

**Answer all questions (8 pts).**

**Show your work. State your assumptions.**

1. (6 pts) Convert the oil flow rate from the Deepwater Horizon oil spill from

45029 barrels of oil per day to cubic meters per hour.

A barrel of oil is 42 gallons (not exact)

2. (8 pts) An electric water heater runs for 2 hours to raise water temperature.

Determine the amount of electric energy used by the heater in kWh AND kJ.

2.3 kW is the assumed power consumption of the electric water heater.

3. (4 pts) Provide the MLT-based fundamental dimensions for torque [N m].

(E.g., the MLT-based fundamental dimensions for velocity is L/T (length/time)).

4. (6 pts) Let's say you have an equation  $q = k A (T/L)$ .

This is from a course you might take called Heat Transfer Processes.

The equation solves for the total heat transfer rate

$q$  [W] during conduction within a solid of length  $L$ .

The cross section of the solid is represented by the area  $A$  and

the temperature difference between the two sides is represented by  $T$ .

$k$  is a material property of the solid. What are the dimensions of  $k$  in metric units?

5. (6 pts) The volumetric flow rate of a liquid is given by the volume of flow per unit time,

while the mass flow rate of a liquid is given by the quantity of mass flowing per unit time.

What fluid property is multiplied by volumetric flow rate to determine

mass flow rate? Hint: use units to figure this out.

6. (8 pts) A bacterial growth rate was found to follow an exponential relationship with time.

When the rate (cells/h) was plotted as a function of time (h),

the relationship was determined to be:

$$r = 10.0e^{0.05t}$$

What are the units of the constants (10.0 and 0.05) in the equation?

Hint: the exponent  $0.05t$  must be unitless.

Write the linearized form of the equation and

determine which axes to use to make this type of relationship plot linearly.

7. (6 pts) The relationship between Current (I) & Time (t)

for an electromagnet is shown in Figure 1.

Determine the slope and the intercept of the line including units by interpreting the chart.

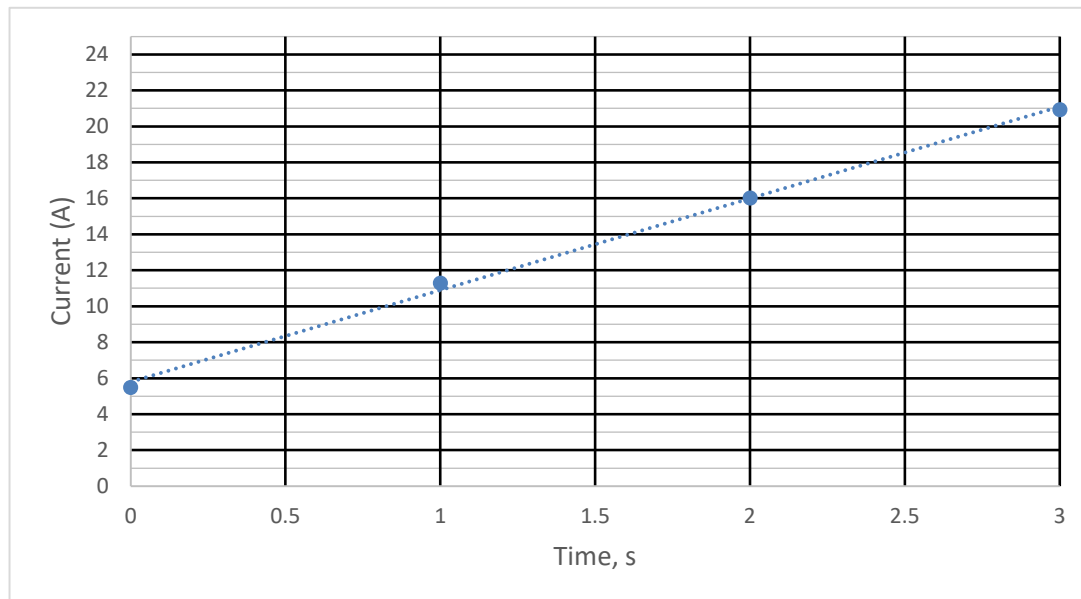


Figure 1. Current vs time for an electromagnet.

8. (8 pts) The Freundlich isotherm equation can be used to predict the

adsorption of gas molecules on a solid surface, here: CO<sub>2</sub> on Activated Charcoal.

$$q = kP^{1/n}$$

where q = mol gas adsorbed per g solid and P = pressure (Pa).

k & n are constants you determine using Figure 2. (q & k here are different than in problem 4).

Write the linearized form of the power law equation associated with this data with

the units for the slope and intercept. Determine the values & units of k and n using Figure 2.

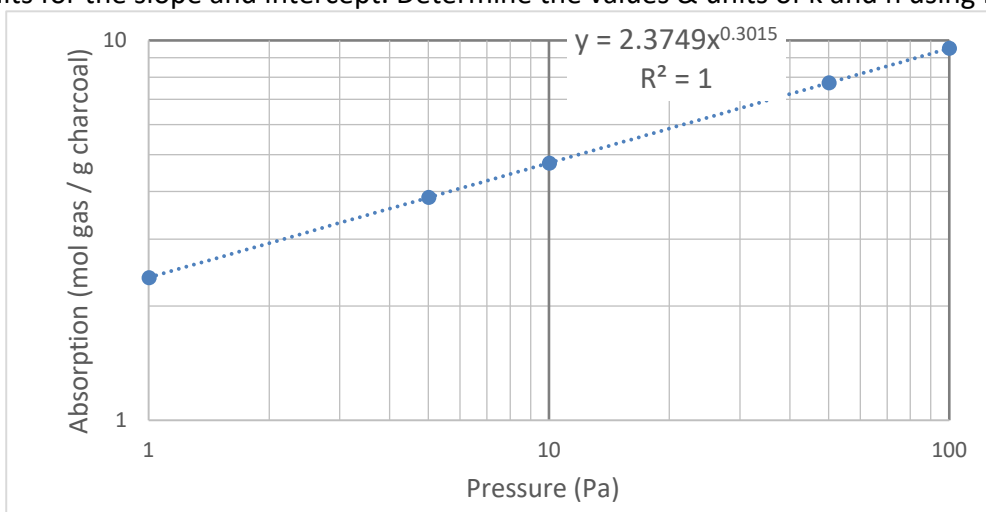


Figure 2. Adsorption isotherm for CO<sub>2</sub> on activated charcoal.

Because you do not know the significant digits of the raw data, assume 3 sig figs.

The final answer is the linearized equation including the values & units of k and n.