INDIAN INSTITUTE OF TECHNOLOGY, BOMBAY

**Department of Metallurgical Engineering and Materials Science**

**MM 209: THERMODYNAMICS : 2015-26: Fall**

**QUIZ I \_\_\_\_\_\_\_\_\_\_\_ \_\_\_ Date: Aug 11, 2015: 1730-1825h**

1. A coal burning burner is fed with powdered coal (assume pure carbon) preheated to 1800K and dry air (N2:O2=79:21, by volume) preheated to 1200K. The coal to air ratio is such that the product is only a gas containing CO and N2. Perform a material balance and a heat balance and calculate the adiabatic flame temperature (of the product gas) .

Take only 1 mol (12g) carbon as the mass basis. You need to present data as **mass and heat balance tables**. (Only the entries in the table may be seen for valuation) **4 marks**

1. 1 mole of a super-cooled material is adiabatically contained at 400 K at constant pressure. If it spontaneously freezes, what is the final temperature? What fraction of the material freezes?

J/mol.K

10-3 T J/mol.K

[Note that starting from a temperature lower than the melting point, an adiabatically contained material cannot cross the melting point by releasing the latent heat and heating itself. This would violate the second law as we will see later. **Hence the maximum temperature can be 600K. It can be lower**]. **2marks**

***+2 marks bonus,*** *if the numerical answer is rigorous conceptually ! There is a standard mistake that people commit.*

1. A mixture of steam at **400K**  and oxygen at **300K**, both at 1 atm., react with a bed of graphite granules at **1000K** to yield a mixture of H2 and CO at **1000K**. Calculate the composition of the CO/H2 mixture, if the above process should be adiabatic (i.e. no heat effect). **Answer in tables** **4 marks**

Further data

|  |  |  |
| --- | --- | --- |
|  | **, J/mol** | **, J/mol** |
| CO | 36.6T - 16400 | -111000 |
| CO2 | 61.0T - 30500 | -394000 |
| H2O(g) | 47.4T - 22200 | -242000 |
| N2 | 36.4T - 16500 | - |
| O2 | 36.2T - 13500 | - |
| C | 23.5T - 11800 |  |

Note : **; that is, it is an integrated expression.**