

NOTE: Use engineering format for problems 1. Use non-engineering format for the remaining problems. This is an individual assignment except for

- the part of problem 4a that requires that you make marks on your pump parts.
1. A pump is connected to an electric motor. The motor is supplied with 2 A of current from a 12 VDC source (VDC = direct current volts). The apparatus is run steadily for 60 seconds, and the following measurements are recorded:
- mass of fluid collected: 750 grams (0.75 kg)
 - diameter of exit tube: 0.5 inch (0.0127 m)
 - density of water: 1000 kg/m³
 - height of fluid exit above reservoir: 36 inches (0.9144 m)
 - remember that $g=9.81 \text{ m/s}^2$ (g is the gravitational constant ... you need this to find weight!)

Find:

- a. the weight of the fluid collected $W = 7.36\text{N}$
- b. fluid velocity at exit in m/s (meters per second) $v = 0.0987\text{m/s}$
- c. flow rate in L/min (1 liter = 0.001 m³) $Q = 0.75\text{L/min}$
- d. system efficiency (express as a percentage) $\eta = 0.467\%$

Note: Include ALL units in calculations. Use consistent SI units! For example, you should use ...

- kilograms (kg) for mass
- meters (m) for length
- Newtons (N) for force
- volts (V) for voltage
- amps (A) for current
- meters per second (m/s) for velocity

Sometimes you need to collapse or expand a group of units to make sense of what's going on!

$$1 \text{ Newton} = N = kg \cdot \frac{m}{s^2} = \frac{kg \cdot m}{s^2} \quad \text{Can you see Newton's 2}^{nd} \text{ law? } (F=ma)$$

$$1 \text{ Joule (unit for energy)} = J = N \cdot m = \frac{kg \cdot m}{s^2} \cdot m = \frac{kg \cdot m^2}{s^2} \quad (\text{work} = \text{force} \cdot \text{distance})$$

$$1 \text{ Watt (unit for power)} = \frac{J}{s} = \frac{N \cdot m}{s} = \frac{kg \cdot m}{s^2} \cdot \frac{m}{s} = \frac{kg \cdot m^2}{s^3} \quad (\text{power} = \text{work}/\text{time})$$

2. Water pressure readings are recorded as a function of depth by a diver, resulting in the following readings:

Water Depth (m)	Pressure (Pa)
1.0	9780
2.5	23730
6.0	56010
8.0	82400

- a. Determine the best fit line for pressure as a function of water depth manually using Excel.
A: slope=10174 Pa/m, y-intercept=-1531 Pa
- b. Compute the theoretical pressures as $P = \rho \cdot g \cdot h$ where $\rho = 1000 \frac{kg}{m^3}$ and $g = 9.81 m/s^2$.
- c. How well does the theory from part (b) agree with the best fit line at the measured depths from part (a)? Determine the % difference at each depth using the following equation:

$$\% \text{ difference} = \frac{\text{theory} - \text{fit}}{\text{theory}} \cdot 100\%$$

- d. Plot the data (markers only) and the fit (lines only) on the same graph.
3. Implement the photoresistor circuit discussed in class. Provide a screenshot of your sketch and the serial monitor printing out values. Values should change depending on the amount of light received by the photoresistor.

NOTE: If you want to play around with the photoresistor, try to make an LED come on when you cover the photoresistor with your hand ... you will need an if statement.

Note: Have your Arduino/photoresistor circuit out on your table with the program running so that your instructor or class assistant can quickly check your work. Do not turn your homework in at the front; have it ready so that the instructor / assistant can grade your photoresistor activity.

4. Use the pump fabrication presentation on the downloads page to assist you in:
- (Group)** Making marks on the pump parts to prepare for fabrication in the upcoming classes.
 - (Individual)** Drawing the pump body and faceplate in SolidWorks. Please include screenshot views from both sides of the final part for the pump body; you only need a single screenshot of the faceplate since it is symmetric. You may want to print out an extra copy to use as a reference for building your pump.
 - (Individual)** Complete the milling safety quiz through the ENGR 120 Meta Moodle. We will be using the milling machines in class 13, so you **MUST** complete the quiz before using the machines.
 - Print out a screenshot that shows your name and proof of completion for the quiz. Do not turn this in with your homework. Instead, hold onto your proof of completion page until instructor asks for you to turn it in before you start using the milling machines.