1. The movie “The Gods Must be Crazy” begins with a pilot dropping a bottle out of an airplane. It is recovered by a surprised native below, who thinks it is a message from the gods. If the plane from which the bottle was dropped was flying at an altitude of 500.0 m, and the bottle lands at 400 m horizontally from the initial dropping point, how fast was the plane flying when the bottle was released?



2. Tad drops a cherry pit out the car window 1.0 m above the ground while traveling down the road at 18 m/s.

a. How far, horizontally, from the initial dropping point will the pit hit the ground?

b. Draw a picture of the situation.

c. If the car continues to travel at the same speed, where will the car be in relation to the pit when it lands?



3. Ferdinand the Frog is hopping from lily pad to lily pad in search of a good fly for lunch. If the lily pads are spaced 2.4 m apart, and Ferdinand jumps with a speed of 5.0 m/s, taking 0.60 s to go from lily pad to lily pad, at what angle must Ferdinand make each of his jumps?

4. At her wedding, Jennifer lines up all the single females in a straight line away from her in preparation for the tossing of the bridal bouquet. She stands Kelly at 1.0 m, Kendra at .5 m, Mary at 2.0 m, Kristen at 2.5 m, and Lauren at 3.0 m Jennifer turns around and tosses the bouquet behind her with a speed of 3.9 m/s at an angle of 50.0° to the horizontal, and it is caught at the same height 0.60 s later.

a. Who catches the bridal bouquet?

b. Who might have caught it she had thrown it more slowly?

5. At a meeting of physics teacher in Montana, the teachers were asked to calculate where a flour sack would land if dropped from a moving airplane. The plane would be moving horizontally at a constant speed of 60.0 m/s at an altitude of 300 m.

a. If one of the physics teachers neglected air resistance while making his calculation, how far horizontally from the dropping point would he predict the landing?

b. Draw a sketch that shows the path the flour sack would take as it falls to the ground (from the perspective of the observer on the ground and off to the side).



6. Jack be Nimble, Jack be quick, Jack jumped over the candlestick with a velocity of 5.0 m/s at an angle of 30.0° to the horizontal. Did Jack burn his feet on the 0.25 m high candle?

7. Suppose a car drove horizontally off a cliff and landed 130 m away and was in the air for 5 seconds (ignore air resistance).

a. What was the initial velocity of the car?

b. How fast was the car going when it hit the ground?

8. Jane drives her remote control Ferrari horizontally off a cliff at 17 m/s. It falls for 4.5 seconds and hits the ground (ignore air resistance).

a. What was the height of the cliff?

b. How far from the base of the cliff did the Ferrari land?

c. What was the Ferrari’s velocity as it hits the ground?

9. An airplane flies horizontally at 150 m/s. Ignoring air resistance, if the airplane drops a package which takes 4.6 seconds to fall, then

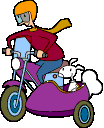
a. How far does the plane travel before the package hits the ground?

b. How far does the package move horizontally?

c. How far does the package fall vertically?

d. Where is the plane relative to the package when the package lands?

e. What is the package’s velocity as it hits the ground?

10. Evel Knievel, a famous former daredevil, is at it again. Now he is trying to jump over the river at the base of the Niagara Falls. He builds a ramp of 35°. He rides his sooped-up motorcycle really fast and hits the jump. At 3 seconds, he hits the peak of his path.

a. How long is Evel in the air (assuming he makes the jump across the river and ignoring air resistance)?

b. What is the initial vertical velocity of Evel?

c. What is the horizontal velocity of Evel?

d. How far does Evel jump?

11. A water balloon is launched at an initial velocity of 15 m/s at various angles. Fill in the chart below (ignore air resistance):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Angle  (°) | Vx  (m/s) | Viy  (m/s) | tpeak  (s) | ttotal  (s) | ∆X  (m) |
| 15 |  |  |  |  |  |
| 30 |  |  |  |  |  |
| 45 |  |  |  |  |  |
| 60 |  |  |  |  |  |
| 75 |  |  |  |  |  |
| 90 |  |  |  |  |  |

a. At what angle does the balloon go the farthest?

b. Compare the angles that add up to 90°. What do you notice about their displacements?

ANSWERS

1. The movie “The Gods Must be Crazy” begins with a pilot dropping a bottle out of an airplane. It is recovered by a surprised native below, who thinks it is a message from the gods. If the plane from which the bottle was dropped was flying at an altitude of 500.0 m, and the bottle lands at 400 m horizontally from the initial dropping point, how fast was the plane flying when the bottle was released?

Vx

dy

dx

@

dy = 500.0 m dx = 400 m

dy = vit + ½ gt2 … vi (y) = 0

… rearrange to t = √(2d/g)

t = √(2)(500 m)/(10 m/*s*2*) = 10 s*

*Vx = d/t = 400 m/10 s = 40 m/s*

2. Tad drops a cherry pit out the car window 1.0 m above the ground while traveling down the road at 18 m/s.

a. How far, horizontally, from the initial dropping point will the pit hit the ground?

dy = 1.0 m Vx = 18 m/s

dy = vit + ½ gt2 … vi (y) = 0 … rearrange to t = √(2d/g)

t = √(2)(1 m)/(10 m/*s*2*) = 0.45 s*

*Vx = d/t …rearrange to d = Vx t = (18 m/s)(0.45 s) = 8.1 m*

Vx

dy

dx

@

b. Draw a picture of the situation.

c. If the car continues to travel at the same speed, where will the car be in relation to the pit when it lands?

*The car will be directly over the pit when it lands (assume no air resistance) because the pit and the car were both traveling at 18 m/s when the pit dropped.*

3. Ferdinand the Frog is hopping from lily pad to lily pad in search of a good fly for lunch. If the lily pads are spaced 2.4 m apart, and Ferdinand jumps with a speed of 5.0 m/s, taking 0.60 s to go from lily pad to lily pad, at what angle must Ferdinand make each of his jumps?

Vi

Vy

Vx

@

dx

dy

Vi

@

Vy

dx = 2.4 m / 2 = 1.2 m

dy = vit + ½ gt2 = 0 + ½ (10 m/*s*2*)(0.3 s)*2 *= 0.45 m … (take ½ of the hang time)*

Tan @ = dy/dx … rearrange to @ = tan-1 (dy/dx) = tan-1 (0.45 m / 1.2 m) = 20°

*Confirmation*

*Vy = davg/t =* (0.45 m - 0*)(0.3 s) = 1.5 m/s Vx = d/t = 1.2 m / 0.3 s = 4 m/s*

Tan @ = Vy/Vx … rearrange to @ = tan-1 (Vy/Vx) = tan-1 (1.5 m/s / 4 m/s) = 20°

4. At her wedding, Jennifer lines up all the single females in a straight line away from her in preparation for the tossing of the bridal bouquet. She stands Kelly at 1.0 m, Kendra at .5 m, Mary at 2.0 m, Kristen at 2.5 m, and Lauren at 3.0 m Jennifer turns around and tosses the bouquet behind her with a speed of 3.9 m/s at an angle of 50.0° to the horizontal, and it is caught at the same height 0.60 s later.

a. Who catches the bridal bouquet?

Vi

Vy

Vx

50°

b. Who might have caught it she had thrown it more slowly?

Vi = 3.9 m/s t = 0.6 s

Cos 50° =Vx/Vi … rearrange to Vx = Vi cos 50° = 2.5 m/s

Vx = dx/t … rearrange to *dx* = Vx t = 2.5 m/s x 0.6 s = *1.5 m*

1.5 m

1.0 m

*Kendra catches the bouquet (1.5 m)*

5. At a meeting of physics teacher in Montana, the teachers were asked to calculate where a flour sack would land if dropped from a moving airplane. The plane would be moving horizontally at a constant speed of 60.0 m/s at an altitude of 300 m.

a. If one of the physics teachers neglected air resistance while making his calculation, how far horizontally from the dropping point would he predict the landing?

Vx

dy

dx

@

dy = 500.0 m dx = 400 m

dy = vit + ½ gt2 … vi (y) = 0

… rearrange to t = √(2d/g)

t = √(2)(300 m) / (10 m/*s*2*) = 7.7 s*

Vx = dx/t … rearrange to *dx* = Vx t = 60.0 m/s x 7.7 s = *462 m*

b. Draw a sketch that shows the path the flour sack would take as it falls to the ground (from the perspective of the observer on the ground and off to the side).

Vx

dy

dx

airplane

6. Jack be Nimble, Jack be quick, Jack jumped over the candlestick with a velocity of 5.0 m/s at an angle of 30.0° to the horizontal. Did Jack burn his feet on the 0.25 m high candle?

Vi

Vy

Vx

30°

Sin 30° = Vy/Vi

Vy = Vi sin 30 = 2.5 m/s

Vi

dy

30°

Vi = 5 m/s candle (dy) = 0.25 m

*Vy = gt … rearrange to t = Vy / g = 2.5 m/s /* 10 m/*s*2 *= 0.25 s*

dy = vit + ½ gt2 = 0 + ½ (10 m/*s*2*)(0.25 s)*2 *= 0.31 m*

*The candle is only 0.25 m tall, so Jack did jump over the candlestick*

7. Suppose a car drove horizontally off a cliff and landed 130 m away and was in the air for 5 seconds (ignore air resistance).

a. What was the initial velocity of the car?

*Vx = dx/t = 130 m / 5 s = 26 m/s*

b. How fast was the car going when it hit the ground?

*Vy = gt =* (10 m/*s*2*)(5 s) = 50 m/s*

8. Jane drives her remote control Ferrari horizontally off a cliff at 17 m/s. It falls for 4.5 seconds and hits the ground (ignore air resistance).

a. What was the height of the cliff?

Vx = 17 m/s

dy

dx

dy = vit + ½ gt2 … vi (y) = 0

dy = ½ gt2

dy = ½ (10 m/*s*2*)(4.5 s)*2 *= 101.25 m*

b. How far from the base of the cliff did the Ferrari land?

Vx = dx/t … rearrange to *dx* = Vx t = 17 m/s x 4.5 s = *76.5 m*

c. What was the Ferrari’s velocity as it hits the ground?

*Vy = gt =* (10 m/*s*2*)(4.5 s) = 45 m/s*

9. An airplane flies horizontally at 150 m/s. Ignoring air resistance, if the airplane drops a package which takes 4.6 seconds to fall, then

a. How far does the plane travel before the package hits the ground?

Vx = 150 m/s

dy

dx

Vx = dx/t … rearrange to *dx* = Vx t

*dx* = 150 m/s x 4.6 s = *690 m*

b. How far does the package move horizontally?

Vx = dx/t … rearrange to *dx* = Vx t = 150 m/s x 4.6 s = *690 m*

c. How far does the package fall vertically?

dy = vit + ½ gt2 … vi (y) = 0

dy = ½ gt2

dy = ½ (10 m/*s*2*)(4.6 s)*2 *= 105.8 m*

d. Where is the plane relative to the package when the package lands?

*The plane is directly over where the package lands because both began at the same velocity (150 m/s in the same direction)*

e. What is the package’s velocity as it hits the ground?

*Vy =gt =* (10 m/*s*2*)(4.6 s) = 46 m/s*

10. Evel Knievel, a famous former daredevil, is at it again. Now he is trying to jump over the river at the base of the Niagara Falls. He builds a ramp of 35°. He rides his sooped-up motorcycle really fast and hits the jump. At 3 seconds, he hits the peak of his path.

a. How long is Evel in the air (assuming he makes the jump across the river and ignoring air resistance)?

*It takes 3 s to reach the highest point, and therefore, 3 s to return to the ground. The total time would be 6 s (hang time).*

b. What is the initial vertical velocity of Evel?

Vi

Vy

Vx

35°

*To find Vi, you need to find the component*

*velocity, Vy, using Vy = gt*

*Vy =gt =* (10 m/*s*2*)(3 s)= 30 m/s*

c. What is the horizontal velocity of Evel?

Tan 35° = Vy / Vx … rearrange to Vx = Vy / Tan 35° = 42.9 m/s

d. How far does Evel jump?

Vx = dx/t … rearrange to *dx* = Vx x t = 42.9 m/s x 6 s = *257.4 m*

Use hang time (2t)

11. A water balloon is launched at an initial velocity of 15 m/s at various angles. Fill in the chart below (ignore air resistance):

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Angle  (°) | Vx  (m/s) | Viy  (m/s) | tpeak  (s) | ttotal (s)  hang time | ∆X (m)  [dx] |
| 15 | 14.5 | 3.9 | 0.39 | 0.78 | 11.3 |
| 30 | 13.0 | 7.5 | 0.75 | 1.5 | 19.5 |
| 45 | 10.6 | 10.6 | 1.1 | 2.2 | 23.3 |
| 60 | 7.5 | 13 | 1.3 | 2.6 | 19.5 |
| 75 | 3.9 | 14.5 | 1.45 | 2.9 | 11.3 |
| 90 | 0 | 15 | 1.5 | 3.0 | 0 |

Vi

Viy

Vx

@

dx

dy

Vi

@

Vx 🡪 cos@ = Vx/Vi … rearrange to Vx = Vi cos @

Viy 🡪 sin@ = Viy/Vi … rearrange to Viy = Vi sin @

tpeak 🡪 Viy = gt … rearrange to t = Viy / g

∆X = dx 🡪 Vx = dx/t … rearrange to dx = Vx ttotal

a. At what angle does the balloon go the farthest?

*An initial angle of 45*° *sends the balloon the farthest*

b. Compare the angles that add up to 90°. What do you notice about their displacements?

*15° and 75° have the same displacement & 30° and 60° have the same displacement*