

# Rational Models: Understanding Practice 4

**Goal:** Be able to model rational functions in general cases and interpret the model in a meaningful way.

Given the following situations, what are important numbers (constants and variables) that are needed to understand and predict things, and what would we want to predict about the situation?

A. A plane is flying between cities while it is windy.

B. Two heaters are being used to heat a cabin.

C. Two solutions of food colouring are being mixed together.

1. In situation A, I imagined a plane travelling between Vancouver and Calgary (1000 km) and the speed of the plane is 600 km/h if there is no wind. The wind is 100 km/h and the plane flies through the headwind for 400 km and flies through the tailwind on the way back for 500 km. I would want to know how long it takes to make a round trip.

Build an equation to determine the time it would take for a round trip.

2. Generalize this. The plane's speed is  $p$  (km/h), the wind's speed is  $\omega$ , the distance between the cities is  $d$  (km) and the plane flies through the headwind for  $d_H$  (km) and flies through the tailwind for  $d_T$ .

Build an equation for the time it takes to make a round trip

- Use the following situation:  $p = 600$ ,  $d = 1000$ ,  $\partial_H = 500$  and  $\partial_T = 500$  to make an equation for the time  $t$  as a function of the wind speed  $\omega$ .
- What is a reasonable domain for the function?
- Determine the interval of wind speeds that would allow the plane to make the round trip in under 3 hours and 30 minutes.

6. In situation B I imagined a heavy-duty heater that could raise the temperature in the room by  $1^\circ\text{C}$  in 3 minutes and a less impressive heater that could raise the temperature in the room by  $1^\circ\text{C}$  in 20 minutes. I would want to know working together how long would it take to heat the room by  $20^\circ\text{C}$  (something reasonable like from  $-5^\circ\text{C}$  to  $15^\circ\text{C}$ )

How long would it take the heaters working together to heat the room by  $20^\circ\text{C}$ ?

7. Generalize this. The strong heater will raise the temperature by  $1^\circ\text{C}$  in  $\tau_H$  minutes and the weak heater will raise the temperature by  $1^\circ\text{C}$  in  $\tau_h$  minutes. We want to raise the room's temperature by  $T$  degrees Celsius. Make an equation for the time needed  $t$ .

8. Use the following situation:  $T = 20$ ,  $\tau_h = 20$ . Make an equation so your time  $t$  is a function of  $\tau_H$  (the time needed for the heavy-duty heater).

9. What would be a reasonable domain for  $\tau_H$ ?

10. What does  $\tau_H$  need to be in order for the room to gain  $20^\circ\text{C}$  in 30 minutes?

11. In situation C I imagined I had 100mL of a 25% red solution being mixed with 200mL of a 40% solution. I want to know what the concentration of the mixture is.

Determine the concentration of the mixture.

12. Generalize this. You have  $V_0$  litres of a solution of concentration  $c_0$  and add  $V$  litres of a solution of concentration  $c$ . Determine an equation for the concentration of the mixed solution.

13. If  $V_0 = 0.2$  and  $c_0 = 0.25$ , write the concentration of the mixture as a function of  $V$ .

14. What is the horizontal asymptote and what does it represent?

15. If I want a 30% mixture and have an 80% bottle of red. How much of the 80% do I need to add?