SPH4C REVIEW

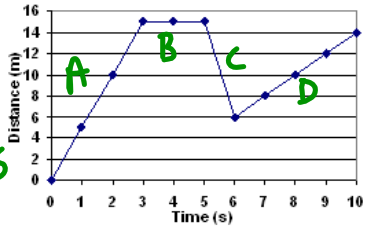
CH 1 – Motion

Define: Scalar, Vector, Uniform Motion, Non-Uniform Motion, Distance, Displacement, Speed, Velocity, Acceleration.

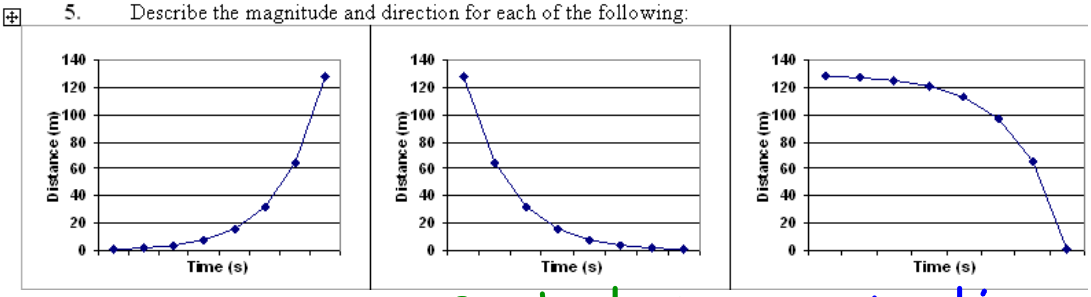
Problems: **Know how to solve similar questions to the following:**

1. A jogger runs 6 km [N] then 12 km [S] during a 2 h race. Determine the runner's:
   a. Average speed 9 km/h
   b. Average velocity 3 km/h [S]
2. Bill travels at a speed of 30 m/s for 1 h. How far did Bill go? 108000 m or 108 km
3. How long would it take for the space shuttle to go 8.3×10^6 km at an average speed of 1.2×10^3 km/h? 6916.7 h
4. Calculate the speed of each section of the following distance-time graph:

$A = \frac{15}{3} = 5 m/s$ $B = 0 m/s$ $C = -9 m/s$ $D = \frac{8}{4} = 2 m/s$



5. Describe the magnitude and direction for each of the following:



Accelerating Away from home

Decelerating towards home

Accelerating towards home

6. A car speeds up from 20 km/h to 100 km/h in 11 seconds. Calculate the acceleration.

$v_1 = 20 km/h$
$v_2 = 100 km/h$
$t = 11 s$

$a = \frac{v_2 - v_1}{t} = \frac{100 - 20}{11}$

$= \frac{80}{11}$

$= 7.27 km/h/s$

7. A golf ball is bounced off the ground and travels straight up at an initial velocity of 32 m/s.
a. When will the ball reach its max height?
b. How far off the ground is the ball at its max height?
c. If you are 2 m tall and wish to catch the ball, how long will you have to wait after the bounce?

$v_1 = 32 m/s$
$v_2 = 0 m/s$
$a = -9.81 m/s^2$
$t = ?$

$a = \frac{v_2 - v_1}{t}$

$t = \frac{v_2 - v_1}{a}$

$t = \frac{0 - 32}{-9.81}$

$t = 3.26 s$

b) $d = ?$

$d = v_1 t + \frac{1}{2} a t^2$

$d = (32)(3.26) + \frac{1}{2}(-9.81)(3.26)^2$

$d = 52 m$

c) $d = 50 m$ fall

$d = v_1 t + \frac{1}{2} a t^2$

$-50 = (0)t + \frac{1}{2}(9.81)t^2$

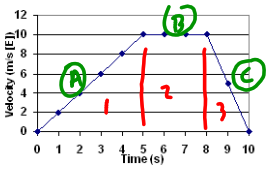
$-50 = -4.9 t^2$

$\frac{-50}{-4.9} = t^2$

$t = 3.2 s$

total time = UP + DOWN
$= 3.26 + 3.2$
$= 6.46 s$

8. Calculate the accelerations of each section and the displacement traveled using the following velocity-time graph:



$a_A = \frac{10}{5} = 2 m/s/s [E]$

$a_B = 0 m/s/s [E]$

$a_C = \frac{-10}{2} = -5 m/s/s [E]$

$A_1 = \frac{5 \times 10}{2} = 25 m [E]$

$A_2 = 3 \times 10 = 30 m [E]$

$A_3 = \frac{2 \times 10}{2} = 10 m [E]$

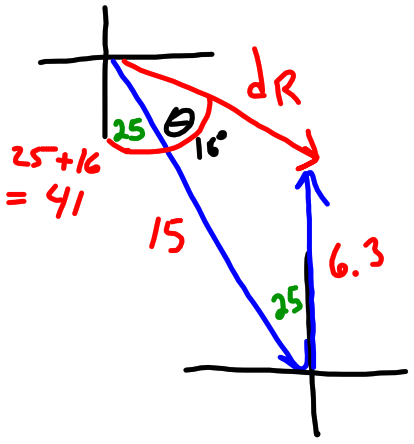
$65 m [E]$

CH 2 – Relative Velocity

Define: Know how to draw diagrams, read directions, and use trig

Problems: **Know how to solve similar questions to the following:**

1. A car travels 15 km [S 25° E] and then travels 6.3 km [N]. Find its displacement.



$(d_R)^2 = (15)^2 + (6.3)^2 - 2(15)(6.3)\cos 25$

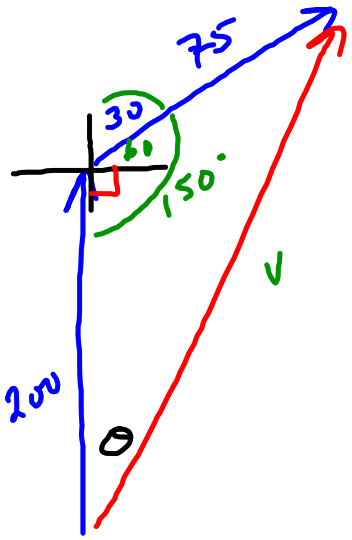
$d_R = 9.66$ km

$\frac{\sin\theta}{6.3} = \frac{\sin 25}{9.66}$

$\theta = 16$

$\vec{d}_R = 9.66\text{ km}\ [S\ 41^\circ E]$

13 A plane has an air speed of 200 km/h [N], there is a wind altering the path of the airplane as it blows 75 km/h [N 30° E]. What is the planes velocity relative to the ground and what is its heading?



$c^2 = a^2 + b^2 - 2ab\cos C$

$V^2 = (200)^2 + (75)^2 - 2(200)(75)\cos 150$

$V^2 = 40000 + 5625 + 25980$

$= 45625 + 25980$

$v = 267.6$ km/h

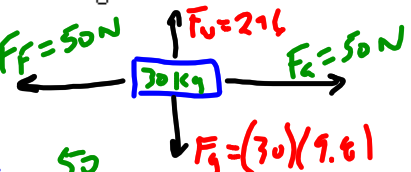
$\frac{\sin\theta}{75} = \frac{\sin 150}{267.6}$

$\theta = 8°$

$\vec{V}_R = 267.6$ km/h [N 8° E]

1) 1. An applied horizontal force of 50N is needed to overcome friction to pull a 30 kg bobsled at constant speed over the snow to the finish line.

a) Draw a free body diagram showing all the forces acted on the bobsled



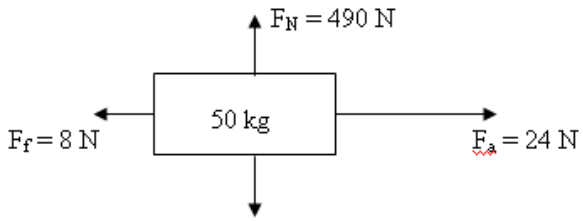
b) Calculate the coefficient of friction between the bobsled and the snow.

$\mu = \frac{F_F}{F_N} = \frac{50}{296}$

$\mu = 0.17$

2) Tell a story of a situation that involves all three of Newton's Laws.

3) Describe and calculate what is happening to the object in the following free-body diagram:



$F_{NET} = 24 - 8$

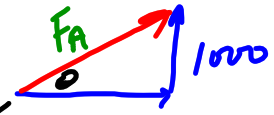
$= 16$ N

$F_{NET} = ma$

$16 = 50a$

$a = 0.32 m/s^2$

4) A plane has engines that thrust forward at 2000 N. It also has wings that create lift at 1000N. What is the resultant of these forces? Which direction would friction or drag be?



DRAG

$\frac{\sin\theta}{1000} = \frac{\sin 90^\circ}{2236}$

$\angle\theta = \sin^{-1}(0.447)$

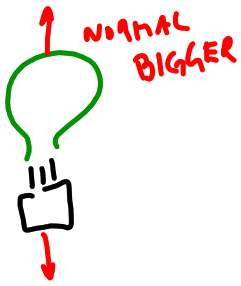
$\angle = 26.55$

$(F_A)^2 = (2000)^2 + (1000)^2$

$F_A = 2236$ N

5) Describe a situation where normal force and gravitational force are different.

RISING HOT AIR BALLOON



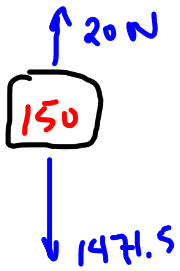
7) John's mother asked him to dispose of an old 150 kg couch. John disposes of the couch at rest by flinging it over a steep cliff at a landfill site that is 500 m deep. A 20 N force of air resistance acts on it as it is dropped.

a) Calculate the force of gravity acting on the couch.

$F_g = mg$ $F_g = (150)(9.81)$ $F_g = 1471.5$ N

b) What is the unbalanced force acting on the couch as it is falling? Provide a free body diagram.

$F_{NET} = 1451.5$ N [Down]



c) Calculate the acceleration of the couch.

$F_{NET} = ma$ $a = 9.7 m/s^2$

$1451.5 = (150)a$

d) How far will the couch fall in 4 seconds?

$d = ?$ $t = 4$

$v_1 = 0$

$a = 9.7$

$d = v_1 t + \frac{1}{2} a t^2$

$d = 0 + \frac{1}{2}(9.7)(4)^2$

$d = 77.6$ m

e) How long will it take for the couch to hit the bottom?

$d = 500$ m

$v_1 = 0$ m/s

$a = 9.7$

$d = v_1 t + \frac{1}{2} a t^2$

$500 = 0 + \frac{1}{2}(9.7) t^2$

$\frac{500}{4.85} = t^2$

$t = 10.15$ s

CH 4 – WORK, POWER, ENERGY

Definitions: Law of conservation of energy, Gravitational Potential Energy, Kinetic energy, Thermal energy, Types of Energy. Work, Power, Energy.

Problems: **Know how to solve similar questions to the following:**

1. A force of 75 N is used to pull a sled 17.4 m across the snow. Calculate the work done.

$F = 75N$, $d = 17.4m$ $\quad W = Fxd = 75 \times 17.4 = 1305\ J$

2. If the same sled was pulled the same distance but we account for a 10 N force of friction, how much work is done *(Trick Question)*.

$W = 75 \times 17.4 = 1305\ J$

3. If the same sled was pulled the same distance but across gravel and an ***additional*** 50 N of force is required to overcome friction, how much work is done?

$F = 75N + 50 = 125N$, $d = 17.4m$ $\quad W = 125 \times 17.4 = 2125\ J$

4. How is it possible to achieve ZERO WORK?

- Exerting a force on an immovable object (Force but no distance)
- No work is done while carrying an object (Work is done in lifting and lowering)

5. Determine the power it takes to pull the sled across the gravel in question 3 if it takes 5.6 s.

$P = \frac{W}{t} = \frac{2125}{5.6} = 380\ W$

6. How much work can be done by a 700 W hair dryer in 1 hour?

$P = 700\ W$, $t = 1h \times 60 \times 60 = 3600s$ $\quad W = Pt$, $W = 700 \times 3600 = 2520000J$

$W = Pt = 0.7 \times 1 = 0.7\ kW \cdot h$ $\quad P = 0.7KW$, $t = 1h$

7. A car's engine exerts a force of 25000 N to move the car 1 km. How much work is done in this case? Where did the car get this energy? What is the energy converted to?

$F = 25000N$, $d = 1km = 1000m$ $\quad W = Fxd = 25000 \times 1000 = 25\,000\,000J$

a) gasoline b) c) Heat is Sound

8. Your body burns approximately 8 400 000 J of energy a day. How much power is that? Where does that energy go?

E or $W = 8\,400\,000J$, $t = 24h \times 60 \times 60 = 86\,400s$ $\quad P = \frac{W}{t} = \frac{8\,400\,000}{86\,400} = 97\ W$

HEAT

9. Convert 1 KW-h to Joules

$1\ kW \cdot h \times 1000 \times 60 \times 60 = 3\,600\,000J$

10. List 8 types of energy.

- Gravitational
- Thermal
- Nuclear
- Light/Radiation
- Kinetic
- Elastic
- Chemical
- Electrical

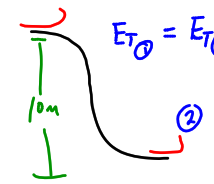
11. What is the total energy of a 50 kg object that is 25m above the ground moving at 2m/s?

↳ gravitational ↳ kinetic

$E_g = mgh = (50)(9.81)(25) = 12\,262.5\ J$ $\quad E_K = \frac{1}{2}mv^2 = \frac{1}{2}(50)(2)^2 = 100J$

$E_T = \Sigma E$, $E_T = E_g + E_K$ $\quad E_T = 12262.5 + 100$, $E_T = 12362.5J$

12. A 50 kg sled is on top of a 10m tall hill. How fast will the sled be going at the bottom of the 50m long hill if the force of friction is 50 N?



$E_{T①} = E_{T②}$

$E_g = mgh = (50)(9.81)(10) = 4905J$

$E_{T①} = \Sigma E$, $E_{T①} = 4905J$

$E_{T②}$

$E_K = \frac{1}{2}mv^2$, $E_K = \frac{1}{2}(50)v^2$

$E_{TH} = F_F xd$, $E_{TH} = (50)(50)$, $E_{TH} = 2500J$

$E_{T②} = E_K + E_{TH}$

$E_{T②} = E_K + E_{TH}$

$4905 = \frac{1}{2}(50)v^2 + 2500$

$4905 - 2500 = 25v^2$

$\frac{2405}{25} = \frac{25v^2}{25}$

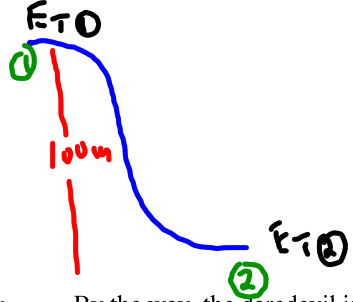
$96.2 = v^2$

$\sqrt{96.2} = v$

$v = 9.81\ m/s$

16 A 75 kg roller skating daredevil step onto a roller coaster track and goes for a ride. He finds himself at the top of the first hill about to start his stunt.

a. If the hill is 100 m tall, how fast will the daredevil be traveling at the bottom of the hill (assume h = 0 m)



$E_{T①} = E_g$

$E_T = mgh$

$E_T = (75)(9.81)(100)$

$E_T = 73575\,J$

$E_{T②} = E_K$

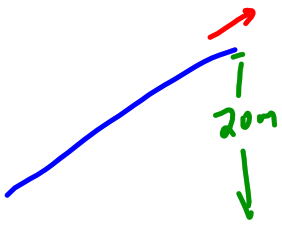
$73575 = \frac{1}{2}mv^2$

$73575 = \frac{1}{2}(75)v^2$

$v = 44.3\ m/s$

b. By the way, the daredevil is Keanu Reeves and unfortunately for him, the track isn't finished. Needless to say, Keanu wishes to jump the gap. The ramp inclines from the ground after the first hill and the track ends 20 m above the ground.

i. How fast will Keanu be going when he leaves the ramp?



$E_T = E_g + E_K$

$73575 = mgh + \frac{1}{2}mv^2$

$73575 = (75)(9.81)(20) + \frac{1}{2}(75)v^2$

$73575 = 14715 + 37.5v^2$

$73575 - 14715 = 37.5v^2$

$58860 = 37.5v^2$

$v = 39.6\ m/s$

ii. Keanu then flies though the air and hits a safety net 5 m above the ground. With what **"*speed*"** does he hit the net?

$E_T = E_g + E_K$

$73575 = mgh + \frac{1}{2}mv^2$

$73575 = (75)(9.81)(5) + \frac{1}{2}(75)v^2$

$73575 = 3678.75 + 37.5v^2$

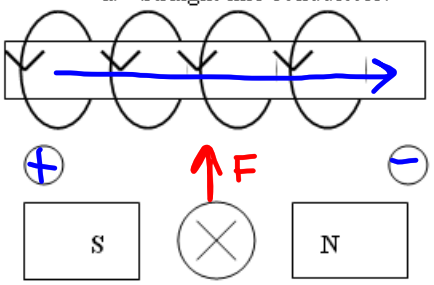
$73575 - 3678.75 = 37.5v^2$

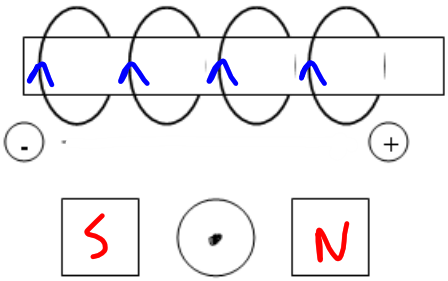
$\frac{69896.25}{37.5} = \frac{37.5v^2}{37.5}$

$v = 43.17\ m/s$

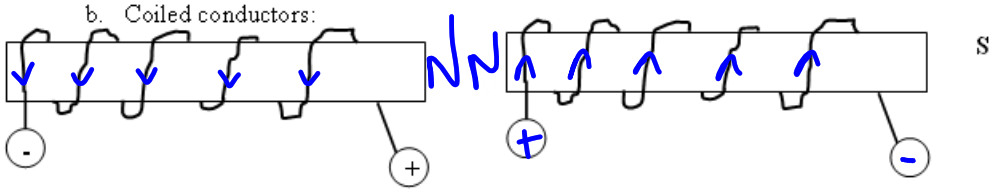
1. Complete the following diagrams:

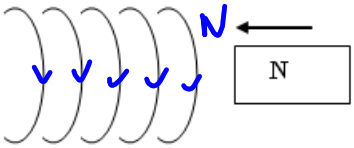
a. Straight line conductors:

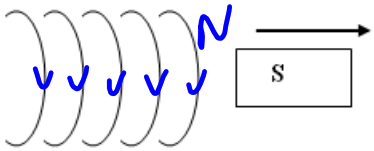




b. Coiled conductors:







. A transformer has 10 turns on its primary coil and 350 turns on its secondary coil. It is designed to supply a compressor motor requiring a current of 1.5 A at a voltage of 750 V.

a) What is the current in the primary coil?

b) What is the voltage in the primary coil?

$N_1 = 10$, $N_2 = 350$, $I_2 = 1.5\ A$, $V_2 = 750\ V$

$\frac{N_1}{N_2} = \frac{I_2}{I_1}$ $\quad \frac{10}{350} = \frac{1.5}{I_1}$ $\quad I_1 = 42.5\ A$

$\frac{N_1}{N_2} = \frac{V_1}{V_2}$ $\quad \frac{10}{350} = \frac{V_1}{750}$ $\quad V_1 = 21.4\ V$

3. A hydrogen vapour lamp operates at 1300 V and has a resistance of 40 Ω. A transformer supplies the energy required, from a 120 V power line.

a) Calculate the power used by the transformer

b) Calculate the primary current

$V_2 = 1300\ V$, $R_2 = 40\ \Omega$, $V_1 = 120\ V$

$I_2 = \frac{V_2}{R_2}$ $\quad I_2 = \frac{1300}{40}$ $\quad I_2 = 32.5\ A$

$P = VI$ $\quad P = (1300)(32.5)$ $\quad P = 42250\ W$

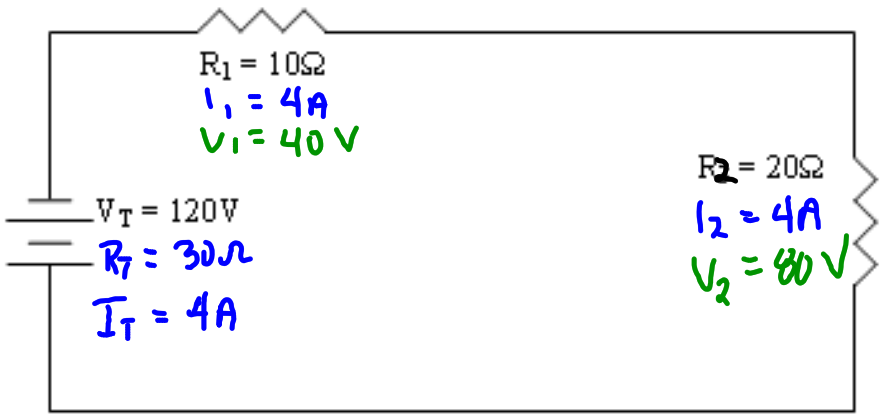
b) $\frac{V_1}{V_2} = \frac{I_2}{I_1}$

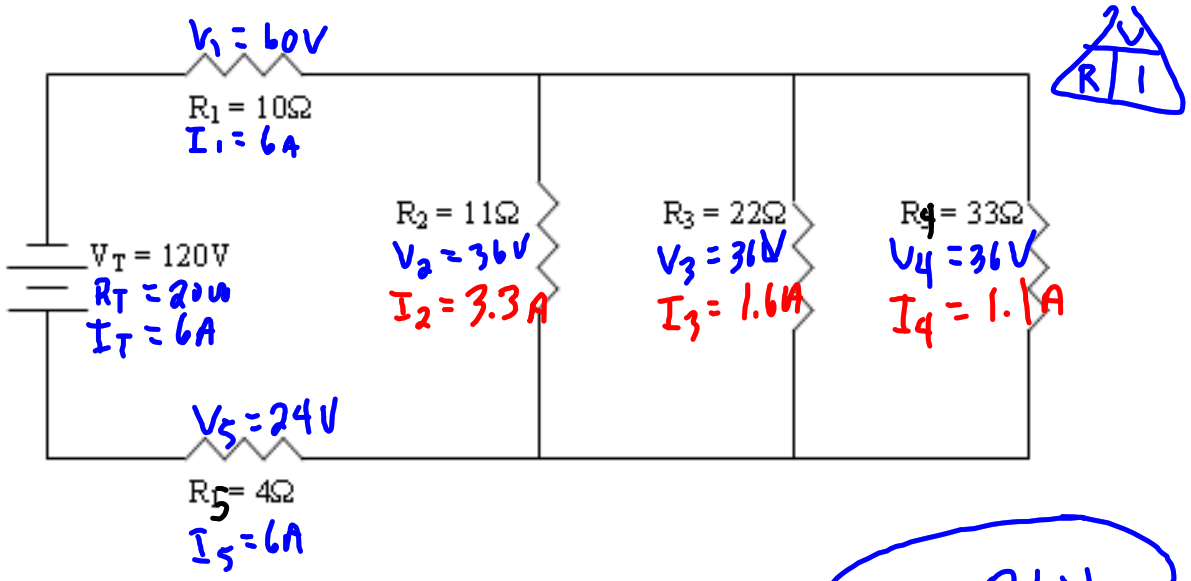
$\frac{120}{1300} = \frac{32.5}{I_1}$

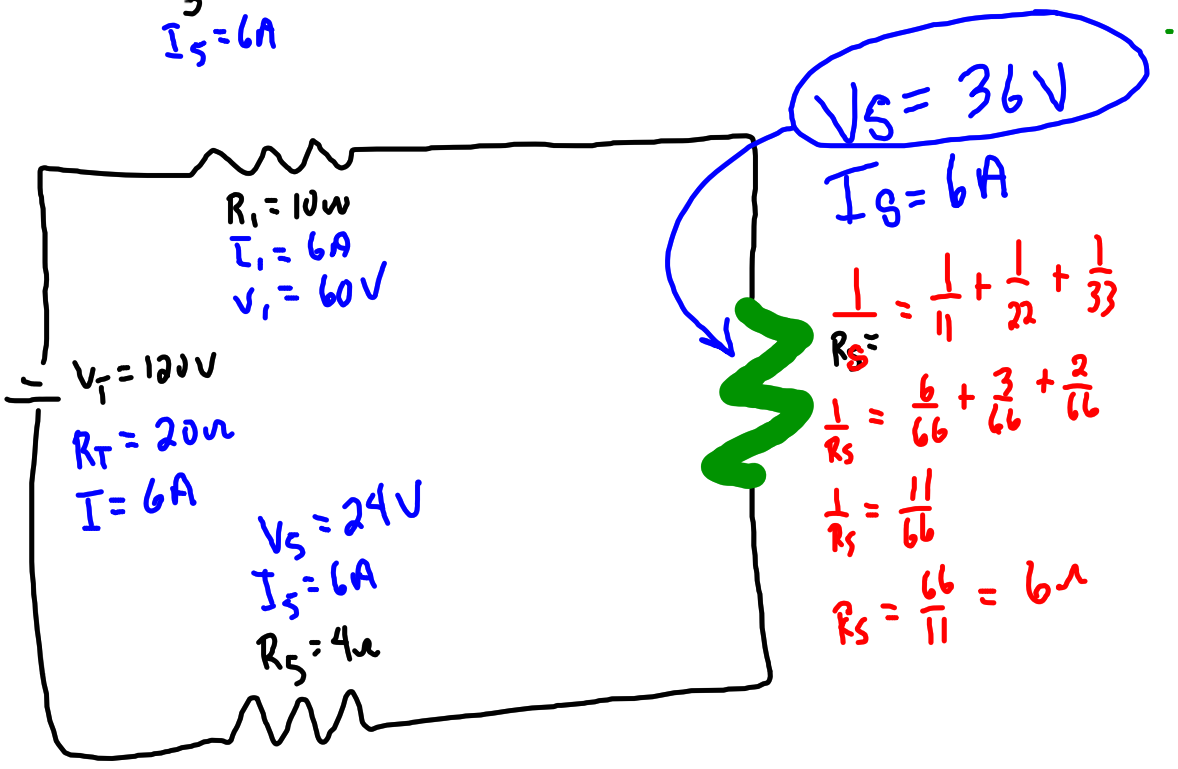
$I_1 = 352.1\ A$

1. Calculate the total resistance of the following resistor combinations:
   25Ω, 30Ω, and 60Ω; if they are connected in:
   a. Series $R_T = 115\Omega$ b. Parallel $\frac{1}{R_T} = \frac{1}{25} + \frac{1}{30} + \frac{1}{60}$ $R_T = 11.11\Omega$
2. Complete the following chart:

Charge (Q)	Current (I)	Time (t)	Voltage (V)	Energy (E)	Resistance (R)	Power (P)
2000 C	100A	20 s	100 V	200000 J	1Ω	10 000 W
40C	0.44A	1.5 min 90 s	25 V	500 J	56.2Ω	11.11W




V = 60V
R1 = 10Ω
I1 = 6A
R2 = 11Ω
V2 = 36V
I2 = 3.3A
R3 = 22Ω
V3 = 36V
I3 = 1.6A
R4 = 33Ω
V4 = 36V
I4 = 1.1A
VT = 120V
RT = 20Ω
IT = 6A
V5 = 24V
R5 = 4Ω
I5 = 6A
V
R
I


VS = 36V
IS = 6A
R1 = 10Ω
I1 = 6A
V1 = 60V
VT = 120V
RT = 20Ω
I = 6A
V5 = 24V
I5 = 6A
R5 = 4Ω
1/RS = 1/11 + 1/22 + 1/33
1/RS = 6/66 + 3/66 + 2/66
1/RS = 11/66
RS = 66/11 = 6Ω

Problems: **Know how to solve similar questions to the following:**

1. Complete: (short answers)

(a) Normal Human Frequency Range (h.f.r.) is from 20 Hz to 20 000 Hz

(b) Sounds above h.f.r. are called ultrasonic

(c) Sounds below h.f.r. are called infrasonic

(d) Electromagnetic waves with longer wavelengths than those detected by the human eye are called Infrared

(e) Electromagnetic waves with shorter wavelengths than those detected by the human eye are called ultraviolet

(f) Another word that means amplitude of sound is volume

(g) Pushing a child on a swing is a specific example of mechanical Resonance

(h) 0 decibels is No Sound

(i) 140 decibels is Ear Drum perforation

(j) How many times louder is 70 dB than 20 dB? 10^5

(k) What will be heard if tuning forks of frequencies 345 Hz and 351 Hz are sounded together? Beats

(l) Give one example of acoustic resonance breaking wine glass with Voice

(m) A guitar and a clarinet are both making a 440 Hz sound at a 90 dB level. How do these two sounds differ on an oscilloscope screen? Quality

(n) Why can't sounds be heard in outer space? No particles (medium)

3. An FM radio station operates at a frequency of 88.7 MHz. If the radio waves travel at 300 000 000 m/s, find their wavelength. ($M = 10^6$)

$f = 88.7\ MHz \times 1000000 = 88700000\ Hz$

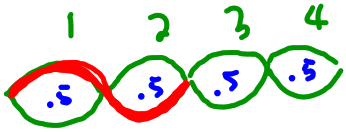
$V = 300000000\ m/s$

$\lambda = ?$

$\lambda = \frac{V}{f} = \frac{300000000}{88700000}$

$\lambda = 3.4\ m$

7. The fourth resonant length of a 80 cm long string vibrates with a frequency of 120 hz. What is the speed of the wave?



4th $L = 2\lambda$

$80 = 2\lambda$

$\frac{80}{2} = \lambda$

$40_{cm} = \lambda$

$V = f\lambda$

$V = (120)(40)$

$V = 4800\ cm/s$

or

$4.8\ m/s$