Q19 Define the following terms (40% of marks): Saturated Vapour Pressure of Water, Absolute Humidity, Relative Humidity, Latent heat of vaporization. Briefly outline how the humidity of air is altered during inspiration and expiration by the respiratory tract. (60% of marks) (Sept 2009, Q13 Sept 2010)

- **Water vapour pressure→** the partial pressure exerted by water vapour in any gas mixture
- **Saturated water vapour pressure (SVP) →** water vapour pressure when the air is saturated with water vapour (temperature dependent). At 37 degrees and atmospheric pressure, this is 47mmHg
- **Absolute humidity →** the amount of water vapour present in a given volume of gas (units g H_2O/m^3 or mgs H_2O /L - numerically, these units are equal, such that 44 mgs H_2O /L = 44 g H_2O $/m^3$). Absolute humidity is temperature independent as it is simply the amount of water vapour present per unit volume
- **Relative humidity →** the amount of water vapour present in the gas expressed as a percentage of the amount of water vapour that would be present if the gas were saturated with water vapour.

$$\text{Relative humidity} = \frac{\text{absolute humidity (actual) in the gas}}{\text{absolute humidity (saturated) at that temperature}} \times 100\%$$

- **Massic enthalpy of evaporation →** (previously termed the latent heat of evaporation) is the heat required to convert 1g of a substance from the liquid phase to the gaseous phase at a given temperature (expressed in J^{g-1})

Humidification of air in the resp tract:

- At the carina: absolute humidity 44g/m3, relative humidity normally 100%
- Optimal function requires: an absolute humidity > 33g/m3 or relative humidity of > 75%
- Typical room air usually has a moisture deficit compared to alveolar air – hence inspired air must be warmed and moistened to prevent structural damage and failure of the mucociliary elevator
- INSPIRED AIR
    - During nose breathing, air flows in a turbulent manner over the nasal epithelium, whose surface area is greatly increased by the nasal turbinates. Air is warmed by the radiant heat from nasal blood supply. As it is warmed, moisture evaporates from the epithelia to increase the relative humidity of the inspired air to ~90%
    - As inspired gas reaches the lungs, it reaches the isothermic saturation boundary where it achieves BTPS (body temperature and pressure, saturated with water vapour) conditions. This usually occurs at the second generation of bronchi.
- EXPIRED AIR
    - During exhalation, expired gas transfers heat back to the cooler trachea and nasal mucosa. As this saturated gas cools, it can hold less water vapour (its saturated water vapour pressure falls) and condensation occurs on the mucosal surfaces, where the liquid water is reabsorbed. Reabsorption reduces potential airway water losses from 300ml/day to ~150ml/day
- Mouth breathing reduces the relative humidity of inspired air to 60-70%
- Tracheal temperature and humidity fall with an increase in respiratory rate (ie, the isothermic saturation boundary moves more away from the upper airway)