

1. Read the following statements and mark "O" for true and "X" for false. (5 pt each, 25 pt in total)
  - (a) Moist air containing water vapor is heavier (higher density) than dry air.
  - (b) Generally, water bodies (e.g., lakes, oceans) have a larger heat capacity than the land (soil).
  - (c) Emissivity of a body is equal to its absorptivity when the body remains in thermal equilibrium with its surrounding.
  - (d) Photosynthesis is stimulated by radiation in the same waveband as human vision.
  - (e) The sky is colored blue because of the scattering by particles larger in size than a wavelength.
2. Select the correct answer from the options below each statement. (5 pt each, 15 pt in total)
  - I. Plants absorb the portion of light of 400-700 nm for photosynthesis. What color of light is relatively less absorbed by plants?  
(a) Blue (b) Yellow (c) Green (d) Red
  - II. Which surface has the greatest albedo?  
(a) Forest (b) Grass (c) Soil (d) Snow
  - III. Which city in Taiwan can the zero zenith angle of the sun be observed only once a year?  
(a) Taipei (b) Kaohsiung (c) Chiayi (d) Taichung
3. In the early growing season, sudden frosts can kill new plant growth. This can be a critical factor in successful forest regeneration. This is mainly due to the **radiative cooling** in the nighttime. Which is more likely to have a successful seedling establishment, a small clearing, or a large clearcut? What is the reason for it? (10 pt)
4. Which mode is relevant to the drought in tropical rainforests in South-east Asia: El Niño or La Niña? What is the reason for it? (10 pt)
5. In the boreal forest region, the vegetation type is sometimes different between north-facing and south-facing slopes. For example, in Interior Alaska, the north-facing slope is covered by black spruce forest over the soil underlain by permafrost. In contrast, the south-facing slope is covered by deciduous broadleaf species on the permafrost-free soil. Explain the reason for it from the view of solar radiation and topography. (10 pt)
6. The air mass at sea level has an air temperature of 26 °C. If this air mass is lifted along the mountain slope adiabatically, and the clouds start to form at the elevation of the NTU Experimental Forest in Xitou (1200 m asl), answer the following questions. Use the dry adiabatic lapse rate of  $\Gamma_d = 0.01 \text{ K m}^{-1}$  and the wet adiabatic lapse rate of  $\Gamma_w = 0.005 \text{ K m}^{-1}$ . (10 pt in total)
  - (a) What is the dew point temperature of this air mass? (3 pt)
  - (b) What is the temperature of this air mass at the top of a 2000 m mountain? (3 pt)
  - (c) If the air loses all the condensed water by precipitation and descends on the leeward to the 0 m elevation, what is the air temperature? (4 pt)
7. Given a water vapor density ( $\rho_v = 20 \text{ g m}^{-3}$ ), the molecular mass of water ( $M_w = 18 \text{ g mol}^{-1}$ ), the molecular mass of dry air ( $M_d = 29 \text{ g mol}^{-1}$ ), the universal gas constant ( $R = 8.31 \text{ Pa m}^3 \text{ mol}^{-1} \text{ K}^{-1}$ ), atmospheric pressure  $P = 100 \text{ kPa}$ , and air temperature is  $T = 300 \text{ K}$ , answer the following questions. (20 pt in total)
  - (a) What is the water vapor pressure  $e$  (kPa)? (5 pt)
  - (b) What is the density of dry air  $\rho_d$  ( $\text{g m}^{-3}$ )? (5 pt)
  - (c) What is the specific humidity  $q$  ( $\text{g kg}^{-1}$ )? (5 pt)
  - (d) What is the mixing ratio  $\chi$  ( $\text{g kg}^{-1}$ )? (5 pt)