1. **Daisyworld:** Imagine four “Daisyworld” cases. (a) white daisies/warm climate, (b) white daisies/cool climate, (c) black daisies/warm climate, and (d) black daisies/cool climate. White daisies cause planetary albedo to increase. Black daisies cause planetary albedo to decrease. (Note: each case has either white or black daisies, but not both.) Warm and cool refer to where the temperature is in relation to the optimum for daisy growth. For the cool climate, an increase in temperature causes more daisies to grow. For the warm climate, an increase in temperature causes fewer daisies to grow. Draw a three-component system diagram for each of these cases. The three components should be daisy coverage (C), planetary albedo (A), and average surface temperature (T). Give the sign of the feedback loop in each case and state whether the equilibrium point would be stable or unstable. [20 pts]

2. **Daisyworld:** Look at Figure 2-14 from the text. This shows how daisy coverage (panel a) and surface temperature (panel b) change as a function of solar luminosity for the case of white daisies. (Part I) Draw a third panel showing how planetary albedo changes as a function of solar luminosity. Include the "lifeless case" as a dashed line for reference (as in panel b). (Part II) Now redraw all three panels for the case of a world with black daisies (where an increase in daisy coverage causes a decrease in planetary albedo). The figures do not need to be precise, but should show the form of each curve. Include the “lifeless case” as a dashed line in the plots that show temperature and planetary albedo. Hand-drawn figures are fine. The x-axes should be labeled "Solar luminosity" for all plots. The y-axes should be labeled "C" (on the percent daisy coverage plot), "T" (on the average surface temperature plot) and "A" (on the planetary albedo plot). You can omit the numbers from the x- and y-axes. [20 pts]

3. **Radiation and matter:** (a) State the four ways that radiation and matter interact. (b) Arrange these types of radiation in order from the shortest to the longest wavelength: red light, blue light, ultraviolet, infrared. (c) Besides radiation, what are the two other primary mechanisms of heat transfer in the atmosphere? [10 pts]

4. **Radiation and albedo:** A lamp shining on a table delivers 1000 Watts (W) of energy to the surface. The table has a surface area of 2 m². (a) What is the incident flux of energy coming directly from the lamp and impinging on the table? Calculate the flux of energy coming directly from the lamp and being absorbed by the table if the albedo of the table is (b) 0.9, (c) 0.2. Answers (a)-(c) should be expressed in units of W/m². (d) Assume that the lamp and the table are inside a room with no windows and are the only objects in that room. Name two other sources of radiant energy to the surface of the table. [10 pts]
5. **Applying the planetary energy balance equation.** The solar constants for Venus, Earth, and Mars are 2643, 1370, and 593 W/m², respectively. The albedos are 0.8, 0.3, and 0.22, respectively. (a) Compute $E_{IN}$ for each planet (the flux of solar energy absorbed, in W/m².) (b) Compute $T_e$ for each planet (the effective radiating temperature, K.) (c) The surface temperatures of Venus, Earth and Mars are 450, 15, and –55 °C, respectively. Convert these temperatures to degrees Kelvin, K, and then (d) compute the greenhouse effect, $\Delta T_g$, for each planet. [20 pts]

6. **Climate change theory:** The conceptual model that underlies concern about global warming is expressed in the equation: $\Delta T = \lambda \Delta F$. State which one of these three terms is most directly associated with the following: (a) changing atmospheric concentration of CO₂, (b) changing atmospheric concentration of water vapor, (c) urban heat-island effect, (d) ice-albedo feedback, (e) change in cloud cover [10 pts]

7. **Define the following terms in the context of this course:** (a) albedo, (b) negative feedback loop, (c) infrared radiation, (d) unstable equilibrium, (e) stratosphere [10 pts]

**Extra credit:** Do Critical-Thinking Problems 2 and/or 4 at the end of Chap 2 (p 32). Up to 10 extra credit points for each problem (20 total).

[HINT on problem 4: Use the quadratic formula (in a math reference book) to find the roots of the combined equation.]