PHYSICS DEPARTMENT, IIT DELHI

Major : PHL-723 (Vacuum Science and Cryogenics)

Date: *Nov 21, 2008-2009*   **Time:***1:30 hr*
Note: *Attempt all the questions.*   **Max. Marks**: *35*

1. (a) What do you understand by superinsulation?
    (b) Explain briefly the utility of "baffles" in a liquid helium cryostat.
    (c) Write down the expression relating the Helium boil off rate with the heat input
    in a Helium cryostat.   *1,1,½*

2. Using a schematic diagram explain the working of liquid helium Cryostat for
    obtaining temperature between 4.2 K and about 1K.   *3½*

3. (a) Explain why it is important to minimize the amount of ^{4}He in the re-circulated
    gas in a dilution refrigerator.?
    (b) In the still chamber of a dilution refrigerator, where heater is located, too high
    a still temperature is undesirable. Explain briefly the reasoning.
    (c) What is typical range of temperature inside the still chamber of a dilution
    refrigerator?   *3,2,1*

4. Discuss the heat leak considerations and their solutions while working at
    millikelvin temperatures?   *4*

5. Using first law of thermodynamics, explain why adiabatic demagnetization of a
    paramagnetic salt always results in a cooling? Show that in such a process one
    expects the final temperature of the salt should be zero when external field is
    reduced to zero. Why, in practice, this is never the case with real samples? *2,1,1*

6. (a) Write a short note on the superconducting heat switch employed in single-
    stage nuclear cooling system?
    (b) Also explain why the copper sample used in such a system is made of bundle
    of fine wires?   *3,1*

7. (a) Describe the thermometry methods employed for low temperature and high
    magnetic field environments.
    (b) Describe the basic different between the cold-leak and super-leak.   *4½, 1*

8. (a) Explain clearly how the errors in temperature measurements using a resistance
    thermometer are minimized using a four wire measurement.
    (b) Describe the AC-resistance thermometry from the view-point of need and
    method.   *3, 2½*