Oxygen and Hydrogen Isotope Systematics for Hydrological Applications / Exercise-1

Name of the participant:

In case of MCQs tick the correct answer. In case of other questions solve the problem as required; answer sheet should reflect how you have solved the problem.
Questions carry unequal marks. Use of calculator is permitted.

1. Craig's Meteoric Water Line is:
- **a.** $\delta D = 8 \times \delta^{18}O+10$
- **b.** $\delta^{18}O = 8 \times \delta D +10$
- **c.** None of the above

2. *d*-excess is defined as:
- **a.** $\delta D - 8\times\delta^{18}O$
- **b.** $\delta^{18}O - 8\times \delta D$
- **c.** None of the above

3. Which one is the correct statement?
- **a.** Global Meteoric water line passes through origin in the $\delta^{18}O$-δD plot
- **b.** Global Meteoric water line does not pass through origin in the $\delta^{18}O$-δD plot
- **c.** None of the above

4. GISP is:
- **a.** Greenland Ice Sheet Precipitation
- **b.** Global Isotopic Surface Precipitation
- **c.** Global Isotope Standard for Precipitation
- **d.** None of the above

5. Effect of evaporation is manifested in water in the form of:
- **a.** No effect in *d*-excess because both δD and $\delta^{18}O$ increase due to evaporation
- **b.** Increase in *d*-excess
- **c.** Decrease in *d*-excess
- **d.** None of the above

6. IAEA is:
- **a.** Isotopic and Atomic Exploration Agency
- **b.** International Atomic Energy Agency
- **c.** Isotopic and Atomic Energy Agency
- **d.** None of the above

7. Groundwater datasets from two different states have $\delta^{18}O$-δD regression line slopes of (A) 7.8 and (B) 4.2. Which one of this could be from Rajasthan?
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]
- **a.** (A)
- **b.** (B)

8. Precipitation datasets from two different stations in India have $\delta^{18}O$-δD regression line intercepts of 9 for station-A; and 18 for station B. Which of these two datasets could be from Kashmir? **Given:** The atmospheric temperature lapse rate is 6°C and $^{18}\alpha$ at 10°C is 1.0106.
   a. Station-A
   b. Station-B

9. A water sample kept open in refrigerator can be expected to:
   a. Become Isotopically enriched
   b. Become Isotopically depleted
   c. Maintain the same isotopic composition

10. Distilled water from a laboratory distillation plant can be expected to:
   a. Become Isotopically enriched compared to feed water
   b. Become Isotopically depleted compared to feed water
   c. Maintain the same isotopic composition as feed water.

11. $\delta^{18}O$ value of 10‰ for a sample means that:
   a. Sample has 10% more ^{18}O than reference
   b. Sample has 1% more ^{18}O than reference
   c. ^{18}O concentration in sample = 10‰
   d. ^{18}O concentration in sample = 1‰

12. Which one has the lowest vapor pressure
   a. $H_2{}^{18}O$
   b. $H_2{}^{16}O$
   c. $H_2{}^{17}O$
   d. All have same value of vapor pressure

13. Water samples-A has 2005 atoms of ^{18}O per million atoms of ^{16}O and water sample B has 2025 atoms of ^{18}O per million atoms of ^{16}O. What is the value of isotope separation $\Delta_{(A\text{-}B)}$?
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$]

14. From initial 9268 kg of water vapor in a cloud parcel at 7:00 am 2780 kg rain out at 7:15 am due to equilibrium condensation at an altitude of 2.5 km. If the initial $\delta^{18}O$ of vapor was –21 ‰ and the ground temperature at the time of rainfall was 25°C calculate the $\delta^{18}O$ of remaining vapor. The atmospheric temperature lapse rate is 6°C and $^{18}\alpha$ at 10°C is 1.0106.
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]

15. A water sample has isotopic composition of $\delta^{18}O = -7$‰ and $\delta D = -48.0$‰ with respect to VSMOW. Calculate the abundance ratios $^{18}O/^{16}O$ and $^{2}H/^{1}H$ in this water sample.
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]

16. Two compounds X and Y in thermodynamic equilibrium have isotopic compositions of $\delta x = 0$ ‰ and $\delta y = 0$ ‰, what is the value of equilibrium fractionation factor $\alpha_{x\text{-}y}$?

17. Two compounds A and B under equilibrium have isotopic compositions of $\delta A = 10$ ‰ and $\delta B = -10$ ‰, calculate the value of $\varepsilon_{A\text{-}B}$:
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]

18. Two compounds X and Y in thermodynamic equilibrium have isotopic compositions of $\delta x = 0$ ‰ and $\delta y = -20$ ‰, calculate the value of $\alpha_{y\text{-}x}$:
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]

19. If the $^{18}O/^{16}O$ and $^{2}H/^{1}H$ ratios in a sample are given to be 0.0020410 and 0.0001735 respectively. Calculate the oxygen and hydrogen isotopic composition ($\delta^{18}O$ and δD in ‰) with respect to VSMOW.
Given: [VSMOW $^{16}O/^{18}O = 498.7033712$; $^{1}H/^{2}H = 6420.545746$]

20. Two samples, of water and vapor in thermodynamic equilibrium at 25°C, were found to have following isotopic compositions:
Water: $\delta^{18}O = -5$ ‰; $\delta D = -29.6$ ‰;
Vapor: $\delta^{18}O = -14.2$‰; $\delta D = -98.6$ ‰
Calculate the observed water-vapor equilibrium fractionation factor $\alpha_{\text{(water-vapor)}}$ for both oxygen and hydrogen.

Notes:

$$\left(\frac{^{18}O}{^{16}O}\right)_{VSMOW} = (2005.2 \pm 0.5)\times 10^{-6}$$

$$\left(\frac{^{2}H}{^{1}H}\right)_{VSMOW} = (155.75 \pm 0.45)\times 10^{-6}$$

$$\delta\,(‰) = \left(\frac{[R]_{Sample}}{[R]_{Standard}} - 1\right) \text{x } 1000$$

$$\varepsilon_{x-y} = (\alpha - 1).10^{3} = \left(\frac{R_x}{R_y} - 1\right).10^{3}$$

$$\alpha_{X-Y} = \frac{1+\frac{\delta_X}{1000}}{1+\frac{\delta_Y}{1000}} = \frac{1000+\delta_X}{1000+\delta_Y}$$