

## Kinematics Problems without Numbers

There are two types of problems without numbers.

1. One gives you two comparable scenarios.
2. The other asks you to calculate a quantity in terms of the givens and knows physical constants.

I. The “Ones Game” for problems with two comparable scenarios.

1. The Regents Exam has a lot of these types of problems, in all topics, not just kinematics.
2. Figure out which equation pertains to the question being asked.
3. Substitute in a ONE for all the variables and all the constants. The answer is one!
4. Now, change the one or more variables that are changed for the second scenario. Keep all other variables and constants equal to one.
5. Resolve. The answer you get is the factor by which the answer changes.
6. This is hard to explain. Let’s do some examples.

### Examples:

1. This one is easy just to get the hang of it. If a car can go  $x$  distance while traveling for  $t$  seconds at speed  $v$ , how far can it go in  $2t$  seconds?
  
  
  
  
  
  
  
  
  
  
2. A car starting from rest moving at constant acceleration attains speed  $v$  after driving  $t$  minutes. With the same acceleration, what is the car’s speed after  $2t$  minutes?

After  $3t$  minutes?

3. A car starting from rest moving at constant acceleration attains speed  $v$  after driving  $x$  meters. With the same acceleration, what is the car’s speed after  $2x$  meters?

4. The stopping distance for a car traveling speed  $v$  is  $x$  meters. If the brakes apply the same friction and the deceleration is the same, what is the stopping distance for a car traveling with speed  $2v$ ?

Traveling  $3v$ ?

5. An object can reach velocity  $v$  after accelerating from rest for time  $t$ . If the acceleration remains the same, what is the velocity after time  $4t$ ?

6. An object can reach velocity  $v$  after accelerating from rest for time  $t$ . If the acceleration is doubled, what is the velocity after time  $2t$ ?

7. A ball falls  $h$  meters in  $t$  seconds. How far will it fall in  $3t$  seconds?

8. A ball reaches a final velocity of  $v$  after falling a height  $x$ . What is its velocity after falling from a height  $2x$ ?

II. Solving problems without numbers in terms of variables and physical constants.

1. The AP Exam has a lot of these problems.
2. Figure out the formula you need to use.
3. Substitute in the variables. Keep the acceleration due to gravity as  $g$ , not the numerical value.

**Examples:**

1. A ball is dropped from rest. What is its speed after falling for  $t$  seconds?
2. A ball is dropped from rest. How far does it fall in  $t$  seconds?
3. A ball is thrown straight up with velocity  $v$ . What maximum height does it achieve in terms of  $v$  and  $g$ ?
4. A car moving at speed  $v$  starts slowing down with acceleration  $-a$ . What is the car's stopping distance?
5. Two objects approach each other from a distance  $X$  apart. Object A is traveling at constant speed  $v_a$ . Object B is traveling at constant speed  $v_b$ . How far from the point at which object A started will they meet?

6. A ball is launched horizontally off a cliff of height  $h$  with an initial velocity  $v_0$ . Derive an expression for the time the ball is in the air.

b. How far from the base of the cliff does the ball land?

Answers:

1.  $2x$
2.  $2v$   
 $3v$
3.  $\text{Rad}(2)v$
4.  $4x$   
 $9v$
5.  $4v$
6.  $4v$
7.  $9h$
8.  $\text{Rad}(2)v$

Part 2:

1.  $V=gt$
2.  $x=1/2 g t^2$
3.  $x= v^2 / 2g$
4.  $x = v^2 / 2a$
5.  $x_a = v_a x / (v_a + v_b)$
6.  $t=\text{rad}(2h/g)$   
b.  $v_o \text{ rad}(2h/g)$
- 7.