Mathematics 172

Quiz 33 Name: Key

You must show your work to get full credit.

Assume that a dolphin in water that is 2°C loses energy through its skin at a rate of 35(cal/m^2)/hr and that it needs to produce energy at a rate of 1.45(cal/kg)/hr to maintain its body temperature of 36°C. A dolphin which is 2 meters long weights 65kg, has a surface area of 1.8m^2, and produces 2(cal/kg)/hr. Use this information to find the length of the smallest dolphin that can maintain its body temperature in 2°C water.

1. If we scale 2 meter dolphin by a factor what are

(a) The scaled weight? $W_\lambda =$ $65\lambda^3$ kg

(b) The scaled surface area? $A_\lambda =$ $1.8\lambda^2$ m^2

(c) The scaled total energy loss per hour? Loss per hour$_\lambda =$ $63\lambda^2$ cal/hr

Loss/hr = (loss/m2)/hr) × Area

$= 35 \times 1.8\lambda^2 = 63\lambda^2$ cal/hr

(d) The scaled loss of energy per kg per hour? $\frac{.9692}{\lambda}$ (cal/kg)/hr

Divide the last result by the weight

$\frac{63\lambda^2}{65\lambda^3} = \frac{.9692}{\lambda}$ (cal/kg)/hr

2. What is the equation for λ which determines the critical scaling factor?

The dolphin needs to produce 1.45(cal/kg)/hr

The equation is $\frac{.9692}{\lambda} = 1.45$

So the equation is $\frac{.9692}{\lambda} = 1.45$ (cal/kg)/hr

3. What is the minimal length of a dolphin in 2°C water?

Length = 1.3368 m

Solving

$\frac{.9692}{\lambda} = 1.45$

giving $\lambda = \frac{.9692}{1.45} = .6684$

for the scaling factor.

So the critical length $\lambda(2) = (.6684)(2) = 1.3368$ m