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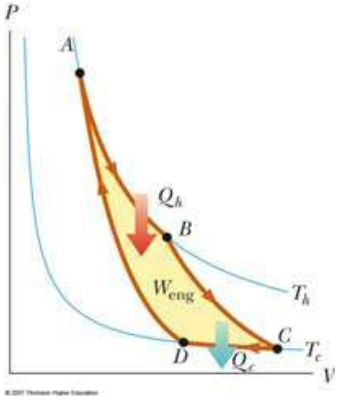
General Physics II, Midterm 3
PHYS10400, Class year 99
03-31-2011

SN:_____, Name:_____

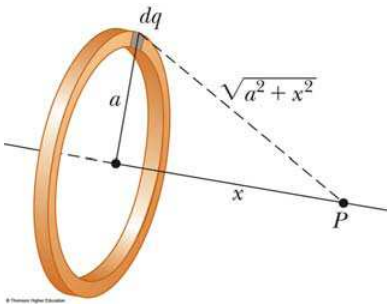
ABSOLUTELY NO CHEATING!

Problems (5 Problems, total 100%)



1. **Carnot Engine:** (total 20%) Refer to the figure on the right for the P-V diagram of a typical Carnot Engine. The heat (energy) absorbed in the isothermal expansion at temperature T_h is Q_h, and the isothermal compression at temperature T_c gives up heat (energy) Q_c. (a) (10%)what is the efficiency (*e*) of the Carnot engine in terms of the temperature T_h and T_c? (b) (5%) What is the requirement to have a perfect efficiency, i.e. *e*=1? (c) (5%) Why it is not possible to have an ideal engine (*e*=1) in reality? Assume, the Carnot Engine operates with ideal gas and the PV relationship for the ideal gas is $PV^{\gamma} = constant$, where γ=Cp/Cv.

2. **Electric field of a charged sphere:** (20%) What is the electric field of a spherically symmetric charged sphere of total charge Q?, (1) at a distance r outside the sphere from the center, (2) at a distance r from the center inside the sphere. (3) Plot the electric field as a function of distance from the center of the sphere. Assume the radius of the sphere is R.



3. **Charged Ring:** (20%) Refer to the figure on the right, (1) what is the electric potential at a distance ***x*** from the center of the ring at point ***P***? (2) Using the answer from the above, derive the electric field at point ***P***.

4. **Energy in a capacitor:** (20%) What is the energy density stored in a parallel plate capacitor? Assuming the capacitor has charge Q in each plate, and potential across the plates is ΔV, the plates are separated with a distance d, each plate has a total area A, and between the plates is vacuum.

5. **Electric dipole in electric field:** (20%) Suppose an electric dipole (***P***) with charge ***Q***, separated by a distance 2***a*** is placed in an electric field ***E***. The dipole makes an angle ***θ*** with the electric field. (1) What is the torque of the dipole experienced due to the electric field? (2) What is the electric potential in this system, i.e. the energy stored in this dipole-electric field system?