Semester 1 Review Problems

1. A car is sitting at a stoplight. When the light turns green, the driver steps on the gas and begins to accelerate at 2.5 m/s^2 for 3 seconds.

a) What is the velocity of the car after the 3 seconds?

$$V_F = V_I + at$$

$$V_F = 0 + \left(2.5 \frac{m}{s^2}\right)(3s)$$

$$V_F = 7.5 \frac{m}{s}$$

b) The driver of the car steps on his brakes and brings the car to a stop in 2.5 seconds. What is the acceleration of the car as it stops?

$$V_F = V_I + at$$

$$0 = 7.5 \frac{m}{s} + a(2.5s)$$

$$a = -3 \, m/s^2$$

2. A rock dropped from the top of a building takes 4.45 seconds to reach the ground.

a) How tall is the building?

$$d = \frac{1}{2} g t^2$$

$$d = (0.5)(9.8 \, m/s^2)(4.45s)^2$$

$$d = 97 \, m$$

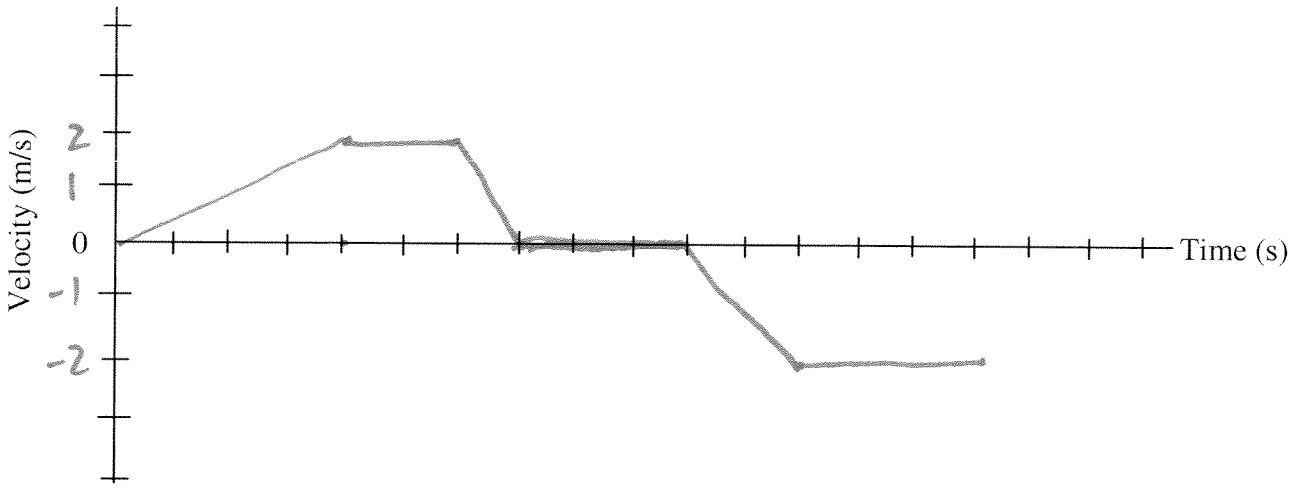
b) How fast is the rock traveling when it hits the ground?

$$V_F = V_I + at$$

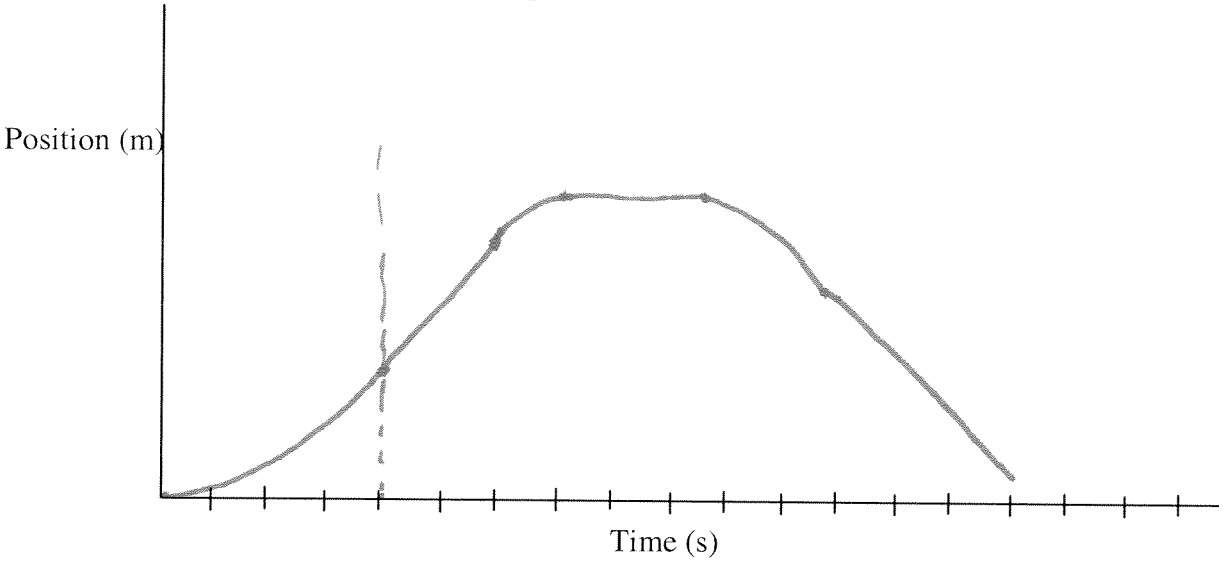
$$V_F = 0 + (9.8 \, m/s^2)(4.45s)$$

$$V_F = 43.6 \, m/s$$

3. On the graph below, draw a sketch of the following motion: A student is initially standing in the hallway. At t = 0 seconds, she accelerates to 2 m/s over 4 seconds. She then walks at that velocity for the next 2 seconds. She slows down to a stop over 1 second and stands still for 3 seconds. She accelerates to 2 m/s in the opposite direction in 2 seconds and then runs at that velocity for 3 seconds.



a) Make a position vs. time graph for the motion above.



b) What is the total displacement of the student from the starting point? (Please show your work)

Area under the v vs. t graph

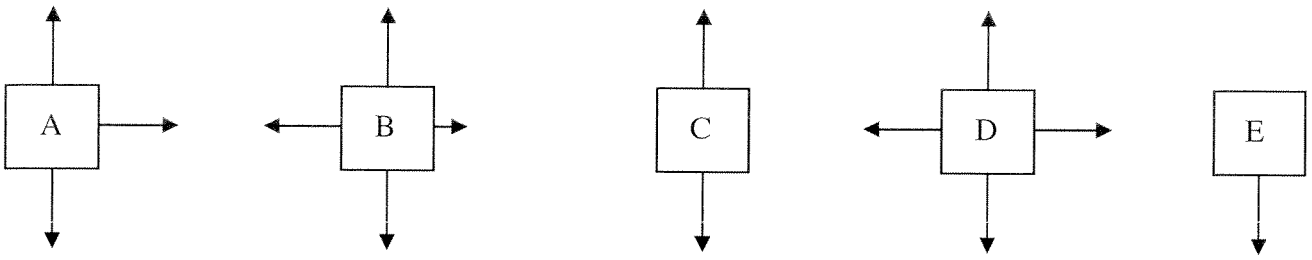
$\frac{1}{2}(4)(2) + (2)(2) + \frac{1}{2}(1)(2) + -\frac{1}{2}(2)(2) + (-2)(3)$

$4 + 4 + 1 - 2 - 6 = \boxed{1\text{m}}$

c) What is the maximum acceleration of the student and when does it occur? (Please show your work.)

$t = 6 \rightarrow t = 7\text{ s}$ $\quad a = \frac{\Delta v}{t} = \boxed{-2\text{ m/s}^2}$

4. Identify which of the following force diagrams (free-body diagrams) represent the situation described in the sentences below by writing the letter in the blank after each sentence.



- Which diagram shows an accelerating object? A, B, E
- Which diagrams show an object that is moving at a constant velocity? C, D
- Which diagrams show an object that is falling without air resistance? E
- Which diagram would you draw to show that an object was moving to the right and friction was acting on it to slow it down? B
- Which diagram would represent an elevator that is in motion between floors? C
- In which diagrams are the forces acting on the object balanced? C, D
- If the object shown in diagram B were in motion to the right, what would the forces shown acting on it cause the object to do?

  Slow down

  How do you know that?

  There is a net force acting to the left, opposite the motion

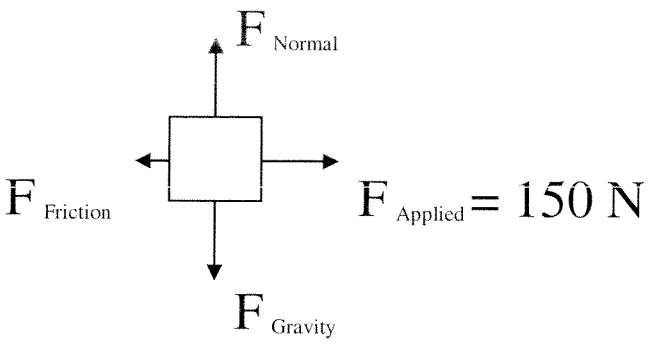
- If the object shown in diagram D were in motion to the right, what would the forces shown acting on it cause the object to do?

  Maintain a constant velocity

  How do you know that?

  The forces are balanced

5. Several forces act on a 35 kg object as shown in the diagram below. What is the weight of the object in Newtons and what is the value of the frictional force when it experiences an acceleration of 2.2 m/s^2?



$\Sigma F = ma$

$F_{Applied} - F_{Friction} = ma$

$150 - F_{Fr} = (35)(2.2)$

$F_{Fr} = 150 - 77$

$F_{Fr} = 73\ N$

$W = mg$

$W = (35\ kg)(9.8\ m/s^2)$

$W = 343\ N$

6. A 3500-kg truck has a velocity of 10 m/s and is heading towards a 1500-kg van that has a velocity of 12 m/s in the opposite direction. After the collision, the truck has a velocity of 3 m/s in its original direction and the van has a velocity of 4.3 m/s in the same direction as the truck, i.e. it is knocked backwards.

a) Determine which vehicle had the larger momentum before the collision? Truck

$p_{truck} = mv = (3500\ kg)(10\ m/s) = 35{,}000\ kg\,m/s$

$p_{van} = mv = (1500\ kg)(12\ m/s) = 18000\ kg\,m/s$

b) Which vehicle had the larger momentum after the collision? Truck

$p_{truck} = 10500\ kg\,m/s$

c) Which vehicle applied a larger force during the collision? Same

$p_{van} = 6450\ kg\,m/s$

d) Which vehicle experienced a larger acceleration? Van

e) Which vehicle had a larger change in momentum? Same

f) Which object had a larger change in velocity? Van

g) Which object experienced a larger impulse during the collision? Same

7. A factory worker pushes a 30 kg box a distance of 2.5 meters across the floor with a force of 100 N applied in the horizontal direction. While he does this, a frictional force of 80 N acts on the box in a direction that is opposite its motion.

a) How much work does the person do on the box?

$W = Fd = 100\,N(2.5\,m)$

$W_{person} = 250\,J$

b) How much work does the force of friction do on the box while it moves 2.5 meters?

$W = Fd = 80\,N(2.5\,m)$

$W = 200\,J$

c) What is the total amount of work done on the box over the 2.5 meters?

$W_{person} - W_{Friction} = W_{net} = 50\,J$

d) What is the kinetic energy of the box after it is pushed for 3 meters?

$W \rightarrow E_k \therefore E_k = 50\,J$

e) How fast is the box moving after the 2.5 meters?

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

$50 = \frac{1}{2}(30)v^2$

$v = 1.83\,m/s$

f) The factory worker stops pushing on the box once it has moved 2.5 meters. How far will the box slide before it comes to rest?

E_k goes from 50J to 0J so the work is 50J.

$W = Fd$

$50\,J = 80\,N\,d$

$d = 0.625\,m$

8. A 12,000 kg truck is moving at 25 m/s when the driver realizes that the brakes do not work. To stop the truck, he manages to pull it onto a runaway truck ramp. The truck travels up the ramp, reaching a final height of 22 meters.

a) What was the initial E_K of the truck?

$E_k = \frac{1}{2}mv^2 = \frac{1}{2}(12000\,kg)(25\,\frac{m}{s})^2$

$E_k = 3,750,000\,J$

b) What is the final E_G of the truck?

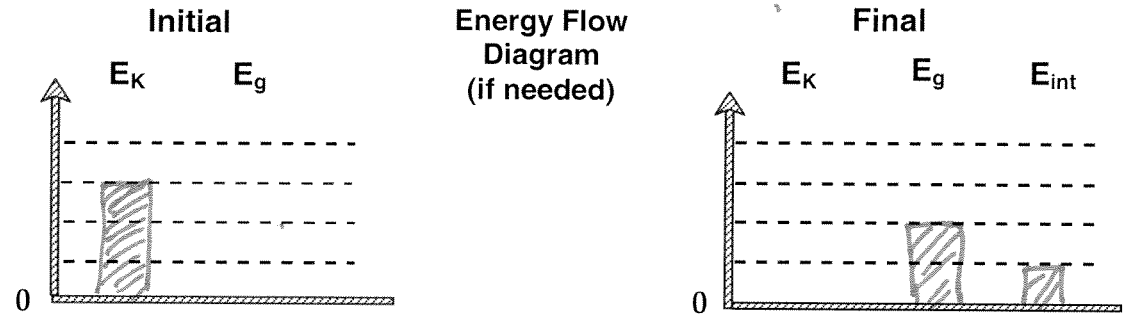
$E_G = mgh = 12000\,kg\,(9.8\,\frac{m}{s^2})(22\,m)$

$E_G = 2,587,200\,J$

c) How much energy is lost due to friction (E_{Int})?

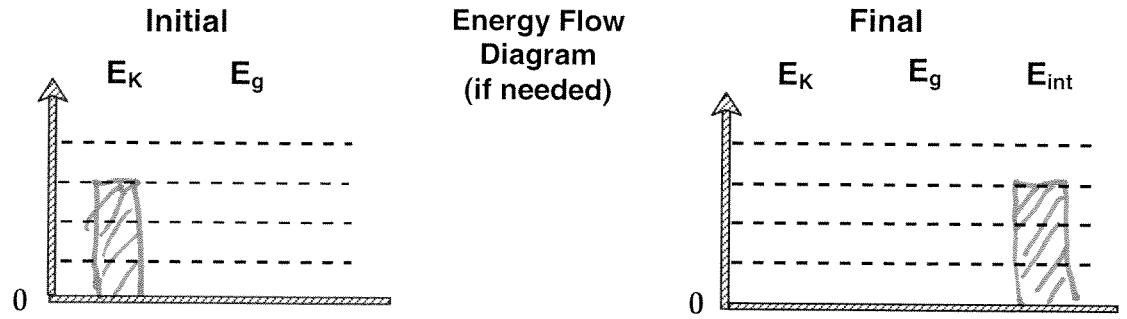
$1,162,800\,J$

d) Construct an energy bar graph for the situation on the graphs below.



9. A 0.140 kg baseball traveling at 20 m/s moves a fielder's glove 0.175 m when the ball is caught.

a) Construct an energy bar graph of the situation, with the ball as the system.



b) What was the average force exerted by the ball on the glove?

K.E. $\rightarrow W_{by\ glove}$

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

$E_k = \frac{1}{2}(0.140\,kg)(20)^2$

$E_k = 28\,J$

$W = Fd$

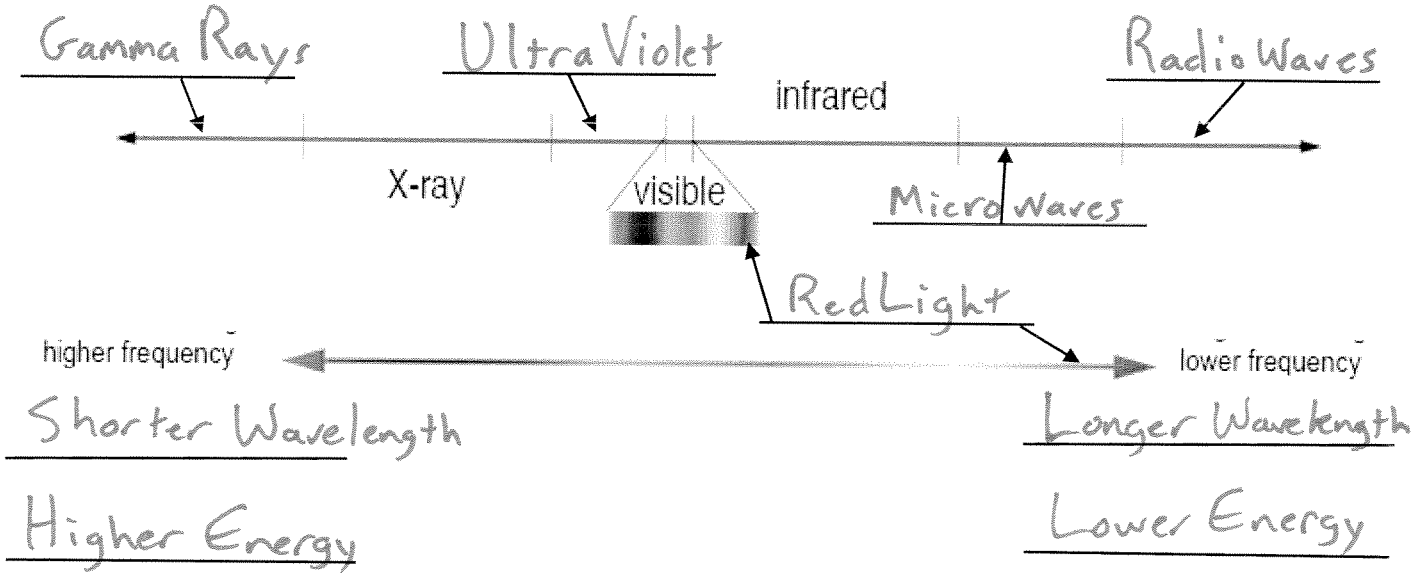
$28\,J = F(0.175\,m)$

$F = 160\,N$

Semester 1 Review Problems

10. For the picture below, use the terms in the box to complete the picture of the electromagnetic spectrum.

Shorter Wavelength	Longer Wavelength	Radio Waves
Gamma Rays	Microwaves	Ultraviolet
Higher Energy	Lower Energy	Red Light



11. What is the frequency of red light that has a wavelength of 6.10×10^{-7}m?

$$C = f\lambda$$
$$3\times10^{8}\ m/s = f\,(6.10\times10^{-7}\ m)$$
$$f = 4.92\times10^{14}\ Hz$$

12. What is the wavelength of a 341 Hz sound, assuming that $v_{sound} = 345$m/s?

$$V = f\lambda$$
$$345\ m/s = 341\ Hz\ \lambda$$
$$\lambda = 1.01\ m$$

13. The Browns' games are broadcast on 100.7 FM. The frequency of the wave from this radio station is 100.7×10^{6} Hz. What is the wavelength of this wave?

$$C = f\lambda$$
$$3\times10^{8} = (100.7\times10^{6})\,\lambda$$
$$\lambda = 2.98\ m$$

14. Which of the following frequencies falls in the auditory range?
a) 10 Hz b. 10, 000 Hz c. 100, 000 Hz d. 100 kHz

15. A train sounding its horn is moving away from you. The pitch of the horn's sound will appear to be _____ than if the train was sounding its horn and not moving.
a) higher b. lower c. no different d. muted

16. A rainbow is created by
a) reflection b. dispersion c. sound waves d. diffraction

17. Which of the following is not an electromagnetic wave?
a) Infrared Light b. Blue Light c. X-Rays d. Ultrasound

18. When light strikes a mirror it will tend to _____.
a) be absorbed b. be reflected c. be refracted d. be amplified

19. Sound waves with frequencies greater than 20,000 Hz are
a) infrasonic waves. b. supersonic waves. c. ultrasonic waves. d. impossible.

20. The type of waves that do not require a medium to carry their energy
a) Compression b. Transverse c. Mechanical d. Electromagnetic

21. The speed of light in a vacuum
a) is found by averaging the different speeds of all the different colors of light.
b) is chosen to be equal to the speed of yellow light, which moves faster than any other color.
c) is higher for blue light than for red light.
d) is higher for green light than for violet light.
e) is the same for all the different colors of light.

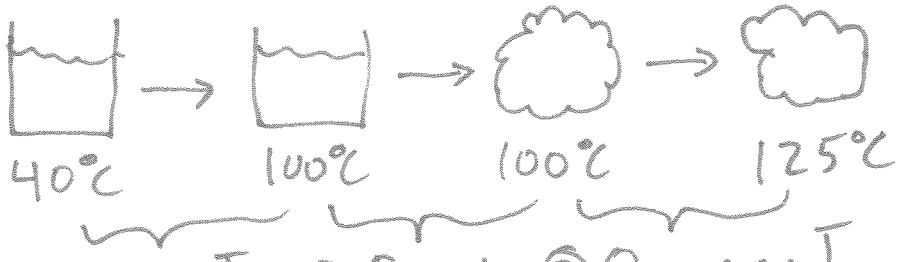
22. The law of reflection says
a) all reflected rays are perpendicular to the incident ray.
b) all reflected rays are parallel to the incident ray.
c) all reflected rays are parallel to each other.
d) the angle of reflection equals the angle of incidence.
e) the angle of reflection equals the angle of refraction.

23. Sound waves cannot travel through outer space because _____.
a) the gas molecules in space are too far apart and there isn't enough gravity
b) they cannot travel through a medium
c) they are electromagnetic waves
d) they are mechanical waves and require a medium

24. A train whistle has a frequency of 450 Hz. You are standing next to the tracks as the train approaches. Describe the changes in frequency that you would hear as the train approaches you and then passes by you.

As it approaches you, the frequency is higher. As it goes away, the frequency is lower.

25. How much heat energy must be added to a 1.30 kg sample of water at 40 °C to turn it into steam at 125 °C? (The specific heat of liquid water is 1 kcal/kg*°C, the specific heat of steam is 0.502 kcal/kg*°C, and the boiling point of water is 100 °C. The latent heat of vaporization for water is 540 kcal/kg.)



① $Q = mc\Delta T$ ② $Q = mL$ ③ $Q = mc\Delta T$

① $Q = mc\Delta T$

$Q = (1.3\text{ kg})(1)(60°C)$

$Q = 78\text{ kCal}$

② $Q = mL_v$

$Q = (1.30\text{ kg})(540)$

$Q = 702\text{ kcal}$

③ $Q = mc\Delta T$

$Q = (1.3\text{ kg})(0.502)($

$Q = 16.3\text{ kcal}$

$Q_1 + Q_2 + Q_3 = \boxed{796.3\text{ kcal}}$

26. A container holds 2.53 kg of water at 27 °C. A sample of water at 85 °C is added to the container, raising the final temperature to 30.3 °C. Assuming no energy is transferred to the container, how much water at 85 °C was added to the original sample?

2.53 kg H_2O @ 27°C gains energy from $m_{unknown}$ H_2O @ 85°C

$$Q_{lost} = -Q_{gained}$$

$$mc\Delta T = -mc\Delta T$$

$$m_{unknown}\left(1\ \frac{kcal}{kg°C}\right)(30.3-85) = -(2.53)(1)(30.3-27)$$

$$m(-54.7) = -8.35$$

$$\boxed{m = 0.153\text{ kg}}$$

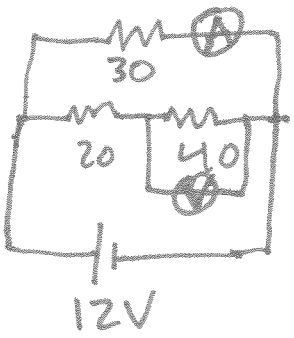
27. A 750-Ω resistor is connected to a 9-volt battery. What is the power of the resistor?

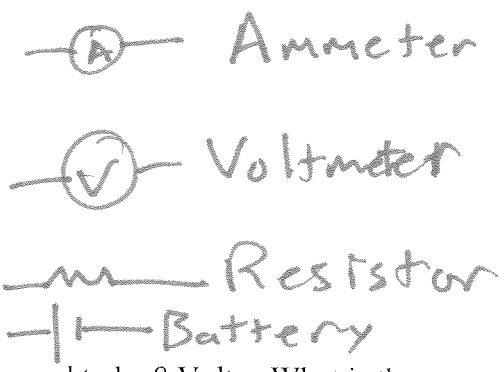
$V = IR \rightarrow I = \frac{V}{R} = \frac{9}{750} = 0.012\ A$

$P = IV = (0.012A)(9V) = \boxed{0.108\ W}$

28. A 20 Ω light bulb and a 40 Ω light bulb are connected in series arrangement that is in parallel with a 30 Ω light bulb. The circuit is connected to a 12 Volt battery, with a voltmeter measuring the voltage across the 40 Ω light bulb and an ammeter measuring the current through the 30 Ω light bulb.

a) Draw a diagram showing this circuit.





b) The voltage across the 40 Ω light bulb is measured to be 8 Volts. What is the current through the 40 Ω light bulb?

$V = IR$

$8 = I(40)$

$\boxed{I = 0.2A}$

c) The current through the 30 Ω light bulb is measured to be 0.4 A. What is the voltage across 30 Ω light bulb?

$V = IR$

$V = (0.4)(30)$

$\boxed{V = 12V}$

d) Determine the current through and voltage across the 20 Ω light bulb.

(a) $I_{40} = I_{20}$ because they are in series

So $I_{20} = 0.2A$.

(b) $V_{20} = IR = (0.2)(20) = \boxed{4\ V}$