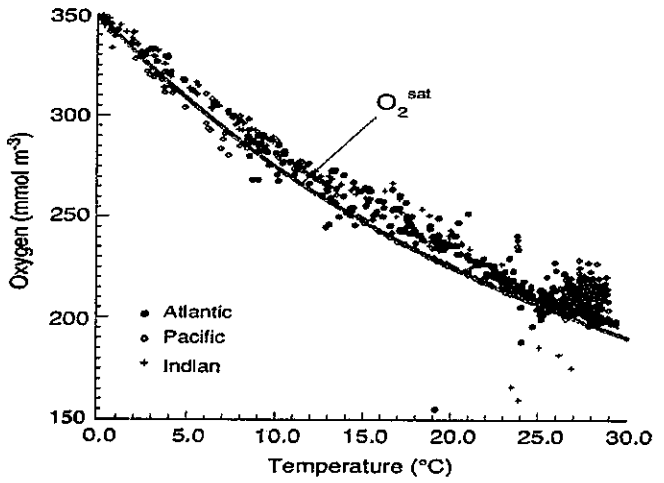
Please answer each question clearly

A. Gas solubility and exchange - O_2 (40%)

1. More oxygen (O_2) is present in the real ocean surface compared to a theoretical saturation curve (O_2^{sat}) at a given temperature (see the following figure).

   a. Explain why?
   b. How to get a theoretical saturation curve (O_2^{sat}) ?
   c. What processes influence surface water oxygen saturation?



2. The flux, F, of oxygen across the air-water interface is related to the degree of oxygen saturation, on average it is 4% supersaturated:

$$F_{O2} = -D\frac{\partial [O_2]}{\partial z} = -D/Z \times \{[O_2] - [O_2]_S\} = K_{O2} \times \{[O_2] - [O_2]_S\}$$

where $[O_2]_S$ is the saturation value (moles/m^3); Z film = 40 μm = 40 x 10^{-6} m (thickness of the stagnant film) ; D_{O2} = 5 x 10^{-2} m^2 y^{-1} (molecular diffusivity of O_2).
K_{O2} is an empirically determined mass transfer coefficient (piston velocity, m/d).
The mean saturation value in the surface ocean is 220 μmoles/l.

   a. Calculate the flux; would it be in or out of the ocean?
   b. Calculate the residence time of O_2 in the ocean mixed layer with respect to gas exchange. (Mixed layer depth = 100m)

B. Vertical distributions of O_2 and nitrate from the surface to 4000 m depth in Atlantic, Indian and Pacific Oceans at a latitude of ~10° N (30%)

1. Please sketch briefly and respectively;
2. Illustrate clearly the related controlling processes and explain why their differences?

C. Define and briefly explain the following terms: (30%)

a) Liebig's law of minimum
b) Biomagnification
c) Allochthonous
d) Ammonification
e) Solubility pump
f) Continental shelf pump
g) Diazotrophs
h) Revelle factor
i) Fick's first law
j) Turnover time

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