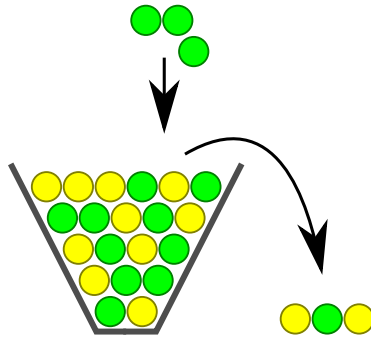


Conservation of limes

A bowl contains 10 limes and 10 lemons. It is noticed that adding three limes to the bowl causes one lime and two lemons to fall out. Find the number of lime additions that are needed to achieve a 'lime fraction' of $\frac{18}{20}$.



Given

- $\chi_{l,out} = \frac{1}{3}$
- $\chi_{l,add} = 1$
- $\chi_{l,initial} = \frac{10}{20}$
- $\chi_{l,final} = \frac{18}{20}$
- $n_{bowl,initial} = n_{bowl,final} = n = 20$
- α is the number of additions
- $n_{add} = 3\alpha$
- $n_{out} = n_{add}$

Solution

Limes in = Limes out

$$n_a \chi_{l,add} + n \chi_{l,initial} = n_o \chi_{l,out} + n \chi_{l,final}$$

$$3\alpha \chi_{l,add} + n \chi_{l,initial} = 3\alpha \chi_{l,out} + n \chi_{l,final}$$

$$3\alpha \chi_{l,add} - 3\alpha \chi_{l,out} = n \chi_{l,final} - n \chi_{l,initial}$$

$$3\alpha (\chi_{l,add} - \chi_{l,out}) = n (\chi_{l,final} - \chi_{l,initial})$$

$$\alpha \underbrace{(3\chi_{l,add} - 3\chi_{l,out})}_1 = n \underbrace{(\chi_{l,final} - \chi_{l,initial})}_2$$

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Consider the meaning of the different parts of this equation:

1. The change in limes per addition
2. Percent change of limes in the bowl between the initial and final states
3. The change in the number of limes in the bowl

Insert values into equation and simplify.

$$\alpha \left(3(1) - 3\left(\frac{1}{3}\right) \right) = n \left(\frac{18}{20} - \frac{10}{20} \right)$$

$$\alpha(3 - 1) = 20 \left(\frac{18}{20} - \frac{10}{20} \right)$$

$$\alpha \underbrace{(2)}_1 = 20 \underbrace{\left(\frac{8}{20}\right)}_2$$

$$2\alpha = \underbrace{8}_3$$

Reconsider the meaning of the different parts of this equation:

1. We get 2 limes per addition
2. There is a 40% increase of limes in the bowl between the initial and final states
3. The number of limes in the bowl increases by 8

Solve for α

$$\alpha = \frac{8}{2} = 4$$

Think about how this problem relates to the salinity mass balance for the fish tank.