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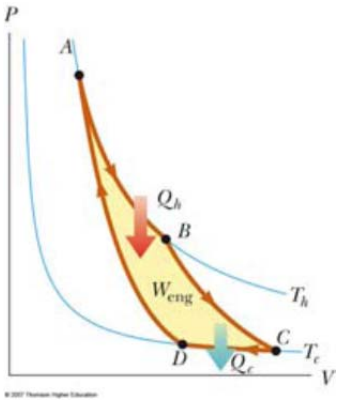
General Physics II, Midterm 2
PHYS10400, Class year 102-2
04-24-2014

SN:_____, Name:_____

ABSOLUTELY NO CHEATING!

Problems (5 Problems, total 100%)



1. **Carnot Engine:** (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) what is the efficiency ***e*** of the Carnot engine in teams of temperature? (b) What is the entropy change for a Carnot engine?

2. **Electric dipole:** (20%) (a) What is the electric field, measured a distance ***z*** from the center, set up by a pair of charges having opposite sign of ***q***, separated by a distance ***d***? (b) If we place the same dipole as in (a) in an uniform electric field, making an angle θ with the dipole, what is the torque the dipole experience due to the electric field. (c) If at a moment the dipole is making a right angle with the electric field, how much work is needed to rotate the dipole to an angle θ?

3. **Gauss's Law:** (20%) Use Gauss law to determine the electric field of spherical solid distribution. Assume the sphere has a radius ***R***, what is the electric field at a distance ***r*** when (a) ***r***>***R***, (b) ***r***<***R***. (c) Plot the electric field as a function of distance r for each the above two cases.

4. **Microscopic view of Current:** (20%) In a microscopic point of view, the current (DC current) can be viewed as charge carrier moving in a conducting wire with a carrier speed (or called drift speed) V_d. Suppose the carrier carries a charge ***q*** moving in a copper wire of cross-sectional area ***A***. The density of the carrier is ***n***, what is the draft speed of the charge carriers? Some useful numbers: the copper wire in a typical residential building has a cross-sectional area 3.31×10^{-6} m^2.The density of copper is 8.92 g/cm^3 and the molar mass of copper is 63.5g. Calculate, (a) what is the number density; (b) what is the draft speed? (c) According to your answer in (b), compare this to your everyday experience of switching on a light, it turns on instantaneously. Explain why?

5. **Biot-Savart Law:** (20%) Biot-Savart law relates the current that produces magnetic field in a current carrying wire. Suppose we have thin horizontal wire of finite length carries a current ***I*** in the positive ***x*** direction. In a distance ***d*** direct above the wire, (a) what is the magnetic field (magnitude and direction) generated by this wire? (b) What is the magnetic field when the wire is infinite long?