Lesson 1 (2 hours)	Lesson 2 (1 hour)	Lesson 3 (1 hour)	Lesson 4 (2 hours)	Lesson 5 (1 hour)
Objective: Students will explore the concept of relative humidity by investigating the equilibrium between liquid water and water vapor in a closed plastic bottle	**Objective**: Students will explore the water vapour conservation diagram and list possible uses	**Objective**: Students will explore the sorption isotherm of hygroscopic materials	**Objective**: Students will explore the buffering effect of hygroscopic materials in closed systems by analysing experimental results on the RH and T within a microclimate vitrine	**Objective**: Students will explore further situations encountered in conservation: the packing of materials conditioned at an RH different from the RH in the environment and the buffering effect in semi-closed systems.
Vocabulary: Maxwell-Boltzmann distribution, Relative Humidity, Absolute Humidity, Saturation Concentration,	**Vocabulary:** Water Vapor concentration diagram, closed and inert systems, Tetens equation.	**Vocabulary:** sorption isotherm, absorption and desorption, equilibrium moisture content (emc),	**Vocabulary:** buffering effect of hygroscopic materials, microclimate vitrines	**Vocabulary:** semi-closed systems, reductio ad absurdum
Activities/Strategies: 1. Model system: 2 L plastic or glass laboratory wide mouth bottle 2. Video of observational experiment results: increase of RH in the bottle after a small beaker with water is inserted. 3. Group work: develop hypotheses for	**Activities/Strategies**: 1. Model system: 2 L plastic or glass laboratory wide mouth bottle 2. Group work: the RH prediction in closed and inert spaces subjected to temperature changes 3. Group work: the RH prediction in closed and inert spaces subjected to temperature gradients 4. Individual work: creating a datasheet with	**Activities/Strategies**: 1. Individual work: definition of emc and calculation in different cases 2. Frontal lecture: Shape of the sorption isotherm for different materials 3. Frontal lecture: swelling, shrinking and capillary water	**Activities/Strategies** 1. Case study and group work “microclimate vitrine” 2. Group work: Based on T measurements (excel sheet) and initial absolute humidity, prediction of RH values if the microclimate would be empty 3. Group work: with measured absolute and relative humidity	**Activities/Strategies** 1. Case study: packing of materials conditioned at a different RH than the environment 2. Reductio ad absurdum 3. Conclusion: in closed system the relative humidity is determined by the moisture content of

the increase of the RH and possible testing experiments 4. Class Discussion on the hypotheses and test experiments. 5. Example of hypotheses: reaction, bond-breaking. 6. Video: Example of test experiment: measurement of RH increase in a desiccator with liquid water but under vacuum. Bond breaking hypothesis can be retained. 7. Observational experiment: simulation of velocities of 4 same mass particles initially with same velocities (Collision Lab at PhET) 8. Group discussion: Expected distribution of velocities of the water molecules in liquid water. 9. GIF Simulation of 2-D collisions and Maxwell Boltzmann distribution	the Tetens equations (excel or google sheet) for the calculation of the saturation concentration 5. Group work: inert spaces: mixing air masses at different humidities. Graphical and mathematical solutions.		4. Group work: Formulation of hypothesis and test experiment for the observed data in the microclimate vitrine 5. Group work Quantitative estimation 6. Work in pairs: comparison of the moisture content of equal volumes of wood and air 7. Frontal lecture: temperature dependency of the sorption isotherm (with peer instruction) 8. Graphical and mathematical solution for the prediction of the Rh in a closed system with hygroscopic materials and subjected to T changes	the hygroscopic materials 4. Observational experiment: RH increase in semi-closed systems containing or not hygroscopic materials 5. Hypothesis and test experiments 6. Preparation for measurements and interpretation in real cases

10. Definition of evaporation rate based on the bond breaking hypothesis 11. Definition of saturation concentration when evaporation rate = condensation rate 12. Definition of absolute humidity and relative humidity				
Materials and technology: - Wide mouth plastic bottles or glass jars, volume 1 or 2 L - little beakers - RH/T datalogger (if experiments are to be performed) - videos of experimental results <u>Optional</u> - Desiccators - Vacuum pump - plastic bottles with small computer ventilators - Salt solutions	**Materials and technology:** - Prints of Water vapor concentration diagram - Datasheet (e.g. Excel or google sheet)	**Materials and technology:** - Prints of sorption isotherm	**Materials and technology:** - Datasheet (e.g. Excel or google sheet) - Measured data in the microclimate vitrine - Prints of sorption isotherm at different temperatures	**Materials and technology:** - Videos of experimental results <u>Measurements in real cases:</u> - Different plastic foils to pack materials - Different types of boxes (isolated or not) - Hygroscopic materials (e.g. newspapers) conditioned at high RH and conditioned at environmental RH.

				- Small RH/T dataloggers