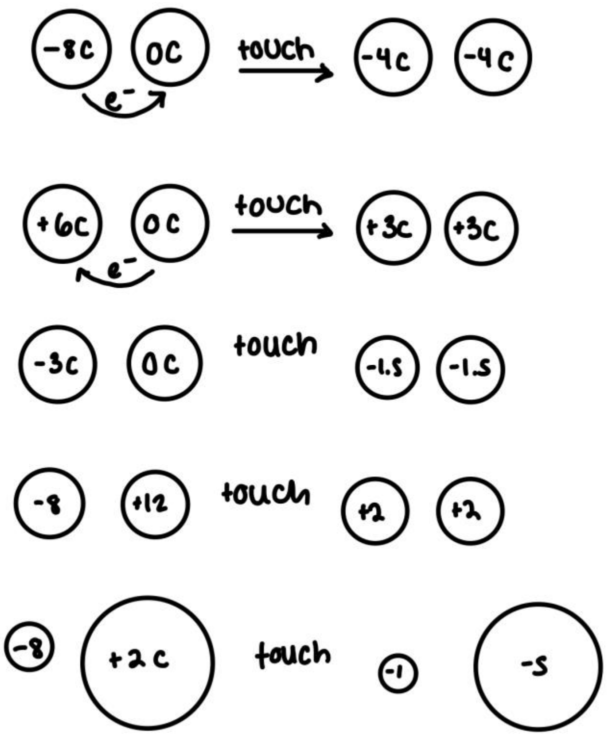


Conduction: material in which electrons tend to be free and therefore rearrange and flow easily.

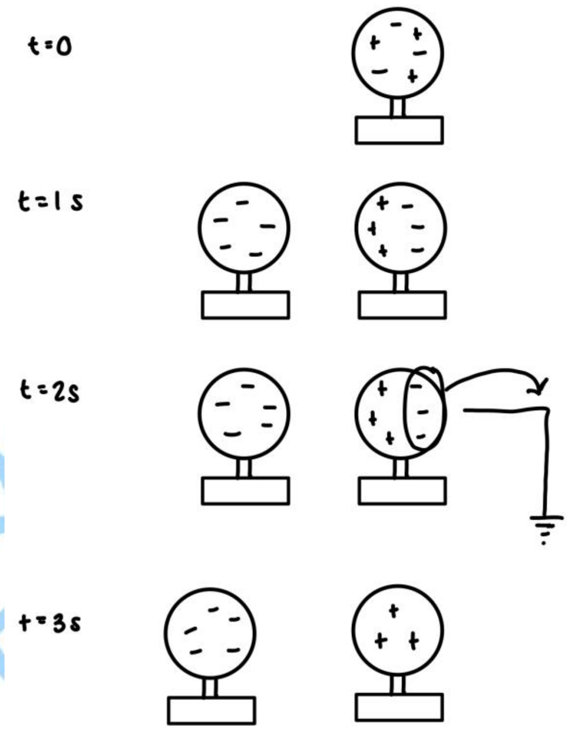
Insulator: material in which electrons do not tend to be free and therefore do not rearrange and flow easily.

Methods of Charging

Conduction→ “touch”



Induction→ no touch-bring near



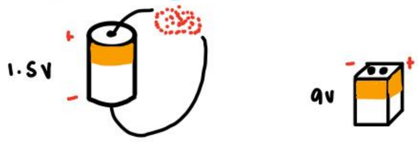
Current Electricity

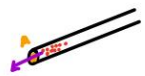
Ohm's Law : $I = \frac{V}{R}$

R = resistance 1 Ω unit: ohm = 1 $\frac{V}{A}$
↳ opposition to flow

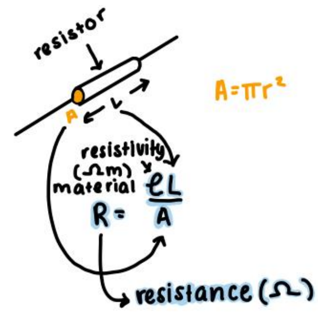
I = current unit: 1 Amp = 1 $\frac{C}{s}$
↳ flow of charge

V = voltage 1 volt = 1 $\frac{J}{C}$





$I = \frac{Q}{t}$
↳ $Q = It$



If V goes ↑, then the current (I) goes ↓ $I \propto V$

If R goes ↑ then I goes ↓ $I \propto \frac{1}{R}$

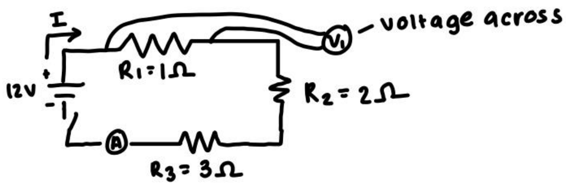
Equation for Power

voltage (V)

$$P = VI$$

power (watt) ↳ current (A)

Series Circuits



Rules + Example

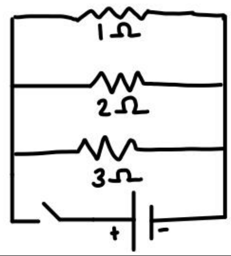
① $R_{total} = R_1 + R_2 + R_3 = 1+2+3 = 6\Omega$

② $I_{total} = \frac{V_t}{R_t} = \frac{12}{6} = 2$ amps

③ $V_1 = IR_1 = (2)(1) = 2$ volts of electrical pressure through R_1

④ $V_T = V_1 + V_2 + V_3 = 2v + 4v + 6v = 12V$

Parallel Circuits



Rules:

① $R_T = (R_1^{-1} + R_2^{-1} + R_3^{-1})^{-1}$
$= (1^{-1} + 2^{-1} + 3^{-1})^{-1} = 0.545\Omega$

② $I_t = \frac{V_T}{R_T} = \frac{12}{.545} = 22$ amps

③ $V_T = V_1 = V_2 = V_3$

④ $I_1 = \frac{V}{R_1}$
$I_2 = \frac{V}{R_2}$
$I_3 = \frac{V}{R_3}$

⑤ $I_T = I_1 + I_2 + I_3$ ← kirchoffs loop rule conservation of energy

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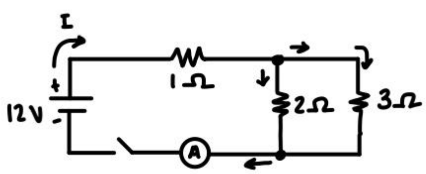
Combination Circuits



Rules:

① $R_T = (2^{-1} + 3^{-1})^{-1} + 1 = 2.2\Omega$

② $I_t = \frac{V_t}{R_T} = \frac{12}{2.2} = 5.45$ amps

③ Vdrop across mainline resitors: $V_1 = IR_1 = (5.45)(1\Omega) = 5.45V$

④ find leftover voltage: $12v - 5.45v = 6.55v$ ← for parallel part

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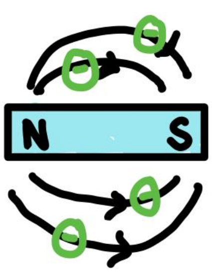
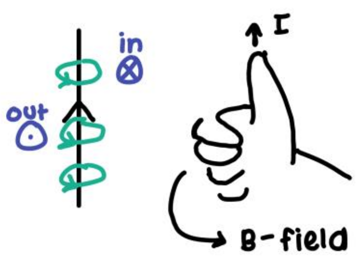
Magnetic Forces

There is a magnetic field that goes from the north to south field



The Right Hand Rule

This video provides some great examples of the right hand rule as it is a difficult concept to understand without being talked through it: https://www.youtube.com/watch?v=lKEt5bvn7LU



Calculating the magnitude of the magnetic field

$4\pi\times10^{-7}\ \frac{Tm}{A}$

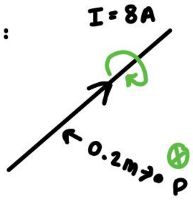
$$B = \frac{\mu_0 I}{2\pi R}$$

current (A)

distance (m)

Magnetic Field (Tesla)

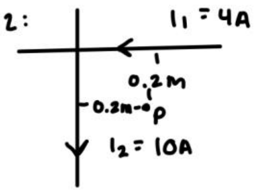
Ex 1:



$$B = \frac{\mu_0 I}{2\pi r} = \frac{(4\pi\times10^{-7})(8)}{2\pi(0.2)} = 8\times10^{-6}\ \text{teslas (T)}$$

$$\boxed{8\times10^{-6}\ T\ \otimes}$$

Ex 2:

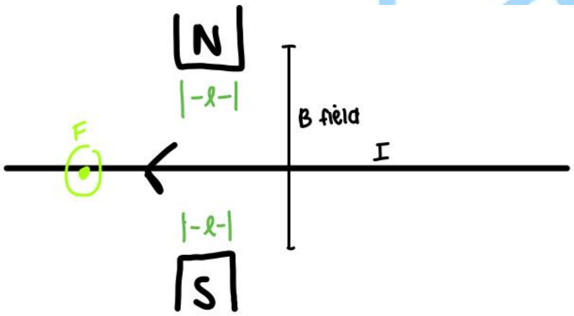


$$B = \frac{(4\pi\times10^{-7})\,4}{2\pi(0.2)} = 4\times10^{-6}\ T\ \odot$$

$$B = \frac{(4\times10^{-7})\,10}{2\pi(0.2)} = 1\times10^{-5}\ T\ \odot$$

$$(4\times10^{-6})+(1\times10^{-5}) = \boxed{10\times10^{-6}\ T\ \odot}$$

Magnetic Forces



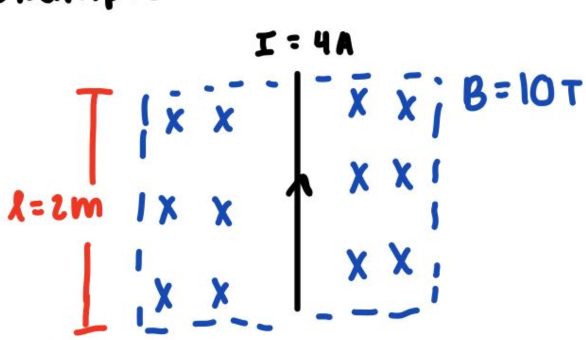
$$F = BI\ell\sin\theta$$

N; (T) (A) (m); angle between B and I

$$F = BVq\sin\theta$$

N; (T) (m/s) (C); b/w B + V

Example:



$$F = (10)(4)(2)\cos 90 = 80\ N \leftarrow$$