# Chemguide – answers

SATURATED VAPOUR PRESSURE

1. a) Evaporation happens as some of the more energetic particles in a liquid can overcome intermolecular attractions and break away from its surface. In boiling, enough energy has been supplied to the liquid for *all* the particles to have enough energy to break the intermolecular forces. That means that boiling takes place throughout the liquid and not just on the surface.

    b) Sublimation is the direct change from solid to gas (or vice versa) without going through the liquid state.

    c) In an open container, any particles which break away from the surface will tend to diffuse away through whatever space is available to them. In a sealed bottle, the particles escaping into the gas are trapped in the space above the liquid, and some of them will hit the surface and rejoin the liquid. An equilibrium is established in which the number of particles leaving the surface in a given time is exactly the same as those rejoining it. At that point the total number of particles in the gas will remain constant, and so exert a constant pressure. This pressure is the saturated vapour pressure.

    d) Using a mercury barometer tube, and taking the diagram from the Chemguide page:

    (The height of the mercury column would only be 760 mm if the pressure was exactly 1 atmosphere. It doesn't matter what it is as long as you measure it accurately.)
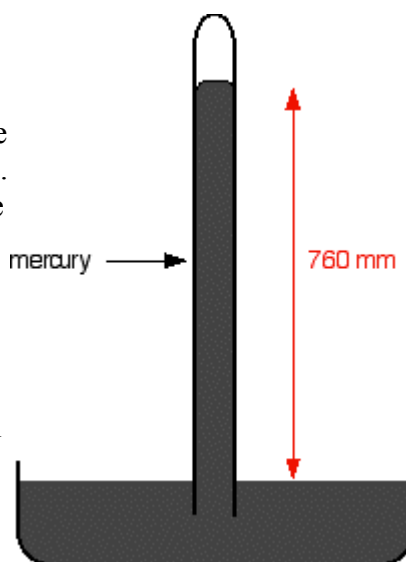
    Add a few drops of water to the tube using a pipette. The liquid will float to the top of the mercury, and some will evaporate. The vapour pressure of the liquid will force the mercury level down a bit.

    If the mercury level fell by, say, 20 mm, the svp of water would be 20 mmHg at that temperature.

2. a) Either: Increasing the temperature increases the average energy of the particles, and therefore increases the proportion of the particles which will have enough energy to escape from the liquid. The net effect will be an increase in the number of particles in the vapour above the liquid at equilibrium, and so an increase in svp.

    Or: Like any other saturated vapour pressure equilibrium, the equilibrium between water and water vapour is endothermic:

    liquid ⇌ vapour   ΔH is +ve

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If you increase the temperature on a system in equilibrium, it will respond by favouring the endothermic change (Le Chatelier). At higher temperatures, there will be more vapour particles present, and so a higher svp.

b) A liquid boils when its svp becomes equal to the external pressure. So in this case, if the external pressure is 50 kPa, the water will boil at a temperature when its svp = 50 kPa. That is approximately 80°C. (It isn't enough to just state a temperature - you must include the first sentence, or something like it.)

c) The svp graph doesn't stop at 100°C - it continues on upwards. If the external pressure is greater than 1 atmosphere (101.325 kPa), then the water won't boil until its svp reaches that pressure.

(You couldn't know this but, out of interest, at about 15 atmospheres (1550 kPa), water boils at 200°C.)