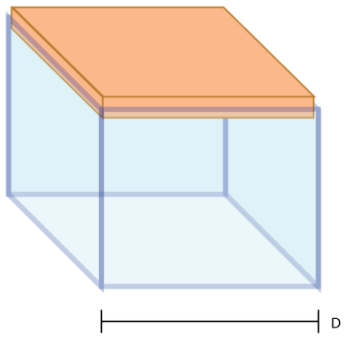
EARTH AND SPACE SCIENCE **Autumn 2017**
431 *PRINCIPLES OF GLACIOLOGY* 4 Credits, SLN 14841
505 *THE CRYOSPHERE* 4 Credits, SLN 14862

Homework 3 – Due Friday, October 20th

1) To experimentally validate the saturation vapor pressure of carbon dioxide, you have built four boxes, each of a difference size (with square tops of side length D). These boxes are sealed by a platform on top, which can be held down using different weights to change the pressure inside.



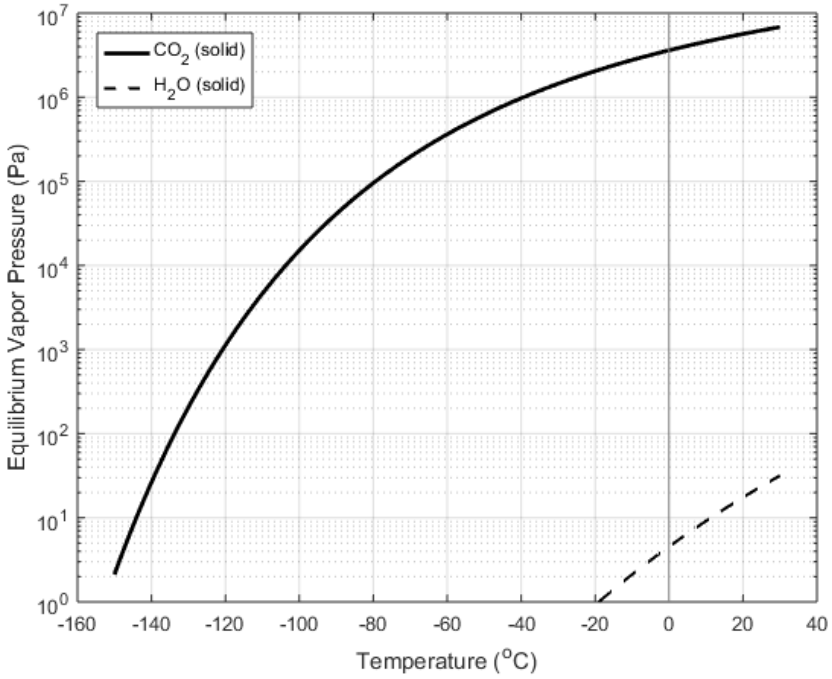
Inside each box you place a block of dry ice, the solid phase of CO_2. Your textbook tells you that at room temperature, the equilibrium vapor pressure of CO_2 is 6 MPa. To test the accuracy of your textbook, you have balanced an animal of known mass on the top platform of each box and pumped out the gas around the dry ice. The ice starts to sublimate, and as more and more mass enters the gas phase, the pressure inside the box rises.

a) Given the following box sizes and animal weights, which animals will be able to sit comfortably as their box stays sealed, and which animals will be forced off their pedestal as the seal is overcome (show your work):

Box Size (D)	Animal and Mass (kg)
0.1 m	Mouse – 0.015 kg
0.1 m	Dog – 10 kg
0.1 m	Human – 70 kg
0.1 m	Elephant – 3000 kg
0.1 m	Blue Whale – 12000 kg

b) Using the plot of equilibrium vapor pressure below, determine the temperatures at which the vapor pressure is in equilibrium with the weighted lid for the given box size.

c) What sized box top is needed for each animal to perfectly balance the internal pressure with the animals' weights at room temperature?



2) Imagine a hail stone of mass .001g falling through super cooled droplets of water. The hailstone starts with a temperature of -10 C. As it passes through the water droplets, they freeze in place on the hail stone, releasing heat and warming the ice.

a) What is the mass of rime that needs to be added to the hail stone to raise its temperature to the melting point? What percentage of the hail stone's mass is this?

b) When the surface of hail reaches the melting point, riming on the surface fails to trap air pockets within the ice. With this in mind, describe the relative rates of riming for the hail stone pictured below. (Hint: while freezing ice to the surface adds heat, the hail stone is also conducting heat back out into the air. The balance of these two processes controls the hail surface temperature).