

EXAM 1 (100 Points, Show All Work)

G.S. Weston

Phy 7B

7-16-02

12 Points Each

1. During each cycle, a Carnot engine removes 100 J of energy from a reservoir at 400 K, does work and exhausts heat to a reservoir at 300 K. Compute the entropy change of each reservoir for each cycle and show that the entropy change of the universe is zero for this reversible process.
2. If 1 Kg of ice at -20°C is heated at a pressure of 1 atm until all of the ice has been changed to steam, how much heat is required?
3. 100 g of CO_2 occupies a volume of 55 L at a pressure of 1 atm.
 - a) Find the temperature of the CO_2 .
 - b) If the volume is increased to 80 L at constant temperature, what is the new pressure?
4. A quantity of air ($\gamma = 1.4$) expands adiabatically from an initial pressure of 2 atm, a volume of 2 L and a temperature of 20°C to twice its original volume.
 - a) Calculate the final pressure.
 - b) Calculate the final temperature.
 - c) Calculate the work done by the gas.

16 Points Each

5. Calculate the magnitude and direction of the electric field at any point P a distance y from a very (∞) long wire of uniformly distributed charge, see Figure 1. Assume that y is much smaller than the length of the wire and let λ be the charge per unit length (C/m). Hint: Show that the electric field has a magnitude, $E = 2k\lambda/y$.
6. An infinite line charge of linear density $\lambda = 0.6 \mu\text{C}/\text{m}$ lies along the z-axis, and a point charge $q = +8 \mu\text{C}$ lies on the y-axis at $y = 3\text{m}$ as shown in Figure 2. Find the electric field at the point P on the x-axis at $x = 4\text{m}$.

20 Points

7. Two equal positive point charges of magnitude $+5\text{ nC}$ are on the x-axis. One is at the origin and the other is at $x = 8\text{ cm}$ as shown in Figure 3.
 - a) Find the electric potential, V, at point P_1 on the x-axis at $x = 4\text{ cm}$.
 - b) Find the potential, V, at point P_2 on the y-axis at $y = 6\text{ cm}$.

Possibly Useful Constants

$$R = 8.31 \text{ J/mole-K} = 0.0821 \text{ L-atm/mole-K}$$

Latent Heat of Water

$$\text{Heat of Fusion} \quad 3.33 \times 10^5 \text{ J/Kg}$$

$$\text{Heat of Vaporization} \quad 2.26 \times 10^6 \text{ J/Kg}$$

Specific Heat of Water

$$\text{Water Ice} \quad 2100 \text{ J/Kg-K}$$

$$\text{Liquid Water} \quad 4186 \text{ J/Kg-K}$$

$$\text{Steam Water} \quad 2010 \text{ J/Kg-K}$$

$$\gamma = C_p/C_v = 1.67 \text{ (Monoatomic gas)}$$

$$\gamma = C_p/C_v = 1.4 \text{ (Diatomic gas)}$$

$$k = 9 \times 10^9 \text{ Nm}^2/\text{C}^2$$

