Projectiles in 2D

Type 1

1. A rock is thrown horizontally from the top of a cliff 98 m high, with a horizontal speed of 27 m/s.

1. For what interval of time is the rock in the air? **Use d=vit+1/2at2 to find that t=4.47 s**
2. How far from the base of the cliff does the rock land? **121 m**
3. With what velocity does the rock hit? **51.5 m/s**

2. A rescue pilot wishes to drop a package of emergency supplies so that it lands as close as possible to a target. If the plane travels with a velocity of 81 m/s and is flying 125 m above the target, how far away (horizontally) from the target must the rescue pilot drop the package? **It will take 5.05 s to fall 125 m (use d = vit+1/2at2), therefore the package must be dropped 5.05 s before the plane flies over its target. Hence, the distance away is d = vxt = 81 x 5.05 = 409 m**

3. A bullet is fired with a horizontal velocity of 330 m/s from a height of 1.6 m above ground. Assuming the ground is level how far from the gun will the bullet hit the ground? **First determine the time for the bullet to drop straight to the ground (use d = vit+1/2at2) which is 0.57 s. The bullet therefore must travel 188 m in that 0.57 s.**

4. A fireman is standing on top of a building 20.0 m high. He finds that if he holds the hose so that water issues from it horizontally at 12 m/s, the water will hit a burning wall of an adjacent building at a height of 15.0 m above the ground. What is the horizontal distance from the fireman to the building? **12.1 m**

Type 2

5. An earth bound golfer strikes a golf ball giving it a velocity of 48 m/s at an angle of 50˚ to the horizontal.

1. What are the vertical and horizontal components of the ball's initial velocity? **vx = 30.9 m/s and vy =36.8 m/s**
2. How long is the ball in the air? **7.51 s**
3. What is the horizontal distance covered by the ball while in flight? **232 m**
4. What velocity does the ball have at the top of its trajectory?

6. A golf ball was struck from the first tee at Lunar Golf and Country Club. It was given a velocity of 48 m/s at an angle of 40˚ to the horizontal. On the moon, agravity = -1.6 m/s2.

1. What are the vertical and horizontal components of the ball's initial velocity? **vx = 36.8 m/s and vy =30.9 m/s**
2. For what interval of time is the ball in flight? **38.6 s**
3. How far will the ball travel horizontally? **1420 m**

7. An archer standing on the back of a pickup truck moving at 28 m/s fires an arrow straight up at a duck flying directly overhead. The archer misses the duck! The arrow was fired with an initial velocity of 49 m/s relative to the truck.

1. For how long will the arrow be in the air? **Only the vy matters … 10.0 s**
2. How far will the truck travel while the arrow is in the air? **280 m**
3. Where, in relation to the "duckless" archer, will the arrow come down? Will the archer have to 'duck'? **The arrow should come straight back into the truck (theoretically right back to the archer)**

8. A ball is thrown with a velocity of 24 m/s at an angle of 30˚ to the horizontal.

1. What are the vertical and horizontal components of the initial velocity? **vx = 20.8 m/s and vy = 12 m/s**
2. How long is the ball in the air? **2.45 s**
3. How far away will the ball land? **51.0 m**
4. To what maximum height will the ball rise? **7.35 m**
5. With what velocity will the ball land? **24 m/s 30˚ from the horizontal**

9. A youngster hits a baseball giving it a velocity of 22 m/s at an angle of 62˚ with the horizontal. How far will the ball travel before it is caught by a fielder (assuming the fielder catches the ball at the same height that it is hit)? **tflight = 3.96 s therefore d = 40.9 m**

10. On level ground, a football is thrown up at a certain angle. The ball is in the air 2.0 s and strikes the ground 30.0 m from the thrower. What was the ball's total initial velocity? **The time for the ball to go upwards to the top of its trajectory must be 1.0 s so viy = 9.8 m/s,** **vx = 15 m/s (based upon how far it traveled in 2.0 s). Finding the resultant vector, v = 17.9 m/s at an angle of 33.2˚ to the horizontal.**

Type 3

11. A pebble is fired from a slingshot with a velocity of 30 m/s. It is fired at an angle of 30˚ to the horizontal. If its flight is interrupted by a vertical wall 12 m away, at what height does it hit the wall? **Since vx = 26.0 m/s, the time that the pebble would hit the wall would be 0.46 s after launch, using d = vit+1/2at2, the distance traveled upwards would be 5.86 m.**

12. A diver takes off with a speed of 8.0 m/s from a 3.0 m high diving board at 30˚ above the horizontal. How much later does she strike the water? **Use d = vit+1/2at2, the displacement is –3.0 m and vy = +4.0 m/s, solve the quadratic equation using quad formula to find t = 1.29 s**

13. A pilot cuts loose two fuel tanks in an effort to gain altitude. At the time of release, the plane was 120 m above the ground and traveling upward at 30˚ to the horizontal, with a speed of 84 m/s. For how long did the tanks fall and with what speed did they hit the ground? **The tanks would have vx = 72.7 m/s and vy =42.0 m/s, use d = vit+1/2at2 to find t (solve the quadratic). Time is 10.8 s. Since the viy = 42 m/s, find vfy = 63.8 m/s using vf = vi +at. The resultant velocity is 96.7 m/s.**

1) a. 4.5 s b. 120 m c. 51 m/s 58o below horizontal 2) 410 m 3)190 m 4) 12 m

5) a. vx = 31 m/s vyo = 37 m/s b. 7.5 s c. 230 m d. 31 m/s

6) a. vx = 37 m/s vyo = 31 m/s b. 39 s c. 1400 m

7) a. t = 10s b. dx = 280 m c. yes

8) a. vx = 21 m/s vyo = 12 m/s b. t = 2.4 s c. dx = 51 m d. dy = 7.3 m e. 24 m/s 30o below horizontal

9) dx = 41 m

10) v = 18 m/s 33o above horizontal

11) dy = 5.9 m

12) t = 1.3 s

13) t = 11s, v = 97 m/s