Name: Section:
ID #:

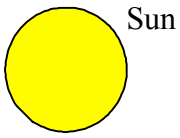
AS 1 Homework # 1 30 points

Put your answers in the boxes. Show work to receive partial credit.

A. (4 points) Suppose we are on an Earth-like planet located twice as far from the Sun as the Earth. What is the solar flux, S, coming in at the top of this planet's atmosphere? Assume the solar flux coming in at the top of the Earth's atmosphere, S_0, is 342 W/m^2. (hint: use the inverse square law)

S=

B. (3 points) For the moment, suppose this planet has no atmosphere. Assume also that this planet's surface, like that of Earth, is reflective of incoming solar radiation resulting in a planetary albedo of 30%. The planet itself also emits radiation according to its temperature. Fill in the schematic diagram that illustrates these flows of radiation, using arrows and labels to indicate radiation fluxes. (You'll need one arrow for incoming solar radiation, one for reflected solar radiation, and one for radiation emitted by the planet.)



Planet's Surface

C. (4 points) With no atmosphere, the surface energy balance is simply:

energy absorbed at surface from the sun = energy emitted by the surface.

Using this equation and the Stefan-Boltzmann law, calculate the surface temperature of this planet. (The Stefan-Boltzmann constant, σ, is 5.67×10^{-8} J K^{-4} m^{-2} s^{-1})

Temperature=

D. (4 points) What is the wavelength at which most of the energy is radiated from the planet and what form of radiation is this?

Wavelength=
Radiation type:

E. (4 points) How does this compare to the wavelength and form of radiation emitted by the planet Earth?

Earth's wavelength=
Radiation type:

F. (2 points) Is the surface temperature of this planet hotter or cooler than that of Earth?

G. (2 points) The surface temperature in part C was calculated assuming NO atmosphere. Suppose we now introduce an atmosphere to this planet, and the planet's albedo remains 30%. The equilibrium energy balance equation at the top of the atmosphere is

solar energy absorbed by planet (including its atmosphere) =
energy emitted by the planet (including its atmosphere)

Use this equation to calculate the radiation flux emitted by the atmosphere.

Flux=

H. (5 points) Like Earth's atmosphere, this planet's atmosphere contains greenhouse gases that absorb all radiation emitted by the surface. The flux you calculated in part G is therefore directed both upwards to space and downwards to the surface. Using this radiation flux and the surface equilibrium energy balance, calculate the new surface temperature when the planet has an atmosphere containing greenhouse gases. Hint: The surface equilibrium energy balance equation is:

energy absorbed at surface from sun + energy absorbed at surface from atmosphere =
energy emitted by the surface

Temperature =

I. (2 points) How much warmer is the planet with an atmosphere containing greenhouse gases compared to when the atmosphere is absent?

Temperature difference =