PHYSICS IN MOTION
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# Unit 2C
# Acceleration and Kinematic Equations
## *Practice Problems TEACHER*

**Work each of the following problems. SHOW ALL WORK.**

1. **A sports car accelerates from rest to 26.8 m/s (roughly 60 mi/h) in 5.1 seconds. What is the acceleration of the car?**

$v_i = 0\,m/s$
$v_f = 26.8\,m/s$
$t = 5.1s$
$a = ?$

$$v_f = v_i + at$$
$$26.8\,m/s = 0\,m/s + a(5.1s)$$
$$26.8\,m/s = a(5.1s)$$
$$a = 5.25\,m/s^2$$

2. **A child goes down a slide, starting from rest. If the length of the slide is 2 m and it takes the child 3 seconds to go down the slide, what is the child's acceleration?**

$v_i = 0\,m/s$
$d = 2\,m$
$t = 3\,s$
$a = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$2\,m = (0\,m/s)t + \frac{1}{2}a(3\,s)^2$$
$$2\,m = \frac{1}{2}a(9\,s^2)$$
$$4\,m = a(9\,s^2)$$
$$a = 0.44\,m/s^2$$

3. **How far does a sled travel in 5 seconds while accelerating from 4 m/s to 10 m/s?**

$v_i = 4\,m/s$
$v_f = 10\,m/s$
$t = 5\,s$
$d = ?$

$$d = \frac{1}{2}(v_i + v_f)t$$
$$d = \frac{1}{2}(4\,m/s + 10\,m/s)(5\,s)$$
$$d = \frac{1}{2}(14\,m/s)(5\,s)$$
$$d = 35\,m$$

4. **A fighter jet is catapulted off an aircraft carrier from rest to 75 m/s. If the aircraft carrier deck is 100 m long, what is the acceleration of the jet?**

$v_i = 0\,m/s$
$v_f = 75\,m/s$
$d = 100\,m$
$a = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$(75\,m/s)^2 = (0\,m/s)^2 + 2a(100\,m)$$
$$5\,625\,m = 2a(100\,m)$$
$$a = 28.13\,m/s^2$$

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**Work each of the following problems. SHOW ALL WORK.**

5. A driver notices an upcoming speed limit change from 45 mi/h (20 m/s) to 25 mi/h (11 m/s). If she estimates the speed limit will change in 50 m, what acceleration is needed to reach the new speed limit before it begins?

$v_i = 20\,m/s$
$v_f = 11\,m/s$
$d = 50\,m$
$a = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$(11\,m/s)^2 = (20\,m/s)^2 + 2a(50\,m)$$
$$121\,m^2/s^2 = 400\,m^2/s^2 + 2a(50\,m)$$
$$-279\,m^2/s^2 = 2a(50\,m)$$
$$a = -2.79\,m/s^2$$

6. One minute after takeoff, a rocket carrying the space shuttle into outer space reaches a speed of 447 m/s. What was the average acceleration of the rocket during that initial minute?

$v_i = 0\,m/s$
$v_f = 447\,m/s$
$t = 1\,min = 60\,s$
$a = ?$

$$v_f = v_i + at$$
$$447\,m/s = 0\,m/s + a(60\,s)$$
$$447\,m/s = a(60\,s)$$
$$a = 7.45\,m/s^2$$

7. A sprinter accelerates from rest to a velocity of 12 m/s in the first 6 seconds of the 100-meter dash.
   a. How far does the sprinter travel during the first 6 seconds?

$v_i = 0\,m/s$
$v_f = 12\,m/s$
$t = 6\,s$
$d = ?$

$$d = \frac{1}{2}(v_i + v_f)t$$
$$d = \frac{1}{2}(0\,m/s + 12\,m/s)(6\,s)$$
$$d = \frac{1}{2}(12\,m/s)(6\,s)$$
$$d = 36\,m$$

   b. How much farther does the sprinter have to travel to reach the finish line?

*100 m - 36 m = 64 m farther*

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**Work each of the following problems. SHOW ALL WORK.**

**c. If the sprinter travels at a constant velocity of 12 m/s for the last 64 m, how long will it take to reach the finish line?**

$$v = 12\,{}^{m}\!/_{s} \qquad d = 64\,m \qquad t = ?$$

$$v = \frac{d}{t}$$
$$12\,{}^{m}\!/_{s} = \frac{64\,m}{t}$$
$$12\,{}^{m}\!/_{s}(t) = 64\,m$$
$$t = 5.33\,s$$

*To get the total time, add the first 6 seconds to these final 5.33 seconds, for a total of 11.33 seconds.*

**8. The school zone in front of your school has a posted speed limit of 25 mi/h, which is about 11 m/s. Let's examine the stopping of a car in several different situations.**

**a. The crossing guard holds up her stop sign, and the driver is paying attention well. The car moves at a constant velocity of 11 m/s for 2.3 seconds while the driver reacts, then slows down at a constant rate of -4.5 m/s². What is the stopping distance for the car in this situation?**

*While the driver is reacting, the car travels at a constant velocity. The first step will be to determine how far the car travels while the driver is reacting:*

$$v = 11\,{}^{m}\!/_{s} \qquad t = 2.3\,s \qquad d = ?$$

$$v = \frac{d}{t}$$
$$11\,{}^{m}\!/_{s} = \frac{d}{2.3\,s}$$
$$(2.3\,s)(11\,{}^{m}\!/_{s}) = d$$
$$d = 25.3\,m$$

*Next, we must determine how far the car travels while the driver is braking:*

$$v_i = 11\,{}^{m}\!/_{s} \qquad v_f = 0\,{}^{m}\!/_{s} \qquad a = 4.5\,{}^{m}\!/_{s^2} \qquad d = ?$$

$$v_f^2 = v_i^2 + 2ad$$
$$(0\,{}^{m}\!/_{s})^2 = (11\,{}^{m}\!/_{s})^2 + 2(-4.5\,{}^{m}\!/_{s^2})d$$
$$0 = 121\,{}^{m^2}\!/_{s^2} + 2(-4.5\,{}^{m}\!/_{s^2})d$$
$$-121\,{}^{m^2}\!/_{s^2} = 2(-4.5\,{}^{m}\!/_{s^2})d$$
$$-121\,{}^{m^2}\!/_{s^2} = (-9\,{}^{m}\!/_{s^2})d$$
$$d = 13.4\,m$$

*The total distance is the sum of the distance the car travels while the driver is reacting plus the distance the car travels as it slows to a stop. The answer is 38.7 m.*

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**Work each of the following problems. SHOW ALL WORK.**

**b. A child appears to be running into the street ahead. It takes 2.3 seconds for the driver to react and begin to brake, but this time at a rate of -7.5 m/s². What is the stopping distance for the car in this situation?**

*While the driver is reacting, the car travels at a constant velocity. The first step will be to determine how far the car travels while the driver is reacting:*

$v = 11\ m/s$

$t = 2.3\ s$

$d = ?$

$$v = \frac{d}{t}$$
$$11\ m/s = \frac{d}{2.3\ s}$$
$$(2.3\ s)(11\ m/s) = d$$
$$d = 25.3\ m$$

*Next, we must determine how far the car travels while the driver is braking:*

$v_i = 11\ m/s$

$v_f = 0\ m/s$

$a = -7.5\ m/s^2$

$d = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$(0\ m/s)^2 = (11\ m/s)^2 + 2(-7.5\ m/s^2)d$$
$$-121\ m^2/s^2 = 2(-7.5\ m/s^2)d$$
$$-121\ m^2/s^2 = (-15\ m/s^2)d$$
$$d = 8.1 m$$

*The total distance is the sum of the distance the car travels while the driver is reacting plus the distance the car travels as it slows to a stop. The answer is 33.4 m.*

**c. The driver is looking at her phone and has a total reaction time of 4.6 seconds as the car is moving at a constant speed of 11 m/s. If the driver slams on her brakes and slows down at a rate of -8.2 m/s², what is the stopping distance for the car in this situation?**

*While the driver is reacting, the car travels at a constant velocity. The first step will be to determine how far the car travels while the driver is reacting:*

$v = 11\ m/s$

$t = 4.6\ s$

$d = ?$

$$v = \frac{d}{t}$$
$$11\ m/s = \frac{d}{4.6\ s}$$
$$(11\ m/s)(4.6\ s) = d$$
$$d = 50.6\ m$$

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**Work each of the following problems. SHOW ALL WORK.**

*Next, we must determine how far the car travels while the driver is braking:*

$v_i = 11\ m/s$

$v_f = 0\ m/s$

$a = -8.2\ m/s^2$

$d = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$(0\ m/s)^2 = (11\ m/s)^2 + 2(-8.2\ m/s^2)d$$
$$0 = 121\ m^2/s^2 + 2(-8.2\ m/s^2)d$$
$$-121\ m^2/s^2 = 2(-8.2\ m/s^2)d$$
$$-121\ m^2/s^2 = (-16.4\ m/s^2)d$$
$$d = 7.4\ m$$

*The total distance is the sum of the distance the car travels while the driver is reacting plus the distance the car travels as it slows to a stop. The answer is 58 m.*