

SN: \_\_\_\_\_, Name: \_\_\_\_\_

**ABSOLUTELY NO CHEATING!**

**Problems (5 Problems, total 110%)**

Note: in all problems, if a parameter is not given, you can assume it with the symbol you like.

- Electric charge:** (a) If we place a total charge  $Q$  (made up of small charges  $q$ ) on a conducting sphere. What will the charge distribution? In (a), if we have total charge  $Q$  place on a sphere of radius  $R$ . What will be the charge density? (20%)
- Electric field:** (a) what is the electric field at a distance  $z$  along the center line perpendicular to the center of a charged disk, radius  $R$ ? (b) What if the electric field when  $z$  approach infinite? (20%)
- Gauss law:** (a) What is Gauss Law? (b) Whatever your answer is in (a), prove it. Please assume all parameters you need. (20%)
- Application of Gauss Law:** If a spherical non-conductor of radius  $R$  has a uniform charged  $Q$  distributed in the sphere. Use gauss law to calculate (a) the electric field at a distance  $r$  outside the sphere (b) the electric field at a distance  $r$  inside the sphere. (c) Draw the relation of electric field as a function of distance  $r$  from the center. (20%)
- Entropy:** (a) What is entropy? What is the total entropy change in a Carnot Cycle? A PV diagram is shown in the figure to the right. (c) Based on your answer in (b), please comment why Carnot is referred to as an ideal engine. (d) If you mix hot water (mass  $m_h$ , temperature  $T_h$ ) and cold water (mass  $m_c$ , temperature  $T_c$ ) together, assumes the specific heat  $c$  is one, what is the final temperature of the water mixture? (e) What is the entropy change in this mixing process? (30%)

