ABRHS PHYSICS NAME: KEY

Ball Toss Problems

1. Jan throws a ball straight up in the air with an initial velocity of 20 m/s.
   a. How long will it take the ball to reach its highest point?

$v_i = 20$ m/s, $a = -10$ m/s^2; $v = 0$ @ highest point

$\therefore \quad v = at + v_i \qquad 0 = -10t + 20$

$\boxed{t = 2 \text{ s}}$

   b. What is the average speed of the ball while it goes up?

$v_i = 20$ m/s, $v_f = 0$ m/s

$\bar{v} = \frac{v_i + v_f}{2} \qquad \bar{v} = \frac{20+0}{2}$

$\boxed{\bar{v} = 10 \text{ m/s}}$

   c. What is the maximum height reached by the ball?

$v_i = 20$ m/s, $a = -10$ m/s^2, $t = 2$ s

$y = \frac{1}{2}at^2 + v_{y_i}t$

$y = \frac{1}{2}(-10)(2)^2 + (20)(2)$

$\boxed{y = 20 \text{ m}}$

OR $\bar{v} = 10$ m/s, $t = 2$ s

$d = \bar{v}t$

$d = (10)(2)$

$\boxed{d = 20 \text{ m}}$

   d. How many total seconds is the ball in the air?

time up = time down

$\therefore$ total time = $2 + 2 =$ $\boxed{4 \text{ s}}$

2. Your friend, Cindy, is playing soccer, and you see her kick the ball straight up in the air. It takes 3.5 seconds for the ball to reach its highest point.
   a. What was the initial velocity of the ball?

$t = 3.5$ s (to max), $v = 0$ m/s (max), $a = -10$ m/s^2

$v = at + v_i$

$0 = -10(3.5) + v_i$

$\boxed{v_i = 35 \text{ m/s}}$

   b. What is the maximum height reached by the ball?

$v_i = 35$ m/s, $a = -10$ m/s^2, $t = 3.5$ s

$y = \frac{1}{2}at^2 + v_i t$

$y = \frac{1}{2}(-10)(3.5)^2 + (35)(3.5)$

$y = -61.25 + 122.5$

$\boxed{y = 61.25 \text{ m}}$

   c. What is the total time the ball is in the air?

3.5 s ↑ ↓ 3.5 s $\quad \therefore \quad 3.5 + 3.5 =$ $\boxed{7 \text{ s}}$

   d. What is the velocity of the ball just it reaches the ground again?

Since that is where the ball started, it will be the opposite velocity so $v_f = -v_i =$ $\boxed{-35 \text{ m/s}}$

OR $v_i = 35$ m/s, $a = -10$ m/s^2, $t = 7$ s

$v = at + v_i$

$v = (-10)(7) + 35$

$\boxed{v = -35 \text{ m/s}}$

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3. Greg is playing golf and he accidentally hits the golf ball straight up in the air with an initial velocity of 42 m/s.
   a. How long does it take the ball to reach its highest point?

$v_i = 42$ m/s
$a = -10$ m/s^2
$v = 0$ m/s @ max height

$v = at + v_i$
$0 = -10t + 42$
$t = 4.2$ s

   b. What is the maximum height reached by the ball?

$y = \frac{1}{2}at^2 + v_i t$
$y = \frac{1}{2}(-10)(4.2)^2 + (42)(4.2)$
$y = -88.2 + 176.4$
$y = 88.2$ m

   c. After only 1.5 seconds, what is the velocity of the ball?

$v_i = 42$ m/s
$t = 1.5$ s
$a = -10$ m/s^2

$v = at + v_i$
$v = (-10)(3.5) + 42$
$v = 7$ m/s

   d. What is the acceleration of the ball at its highest point?

-10 m/s^2 (It's always -10 m/s^2 b/c it's just gravity!)

4. Peter throws a pen straight up in the air with some initial velocity. 2.3 seconds later, it has a velocity of 17 m/s.
   a. What was the initial velocity of the pen?

$a = -10$ m/s^2
together [$t = 2.3$ s, $v = 17$ m/s]

$v = at + v_i$
$17 = -10(2.3) + v_i$
$17 = -23 + v_i$
$v_i = 40$ m/s

   b. What is the maximum height reached by the pen.

$v_i = 40$ m/s
$a = -10$ m/s^2
$v = 0$ m/s @ max

Need time to max 1st.
$v = at + v_i$
$0 = -10t + 40$
$t = 4$ s

then $y = \frac{1}{2}at^2 + v_i t$
$y = \frac{1}{2}(-10)(4)^2 + (40)(4)$
$y = -80 + 160$
$y = 80$ m

   c. What is the velocity of the pen 6 seconds after it was thrown?

$v_i = 40$ m/s
$a = -10$ m/s^2
$t = 6$ s

$v = at + v_i$
$v = (-10)(6) + 40$
$v = -60 + 40$
$v = -20$ m/s

it's coming back down!

Ball Toss Problems

5. Marsha tosses a football straight up in the air, and then catches it 5 seconds later. (She catches it at the same height from which it was tossed.)
   a. How many seconds does it take the ball to reach its maximum height?

Since time to max height is $\frac{1}{2}$ total time

$\frac{5}{2} =$ **2.5 s**

   b. What was the initial velocity of the ball?

$v = 0$ @ max
$a = -10\ m/s^2$
$t = 2.5$ to max

$v = at + v_i$
$0 = -10(2.5) + v_i$
$v_i = 25\ m/s$

   c. What was the maximum height of the ball?

$v_i = 25\ m/s$
$a = -10\ m/s^2$
$t = 2.5\ s$

$y = \frac{1}{2}at^2 + v_i t$
$y = \frac{1}{2}(-10)(2.5)^2 + (25)(2.5)$
$y = -31.25 + 62.5$
$y = 31.25\ m$

6. Bobby tosses a stuffed animal straight up in the air, and then catches it 3.2 seconds later. What is the maximum height reached by the stuffed animal?

① Total time = 3.2 sec.
∴ t to max = **1.6 s**
$v = 0\ m/s$ @ max
$a = -10\ m/s^2$

② $v = at + v_i$
$0 = -10(1.6) + v_i$
$v_i = 16\ m/s$

③ $y = \frac{1}{2}at^2 + v_i t$
$y = \frac{1}{2}(-10)(1.6)^2 + (16)(1.6)$
$y = -12.8 + 25.6$
$y = 12.8\ m$

7. Alice has a tennis ball that she throws straight up. The tennis ball reaches a maximum height of 30 meters above its release point.
   a. How long would it take the tennis ball to fall back down from its maximum height?

$v_i = 0\ m/s$ if dropped
$a = -10\ m/s^2$
$y = -30\ m$ (went down)

$y = \frac{1}{2}at^2 + v_i t$
$-30 = \frac{1}{2}(-10)t^2$
$-30 = -5t^2$
$t^2 = 6$
$t = 2.45\ s$

   b. So how long did it take the ball to reach this maximum height?

time up = time down,
So **2.45 s**

   c. What was the initial velocity of the ball?

Now throwing ball up:
$v_i = ?$
$a = -10\ m/s^2$
$v = 0\ m/s$ @ top

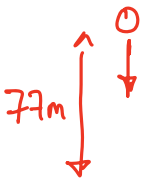
$v = at + v_i$
$0 = -10(2.45) + v_i$
$v_i = 24.5\ m/s$

$t = 2.45\ s$

ABRHS PHYSICS NAME: _____

Ball Toss Problems

8. A rock is fired <u>down</u> off a cliff that is 77 meters high with some initial speed. After 3.2 seconds it hits the ground. What was its initial velocity?



$v_i = ?$

$y_i = 77\ m$

$a = -10\ m/s^2$

$t = 3.2\ s$ for $y = 0$

$$y = \frac{1}{2}at^2 + v_i t + y_i$$

$$0 = \frac{1}{2}(-10)(3.2)^2 + v_i(3.2) + 77$$

$$-25.8 = 3.2\,v_i$$

$$v_i = -8.06\ m/s$$

Answers:

1. a) 2 s b) 10 m/s c) 20 m d) 4 s

2. a) 35 m/s b) 61.3 m c) 7 s d) –35 m/s

3. a) 4.2 s b) 88.2 m c) 27 m/s d) –10 m/s²

4. a) 40 m/s b) 80 m c) –20 m/s

5. a) 2.5 s b) 25 m/s c) 31.25 m

6) 12.8 m

7. a) 2.45 s b) 2.45 s c) 24.5 m/s

8) –8.1 m/s