Astronomy 1102/1104 **Name:** _____

Spring 2016 - Problem Set 8 **Section #** _____

Due in section the week of April 11th
Problems are based off lecture and readings - Show all work - Don't forget units - 10pts total

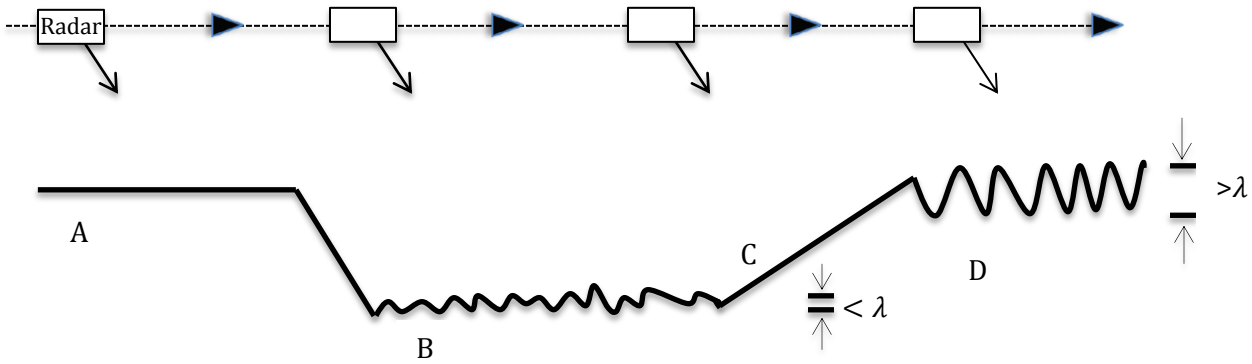
1) Atmospheric Escape

a) Calculate the thermal velocity for water on Venus, Earth, and Mars. Compare this to the escape velocity for the three planets (equations in the lecture slides). From your results, what can you say about the relative abilities of these planets to retain water in their atmospheres? The mass of a water molecule is 2.99×10^{-26}kg. The average temperatures of Venus, Earth, and Mars are, respectively, 735, 289, and 218 degrees Kelvin. The masses of the planets are 4.87×10^{24}, 5.97×10^{24},and 6.39×10^{23} kg, and their radii are 6.05×10^{6}, 6.37×10^{6}, and 3.39×10^{6} m. (2 pts)

b) What can happen to water molecules in the upper atmosphere of Venus? (1 pt)

2) Radar Observations

a) You're studying the surface depicted below with radar. Rank the regions from brightest to dimmest. Be sure to consider the incidence angle. Which region has the largest delay? (2 pts)



b) Why is radar the only tool that can provide high resolution images of Venus's surface? (1pt)

3) Mars Magnetic Field

Planetary scientists think that global magnetic fields are powered by dynamos. Explain why Mars might not be able to support a dynamo is it has cooled faster than Earth? (1pt)

4) Fact-checking *The Martian*:

In the opening scene of *The Martian*, astronauts are worried that a storm on Mars will tip over their rocket. Is this realistic?

a) Assume the wind directly hits one side of the rocket. Find an equation for the force, F, that wind exerts on the rocket in terms of A, the area of the side of the rocket, ρ, the density of the atmosphere on Mars, and v, the wind speed.

i) How far does the wind travel in time Δt? (1/3 pt)

ii) How much mass will hit the rocket in time Δt? Hint: start by calculating the volume of wind that will hit the rocket in time Δt. (1/3 pt)

iii) The amount of force on the rocket is $F = m\frac{v}{\Delta t}$. Use your answer from ii) to find F in terms of ρ, A, and v. Show your work. You should get $F = \rho A v^2$. (1/3 pt)

b) Earth's atmosphere is about 100 times denser than the atmosphere on Mars. Assume that the winds on Mars were at speeds of 60 mph during the storm. How fast would wind have to move on Earth to supply the same force? (1 pt)

c) Look up your answer for part b) on the Beaufort Scale (check out the Wikipedia page). Would this kind of wind be capable of knocking over a rocket? (1 pt)