Major Examination
ASL340: Understanding Weather and Climate

Total Marks: 35

Date: 6. 5. 2023
Time: 2 PM-4 PM; LH316

Please read the following instructions carefully:

Honour Code

"As a student of IIT Delhi, I will not give or receive aid in examinations. I will do my share and take an active part in seeing to it that others as well as myself uphold the spirit and letter of the Honour Code."

Other Instructions/Guidelines

1. Write Question number clearly and correctly before answering
2. Please answer to the point in short as no question requires more than few sentences.
3. The numerical value of any missing constant/parameter may be suitably assumed and mentioned in calculations.
4. Answer all questions in the space provided next to the question. The backside of the page when needed can also be used by writing Q no continued and put a line at the end for demarcation before next one. Backside can also be used for rough work by indicating 'rough' and crossing over it on completion before submission.

5. Answer all questions; 1,2,3,4,5,6,7 which carries marks as 7, 7, 5, 3.5, 5.0, 4.0, 3.5 respectively

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Q 1 (a) What do you understand by Potential temperature and how do you obtain the solution for the same from the first law of thermodynamics? In the lower troposphere, there is a small pressure drop of 50 hPa corresponding to a rise of of an air parcel to about 500 m. Estimate the fall in temperature for an air parcel at pressure 1000 hPa and temperature 27^0 C. 2.5

Q 2 (a) During fires and heavy pollution days, sunrise and sunset looks spectacular than the normal days, explain the phenomena at play for the same. 1.0

Q 2 (b) Depending upon the size, give broad classification of aerosols. Also indicate the class that is optically active to a higher degree and why? 1.5

Q 2 (c) Define Mie scattering and aerosol optical depth. If the incident radiation is same as the solar constant at the top of the atmosphere and optical depth is 0.001 m^{-1}, what is the amount and fraction of the radiation that is transmitted after travelling a pathlength of 1000m? 2.0

Q 2 (d) Briefly discuss the key features for the pressure gradient and Coriolis forces for the ridge and trough formed in the upper atmosphere of the northern hemisphere. 2.5

Q 3 (a) Ozone on photolysis can lead to the production of both singlet state and triplet state oxygen atom and they in turn are capable of producing hydroxyl radicals. What is the basic difference amongst the two oxygen atoms and identify which of the two leads to greater production of hydroxyl radical (from the water molecule) and the distinguishing feature of the nature of reaction for the same. 2.5

Q 3 (b) Show whether photodissociation of oxygen which has a bond energy of 500 kJ mol^{-1} will take place or not if the maximum intensity of the wavelength is given as 400 nanometers. Explain the same with the estimated values. 2.5

Q 4 (a) In modern theory for the initiation of the Indian Summer Monsoon (ISM), it is highlighted that the two prominent jet streams play a very important role. Briefly explain their role with regard to the formation of ISM. 2.0

Q 4 (b) Briefly outline the formation of Ferrel Cell. 1.5

Q 5 (a) Give 3 main differences between tropical and extra-tropical cyclone. Provide structure of cyclone with brief outlines on each of the three components. 2.5

Q 5 (b) What is Ocean Nino Index (ONI) and Southern Oscillation index? State what weather events these indices may influence? 1.5

Q 5 (c) What is Indian Ocean Dipole? How does this effect Indian Summer Monsoon? 1.0

Q 6 (a) Based on the time-frame, define different types of weather forecasting. 1.5

Q 6 (b) A weather bulletin for thunderstorms showed the correct forecast 6 times, false alarm 2 times, missed 4 times and issued correct negative or no thunderstorm forecast 4 times. Estimate the Probability of Detection and the Critical Success Index and comment on these scores in terms of efficiency of the forecast. 2.5

Q 7 (a) Amongst the factors involved in climate change due to human activity, point out the mechanisms of ice-albedo feedbacks (both positive and negative) 2.0

Q 7 (b) Briefly highlight the advantages and disadvantages of Koppen's classification of climate. 1.5

Some useful Constants: Specific heat capacity of dry air at Constant Pressure (Cp)-: 1004 J/kg /K; Molar constant of ideal gas (R): 8.3 J/mol/K; R/Cp = The gas constant for dry air (Rd): 287 J deg^{-1} kg^{-1}; The gas constant for water vapor (Rv): is 461.5 J deg-1 kg-1; Rd/Rv (Epsilon) = 0.623 Planck's constant (h): 6.63 x 10^{-34} m^2 kg s^{-1}; Speed of light ©: 3 x 10^8 ms^{-1} and Avogadro number (A) = 6 x 10^{23} molecules $mole^{-1}$; Density of dry air: 1.15 kg m^{-3} ; Density of Water Vapour: 17 g m^{-3} at 20^0 C, Dry Adiabatic Lapse Rate (DALR): 1^0 C/100 m ; Saturated Adiabatic Lapse Rate (SALR): 0.5^0 C/100 m, Molecular weight of (Mw): 18 g; Molecular weight of dry air (Md): 28 g; Acceleration due to gravity (g): 9.8 m/s-2