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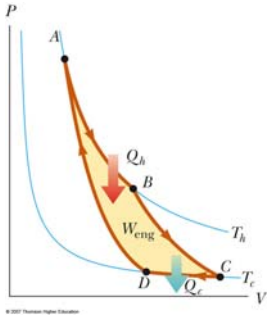
General Physics II, Midterm 3
PHYS10400, Class year 98
04-01-2010

SN:_____, Name:_____

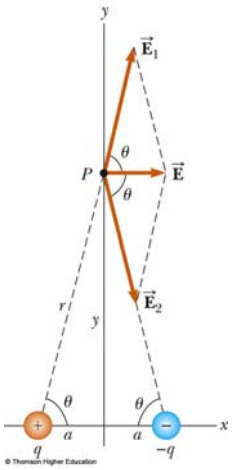
ABSOLUTELY NO CHEATING!

Problems (5 Problems, total 130%)

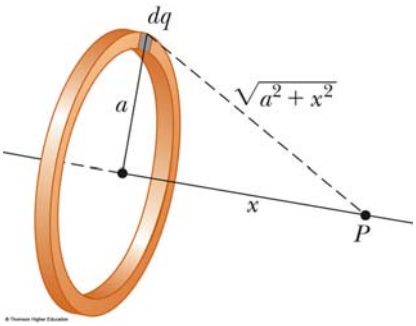


1. **Carnot Engine:** (total 20%) Refer to the figure on the right for the P-V diagram of a typical Carnot Engine. The heat (energy) absorbed in the isothermal expansion at temperature T_h is Q_h, and the isothermal compression at temperature T_c gives up heat (energy) Q_c. (a) (10%)what is the efficiency (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 $PV^{\gamma} = cons\tan t$, where $\gamma=C_p/C_v$.

2. **Entropy:** (20%) (a) What is the meaning of entropy? (b) What is the thermodynamics definition of entropy? (c) What is the entropy change ΔS in a Carnot Engine (using the above diagram)? (d) What is the total entropy change in a free expansion? Suppose initially the gas was confined in a volume of V_i, and is allowed to free expand to a total volume of V_f in an adiabatic, and insulting condition.



3. **Electric field due to a dipole:** (20%) As shown in the figure to the right, in a special case, where we have two charges q that are opposite in sign. In this case, we have an electric dipole separated by a distance 2a. If y axis is sitting at the center of the line joining the two charges and perpendicular to the **x**-axis. (a) What is the total electric field, due to this electric dipole at a point **P** on the y axis at a distance y to the center? To give you a hint, in the figure, we will have E_1=E_2, and the **E** should be parallel to the x axis. (b) What is the total electric field when y>>a?



4. **Gauss law:** (20%) (a) What is Gauss Law in electricity? (b) Use Gauss law to derive the electric field at a distance r away from a point charge Q?

5. **Electric Potential:** (10%) What is the electric potential at a point **P** located at a distance **x** from the center of the charged ring as illustrated in the figure in the right? Assume the total charge of the ring is Q.

6. **Capacitor of Parallel plates:** (10%) What is the capacitor of two large parallel plates (area **A**) separated by a distance ***d***, each has +Q ans –Q respectively? The surface charge density of each plate is σ.