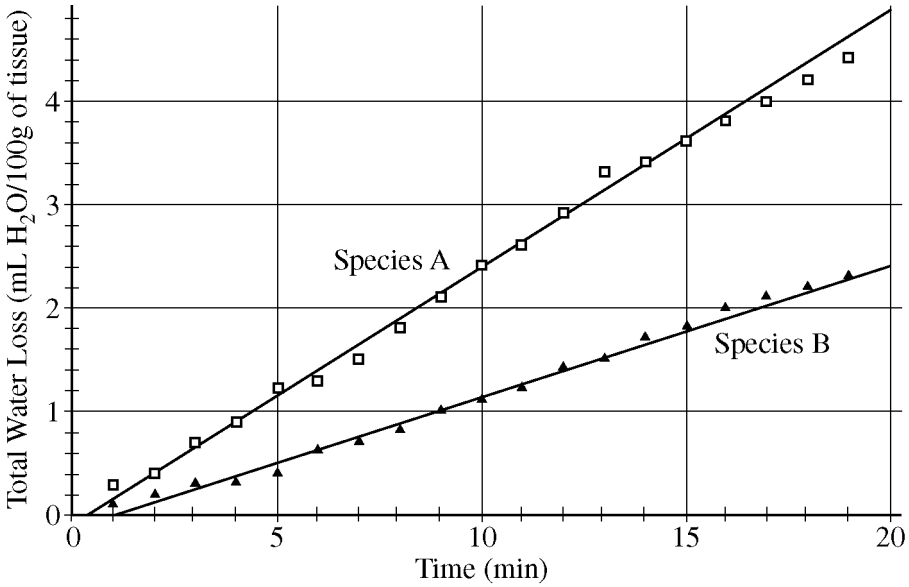
4. The regulation of transpiration is an important homeostatic mechanism in plants.

   (a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.

WATER LOSS VERSUS TIME FOR TWO PLANT SPECIES



   (b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.

   (c) Water potential (Ψ) is described by the following formulas.

$$\Psi = \Psi_p + \Psi_s$$

$$\Psi = -iCRT$$

   Discuss the variables in both formulas and how they affect water potential.

END OF EXAM

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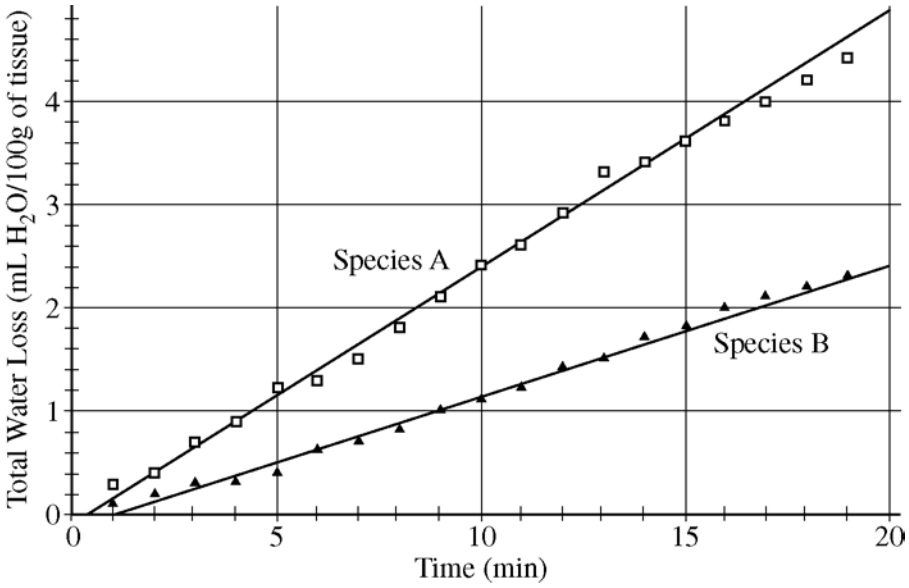
Question 4

The regulation of transpiration is an important homeostatic mechanism in plants.

(a) Under controlled conditions, a transpiration experiment was conducted using two plant species. The data collected are shown in the figure below. Using the data from the experiment, **calculate** the rate of transpiration for species A and species B between the times of 5 and 15 minutes (show your work). **Summarize** the difference between the two transpiration rates.
(3 points maximum)

WATER LOSS VERSUS TIME FOR TWO PLANT SPECIES



- Calculate transpiration rates, with units *(1 point each; 2 points maximum)*.
- Correct setups with incorrect results *(1 point maximum)*.

Species A
(1 point)

$\frac{3.6 \text{ mL } H_2O - 1.2 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

OR

$\frac{3.6 - 1.2}{15 - 5} = 0.24 \text{ mL } H_2O/100g/\text{min } (\pm 0.02)$

OR equivalent

Question 4 (continued)

Species B
(1 point)

$\frac{1.8 \text{ mL } H_2O - 0.4 \text{ mL } H_2O}{15 \text{ minutes} - 5 \text{ minutes}} = 0.14 \text{ mL } H_2O/100g/min \ (\pm 0.02)$

OR

$\frac{1.8 - 0.4}{15 - 5} = 0.14 \text{ mL } H_2O/100g/min \ (\pm 0.02)$

OR equivalent

Summarize the difference between the rates *(1 point).*

- Species A is losing water or transpiring faster than species B.

(b) **Identify** and **explain** THREE different structural or physiological adaptations that could account for the different transpiration rates of species A and B.
(6 points maximum)

Identify adaptation (1 point each; 3 points maximum)	**Explain effect and specify directionality (1 point each; 3 points maximum)**
Cuticle	Thicker cuticle decreases transpiration.
Stomata number	Increased number increases transpiration.
Stomata location	Underside location decreases transpiration.
Stomata size	Larger stomata increase transpiration.
Surface area of leaves	Increased surface area increases transpiration.
Root size or structure	Affects rate of water absorption, amount of water lost.
Root hairs	Increased number increases transpiration.
Leaf hairs	Presence decreases transpiration.
Stomatal crypts or recessed pits	Presence decreases transpiration.
C_3 photosynthesis	Requires more water than C_4.
C_4 photosynthesis: CO_2 concentrated as 4-carbon acid	Requires less water than C_3.
CAM photosynthesis: stomata open at night	Reduced water loss during day.
Abscissic acid	Closes the stomata, slows transpiration.
Guard cell regulation	Turgidity opens stomata, increasing transpiration.

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Question 4 (continued)

(c) Water potential (Ψ) is described by the following formulas.

$$\Psi = \Psi_p + \Psi_s$$

$$\Psi = -iCRT$$

Discuss the variables in both formulas and how they affect water potential.
(4 points maximum)

Variables in $\Psi = \Psi_p + \Psi_s$		**Discussion of effect on water potential (1 point each; 2 points maximum)**
Ψ_p	Pressure potential	Water will move from the area of high pressure to the area of low pressure.
Ψ_s	Solute potential	Water will move from the area of high solute potential (low solute concentration) to the area of lower solute potential (higher solute concentration).

	Variables in $\Psi = -iCRT$	**Discussion of effect on water potential (1 point each; 2 points maximum)**
i	Ionization constant	Greater ionization decreases water potential/increases water movement, OR Decrease in ionization increases water potential/decreases water movement.
C	Concentration	Increase in concentration decreases water potential/increases water movement, OR Decrease in concentration increases water potential/decreases water movement.
R	Pressure constant	No change in water potential/movement.
T	Temperature	Increase in temperature decreases water potential/increases water movement, OR Decrease in temperature increases water potential/decreases water movement.

- Discussion stating that the formula allows osmotic potential or water movement to be calculated or predicted *(1 point).*