

## Objective 3 - Construct Direct and Indirect Variation Models

Link to textbook: [Direct and Indirect Variation](#).

[Video on Direct Variation](#)

[Video on Inverse Variation](#)

[Video on Direct and Inverse Variation](#)

[Video to provide examples from this homework.](#)

Now that we've seen how to recognize whether when we would use direct and inverse variation equations, we'll practice creating the equations. **After you complete the questions in this objective, try to describe the general process to constructing direct and inverse variation equations.**

**Question 1** *Kepler's Third Law: The square of the time,  $T$ , required for a planet to orbit the Sun is directly proportional to the cube of the mean distance,  $a$ , that the planet is from the Sun.*

**Part A.** Write the equation that describes time  $T$  (years) in terms of the mean distance,  $a$  (AUs). Use  $k$  for your constant.

$$T(a) = \boxed{k} a^{\boxed{3/2}}$$

**Part B.** Assume that Mars' mean distance from the Sun is 5 AUs and it takes Mars about 540.47 months to orbit the Sun. Write the equation that describes time  $T$  (years) in terms of the mean distance,  $a$  (AUs).

$$T(a) = \boxed{0.408163265306122 \pi^2} a^{\boxed{3/2}}$$

**Feedback(attempt):** **Part A.** Remember: if you initially had  $c$  as a constant and took it's square root, this is **still** a constant. So we can rebrand it as  $k$ .

**Part B.** Check your units!

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**Question 2** *Ideal Gas Law: The product of pressure,  $P$  (atmospheres), and volume,  $V$  (liters), of a gas is directly proportional to the product of the amount of substance,  $n$  (moles), and temperature,  $T$  (Celsius).*

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Learning outcomes:  
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**Part A.** Write the equation that describes the Ideal Gas Law. Use  $R$  for your constant.

$$\boxed{PV} = \boxed{RTn}$$

**Part B.** Assume that the temperature,  $30C$ , and volume of the gas, 12 liters, remain constant. At 1 atmosphere of pressure, there are 0.048 moles of the gas. Write an equation that describes the pressure on the gas in terms of the amount of the gas.

$$P(n) = \boxed{20.7750000000000}n^{\boxed{1}}$$

**Part C.** Now assume that the pressure, 1 atmospheres, and volume of the gas, 12 liters, remain constant. At  $20C$ , there are 0.072 moles of the gas. Write an equation that describes the temperature of the gas in terms of the amount of the gas.

$$T(n) = \boxed{1.44404332129964}n^{\boxed{-1}}$$

**Question 3** The rate of vibration of a string under constant tension,  $r$  cm/s, varies inversely with the length of the string,  $l$  cm. When the string is 6 mm long, the rate of vibration is 379 cm/s. Write an equation that describes the rate of vibration of a string in terms of the length of the string.

$$r(l) = \boxed{\frac{1137}{5}}l^{\boxed{-1}}$$

**Hint:** Check your units!

**Question 4** The kinetic energy  $K$  (J) of a moving object varies jointly with its mass  $m$  (kg) and the square of its velocity  $v$  (m/s). A 2 ton car traveling at 8 miles per hour has about 11613.32 Joules of kinetic energy. Write an equation that describes the amount of kinetic energy,  $K$  in terms of mass  $m$  and velocity  $v$ .

$$K = \boxed{1/2}m^{\boxed{1}}v^{\boxed{2}}$$

**Feedback(attempt):** On the exam, you would **not** be expected to know the conversions like tons to kg - these will be given on a problem-by-problem basis.