**4.1 Direct Variation**

**Minds-On:**

Susan can jog at a steady pace of 150 m/min for the first hour.

|  |  |
| --- | --- |
| **Time** | **Distance** |
| 0 |  |
| 1 |  |
| 2 |  |
| 3 |  |
| 4 |  |
| 5 |  |
| 6 |  |
| 7 |  |
| 8 |  |
| 9 |  |
| 10 |  |

1. Create a table showing the distance that Susan jogs in 0 min, 1 min, 2 min, and so on up to 10 min.
2. Identify the independent variable and the dependent variable.
3. Graph the relation. You can find printable graph paper online or use Desmos.
4. Describe the shape of the graph. Where does it intersect the y-axis?
5. Write an equation to find the distance, $d$, in meters, that Susan jogs in $t$, minutes.
6. Use the equation to determine the distance that Susan can jog in 40 min.
7. Consider the distance Susan jogged in 2 min. What happens to the distance when the time is doubled? Tripled?
8. Trish’s steady pace jogging is 175 m/min. Develop a similar equation for her distance.
9. How much further has Trish ran in 40 min than Susan?

This has been an example of a **direct variation.** The distance varies directly (and only) by time.

Direct variation situations have the following properties:

* They can be written in equation form as $y=mx$, where $m$ is a rate of change
* The graph is a straight line that passes through (or starts) at the origin (0, 0)

**Example 1:**

Ms. Kuhl travelled 250 km to visit a family member. Assume she was able to maintain a constant speed.

1. After 0.5 hours, her daughter asked “How much longer?”. Ms. Kuhl noticed her trip odometer read that they had travelled 43 km. How fast are they travelling?
2. How long will the entire trip take at the pace in part a)?
3. How long should Ms. Kuhl estimate the rest of the trip will take?

**Example 2:**

Adam works part-time at a local bookstore. He earns $7.50/h.

1. Describe the relationship between his pay, in dollars, and the time, in hours, he works. Use an equation.

|  |  |
| --- | --- |
| Hours Worked | Pay |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

1. Illustrate the relationship using a table of values and a graph.
2. One week, Adam works for 9 hours. Find his earnings for that week.

**Example 3:**

Consider the two equations below.

$y=2x+5$ $y=2x$

Graph them using Desmos. Which is an example of direct variation? How do you know?

**Example 4:**

Consider the two equations below.

$y=2x$ $y=3x$

Graph them using Desmos. How are they the same? How are they different?

**Practice 4.1**

1. Determine the rate of change (or constant of variation) for each direct variation.
2. The distance travelled by a car varies directly with time. The car travels 270 km in 3 h. Find the speed of the car in km/h.
3. The distance travelled on a trip varies directly with the amount of gas used. A car travelled 375 km and used 25 litres of gas. Find the distance travelled per litre used.
4. The money earned by an employee varies directly with time. The employee earned $320 in 40 h. Find the pay per hour.
5. The cost, *C,* in dollars, of building a patio varies directly with its width, *w,* in metres.
6. Find an equation relating $C$ and *w* if the cost of building a patio with a width of 4 m is $300.
7. What does the rate of change represent?
8. Use the equation to determine the cost of the patio with a width of 7 m.
9. The total cost of potatoes varies directly with the mass, in kilograms, bought. Potatoes cost $2.18/kg.
10. Create a table of values showing the cost of 0 kg, 1 kg, 2 kg…up to 5kg of potatoes.
11. Graph the relationship.
12. Write an equation for the relationship in the form $y=mx$.
13. A marina charges $9.50 per hour to rent a boat.
14. Determine an equation to represent the cost of renting the boat given time.
15. Use your equation to find the cost to rent for 12 hours.
16. The volume of water in a water tank varies with time. The tank contains 200 L of water after 2 min.
17. Find the rate of change in litres per minute.
18. Write an equation relating the volume of water and time.
19. Graph the relation using pencil/graph paper or technology.
20. What volume of water is in the tank after 30 min?
21. How long will it take to fill a water tank that can hold 100 000 L of water?