PHYSICS IN MOTION
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Unit 2E
Free Fall
Practice Problems TEACHER

Answer the following.

1. **A ball is dropped from rest.**
   a. **How fast is the ball going after 3 seconds?**

$v_i = 0\ m/s$
$t = 3\ s$
$a = 9.8\ m/s^2$
$v_f = ?$

$v_f = v_i + at$
$v_f = 0 + (9.8\ m/s^2)(3\ s)$
$v_f = 29.4\ m/s$

   b. **How far has the ball fallen in 3 seconds?**

$v_i = 0\ m/s$
$t = 3\ s$
$a = 9.8\ m/s^2$
$d = ?$

$d = v_i t + \frac{1}{2} a t^2$
$d = (0\ m/s)(3\ s) + \frac{1}{2}(9.8\ m/s^2)(3\ s)^2$
$d = 44.1\ m$

2. **Platform diving in the Olympic games takes place at two heights: 5 meters and 10 meters.**
   a. **What is the velocity of a diver entering the water from each platform if he steps off the platform initially?**

$v_i = 0\ m/s$
$d = 5\ m$
$a = 9.8\ m/s^2$
$v_f = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(9.8\ m/s^2)(5\ m)$
$v_f^2 = 98\ m^2/s^2$
$v_f = 9.9\ m/s$

   b. **How much time does it take the diver to reach the water from each platform?**

$v_i = 0\ m/s$
$d = 10\ m$
$a = 9.8\ m/s^2$
$v_f = ?$

$v_f^2 = v_i^2 + 2ad$
$v_f^2 = 0 + 2(9.8\ m/s^2)(10\ m)$
$v_f^2 = 196\ m^2/s^2$
$v_f = 14\ m/s$

3. **A model rocket is launched straight upward at 58.8 m/s.**
   a. **How long does it take for the rocket to reach its peak height?**

$v_i = 58.8\ m/s$
$v_f = 0\ m/s$
$a = 9.8\ m/s^2$
$t = ?$

$v_f = v_i + at$
$0\ m/s = 58.8\ m/s + (-9.8\ m/s^2)t$
$-58.8\ m/s = (-9.8\ m/s^2)t$
$t = 6.0\ s$

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Answer the following.

b. What is the total time of flight of the model rocket?

If we ignore air resistance, the time on the way down will be the same as the time up, so the total time of flight will be 12 seconds.

c. What is the peak height of the rocket from the ground?

$v_i = 58.8\ m/s$
$v_f = 0\ m/s$
$a = -9.8\ m/s^2$
$d = ?$

$$v_f^2 = v_i^2 + 2ad$$
$$(0\ m/s)^2 = (58.8\ m/s)^2 + 2(-9.8\ m/s^2)d$$
$$0 = 3457.4\ m^2/s^2 + (-19.6\ m/s^2)d$$
$$-3457.4\ m^2/s^2 = (-19.6\ m/s^2)d$$
$$d = 176.4\ m$$

4. In a class experiment to determine information about free-fall acceleration, a watermelon and a pumpkin are each set to fall from the back of the stands at your football stadium.

a. If the watermelon and the pumpkin are both dropped at the same time, which one will hit the ground first?

They will hit the ground at the same time because they have the same initial velocity, the same acceleration, and the same vertical distance to the ground.

b. If the watermelon is thrown downward with an initial speed of 10 m/s and the pumpkin is dropped, which one will hit the ground first?

The watermelon will hit the ground first because it has an initial velocity downward.

c. If it takes the watermelon 1 second to reach the ground when it is thrown downward at 10 m/s, how tall are the stands?

$v_i = 10\ m/s$ *downward*
$t = 1s$
$a = 9.8\ m/s^2$ *downward*
$d = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$d = (10\ m/s)(1s) + \frac{1}{2}(9.8\ m/s^2)(1s)^2$$
$$d = 10\ m + 4.9\ m$$
$$d = 14.9\ m$$

d. How long does it take the pumpkin to reach the ground if it is dropped from this height?

$v_i = 0\ m/s$
$d = 14.9\ m$ *downward*
$a = 9.8\ m/s^2$ *downward*
$t = ?$

$$d = v_i t + \frac{1}{2}at^2$$
$$14.9\ m = (0\ m/s)t + \frac{1}{2}(9.8\ m/s^2)t^2$$
$$14.9\ m = (4.9\ m/s^2)t^2$$
$$t^2 = 3.04\ s^2$$
$$t = 1.74\ s$$

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