Physics 262, Final Exam, May 20, 2002, Dr. Baden

Try to do as many problems as you can, and show your work clearly. There are a lot of problems here, more than you might have guessed, the reason for this is to try to cover as much material as possible to try to measure what you've learned. I don't expect everyone to finish every problem, so please do the problems you are more sure of first, then go back to the others. Credit will not be given for answers with no work shown. Partial credit will be given. There are 170 points total you can get on the exam.

Problem 1 (10 points). Water flows thru a fire hose of diameter **5.4cm** at a rate of **0.105 m^3/s**. The fire hose ends in a nozzle that has a diameter of **2.20 cm**. Calculate the speed that water exits the nozzle.

Problem 2 (10 points). An astronaut on the Moon wishes to measure the local value of *g* (as in "F=mg") on the moon (g_{moon}) by timing pulses traveling down a wire that has a large mass suspended from it. Assume that the wire has a mass of **2.20 g** and a length of **1.10 m**, and that a **7.50 kg** mass is suspended from it. A pulse requires **0.015 s** to traverse the length of the wire. Calculate g_{moon} from these data, neglecting the mass of the wire.

Problem 3 (10 points). A point source emits sound waves with an average power output of **1.3 W**.
a) find the intensity and sound level (in dB) **4.50 m** from the source.
b) find the distance at which the sound level is **95 dB**.

Problem 4 (15 points). A **1.2 kg** block of copper at **20 °C** is dropped into a large vessel of liquid nitrogen at **71.3K**. How many kilograms of nitrogen boil away by the time the copper reaches **101.0K**? (The specific heat of copper is **0.092 cal/g°C** and the latent heat of vaporization of nitrogen is **48.0 cal/g**.)

Problem 5 (10 points). In the figure, a fluid expands adiabatically from an initial to a final state. a) Determine the work done by the fluid. b) Calculate the work done on the fluid when it is compressed from final to initial along the same path.

Problem 6 (10 points). A **3.5 liter** vessel contains monatomic gas at **35°C** and **2.50 atm**. Find
a) the total translational kinetic energy of the gas molecules and
b) the average kinetic energy per molecule.

Problem 7 (10 points). A refrigerator has a coefficient of performance equal to **8.5**. Assuming that the refrigerator absorbs **230J** of energy from a cold reservoir in each cycle, find
a) the work required in each cycle
b) the energy expelled to the hot reservoir.

Problem 8 (15 points). Two **5.0mC** point charges are located on the x-axis as in the figure. One is at **x = +2.0 m** and the other is at **x = -2.0m**.
a) determine the electric field on the y-axis at **y = +1.00m** and **x=0**.
b) calculate the electric force on a **–3.00 mC** point charge placed on the y-axis at **y = +1.00m**.

Problem 9 (10 points). Two identical conducting spheres each having a radius of **1.5 cm** are connected by a light **3.0m** long conducting wire. Determine the tension in the wire if **90.0 mC** is placed on one of the conductors. Assume that the surface distribution of charge on each sphere is uniform.

Problem 10 (10 points). Two concentric spherical conducting shells of radii **a = 0.5m** and **b = 1.0m** are connected by a thin conducting wire as shown in the figure. If the total charge **Q=45.0 mC** is placed on the system, how much charge settles on each sphere?

Problem 11 (10 points).

a) Find the equivalent capacitance between points a and b for a group of capacitors connected as shown in the figure if $\mathbf{C_1=2\ mF}$, $\mathbf{C_2=4\ mF}$, and $\mathbf{C_3=5\ mF}$.
b) if the potential difference between points a and b is **16V**, what charge is stored on C_3 ?

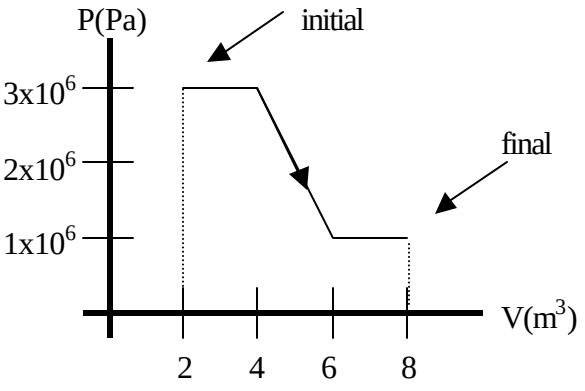
Problem 12 (15 points). The heating element of a coffee maker operates at **120V** and carries a current of **3.50A**. Assuming that the water absorbs all of the energy transferred from the heating element, calculate how long it takes to heat **1.5 kg** of water from room temperature **23°C** to the boiling point. Useful units of conversion are 1cal = 4.186Joules.

Problem 13 (15 points). One light bulb is marked **'25W 120 V'** (dim) and the other is marked **'100W 120V'** (bright). This means that each bulb converts its respective power to heat and light when plugged into a constant **120V** potential difference. Find

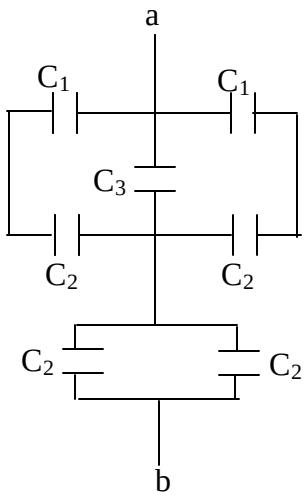
a) the resistance of each bulb
b) How long does it take for **2.20 Coulomb** to pass through the dim bulb?
c) How long does it take for **1.80 Joule** to pass thru the dim bulb?
d) Find the cost of running the dim bulb continuously for **30 days** if the electric company sells electricity at **$0.07/kWhr** (kilowatt hour)?

Problem 14 (20 points). In the figure below, the battery voltage is 12 Volts. Calculate

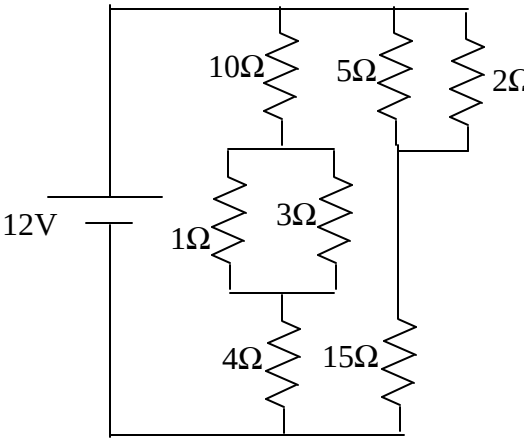
a) the total equivalent resistance in the circuit,
b) the total power dissipated by the entire circuit



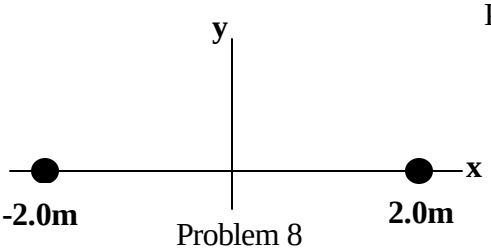
Problem 6



Problem 11



Problem 14



Problem 8