Question 2: Space ship earth.

A spherical planet loses energy to space at some rate proportional to its current temperature T multiplied by its conductivity k (measured in $kJ\,K^{-1}m^{-2}$) and the total planetary surface area. The planet gain energy at a rate equal to in the incoming solar radiation S (measured in $kJ\,m^{-2}$) multiplied by the absorption rate A, and total planetary cross-sectional area.
Assume that at all times the planets temperature obeys the equation $CT=E$, where C the specific heat capacity of the planet.

a) Find the Newton's cooling equation governing the temperature of planet. Your equation should contain $T, \frac{dT}{dt}, C, k, r, A, S$ and any other physical or mathematical constants you deem relevant?

b) At what temperature will our planet be at thermal equilibrium?

c) Discuss how each of your physical parameters (C, k, r, A, S) effect the planets equilibrium temperature.

d) If you were to solve the equation found in (a), what would be the decay constant on your exponential term?

e) Is the above a good model? How might you improve it.

Question 2: Space ship earth.

A spherical planet loses energy to space at some rate proportional to its current temperature T multiplied by its conductivity k (measured in $kJ\ K^{-1} m^{-2}$) and the total planetary surface area. The planet gain energy at a rate equal to the incoming solar radiation S (measured in $kJ\ m^{-2}$) multiplied by the absorption rate A (a unitless number between zero and one), and total planetary cross-sectional area.
Assume that at all times the planets temperature obeys the equation $CT=E$, where C the specific heat capacity of the planet.

a) Given what is stated in the above, what is the total rate at which your planet absorbs energy from its surroundings. Give your answer in terms of S,A, r, and any other relevant physical or mathematical constants.

b) Given what is stated in the above, what is the total rate at which your planet loses energy to its surroundings. Give your answer in terms of T,k, r, and any other relevant physical or mathematical constants.

c) Why do we use the planets total surface area when calculating loss of energy, but only the planets cross-sectional area when calculating energy gains?

d)Given your answers to a and b, please find $\frac{dE}{dt}$. Using this, along with at least one other relevant piece of information from your original brief, find $\frac{dT}{dt}$. Your equation should contain $T, \frac{dT}{dt}, C, k, r, A, S$ and any other physical or mathematical constants you deem relevant.

e) Rearrange your equation into the form $\frac{dT}{dt}=\alpha(\beta-T)$ where alpha and beta are physical constants, or collections of physical constants. For example you might find something to the effect of $\alpha=k\frac{C}{r^3}$ (note, this is example is incorrect, and is meant only as an illustration)

f) An object is said to be in thermal equilibrium when its temperature is no longer changing with respect to time. What does it mean mathematically for your planet to be in thermal equilibrium? For what value of T will this occur? Give you answer in terms of whatever physical and mathematical constants you deem relevant.

g) For each of your physical parameters (C, k, r, A, S) comment on how changes to that parameter effect the equilibrium temperature of your planet. For example you might say "If we were to double the radius of our planet, holding all else constant, this would halve our planets equilibrium temperature."

h) If you were to solve the equation found in (e), what would be the decay constant on your exponential term?

i) The above model makes a number of significant simplifications. Identify at least one such simplification, and indicate very briefly how you might make the model more realistic.
NOTE: you are free to propose changes even if carrying them out is beyond your current ability level.