Free Fall Estimations – Answer Key

Estimate answers to the free fall questions below using \( g = -10 \text{ m/s}^2 \). Assume that there is no air resistance and that up is the positive direction.

1. A brick falls off a bridge. What is its velocity
   a) after one second? \(-10 \text{ m/s}\)
   b) after two seconds? \(-20 \text{ m/s}\)
   c) after six seconds? \(-60 \text{ m/s}\)

2. If it weren’t for air resistance, raindrops would be dangerous! If a raindrop initially at rest in a cloud fell freely for 16 seconds, how fast would it be going when it hit you? \(-160 \text{ m/s}\)

3. A ball is thrown straight up off the edge of a cliff with an initial velocity of 30 m/s. What is its velocity
   a) after one second? \(20 \text{ m/s}\)
   b) after three seconds? \(0 \text{ m/s}\)
   c) after four seconds? \(-10 \text{ m/s}\)
   d) after six seconds? \(-30 \text{ m/s}\)

4. At time \( t = 0 \text{ seconds} \), a ball is thrown upwards off a cliff with some initial velocity. It reaches its highest height after two seconds. What is its velocity
   a) at \( t = 2 \text{ seconds} \)? \(0 \text{ m/s}\)
   b) at \( t = 1 \text{ second} \)? \(10 \text{ m/s}\)
   c) at \( t = 6 \text{ seconds} \)? \(-40 \text{ m/s}\)
   d) at \( t = 0 \text{ seconds} \)? \(20 \text{ m/s}\)

5. A bullet is fired straight up with a velocity of 300 m/s. What is its velocity
   a) three seconds after it reaches the top of its path? \(-30 \text{ m/s}\)
   b) three seconds before it reaches the top of its path? \(30 \text{ m/s}\)

6. A cannonball is fired straight up. It hits the ground 10 seconds later.
   a) When does the cannonball have zero velocity? \( t = 5 \text{ sec} \)
   b) What was the cannonball’s initial velocity? \(50 \text{ m/s}\)
7. An arrow is shot straight up at +40 m/s.
   a) When will it reach its highest height? at \( t = 4 \text{ sec} \)
   b) How long will it be in the air? \( 8 \text{ sec} \)

8. Superman throws a chocolate-covered peanut into the air and catches it in his mouth 6 seconds later.
   a) How fast did he throw the peanut? \( 30 \text{ m/s} \)
   b) What if Superman is on Planet Krypton, where \( g = -15 \text{ m/s}^2 \)? \( 45 \text{ m/s} \)
   c) What if Superman is on the moon, where \( g \) is approximately \( -2 \text{ m/s}^2 \)? \( 6 \text{ m/s} \)

9. A robber is making his getaway on the roof of a skyscraper. He fires a bullet straight down with a velocity of -250 m/s, and at the same instant he drops his bag of loot. One second later . . .
   a) What are the velocities of the loot and bullet? \( -10 \text{ m/s} \quad -260 \text{ m/s} \)
   b) What are the accelerations of the loot and bullet? \( -10 \text{ m/s}^2 \quad -10 \text{ m/s}^2 \)

10. A monkey in a tree has two caps. He throws the blue cap straight up with a velocity of +10 m/s and he throws the red cap straight down with a velocity of -10 m/s. The red cap hits the ground 2 seconds later.
    a) How fast is the red cap going when it reaches the ground? \( -30 \text{ m/s} \)
    b) How long is the blue cap in the air? \( 4 \text{ sec} \)
    c) Which cap is going the fastest when it hits the ground? red, blue or same? \( \text{same speed} \)

11. Ball A is thrown straight up from the origin with some initial speed.
    Ball B is thrown straight down from the origin with the same initial speed.
    Which pair of profiles for the two balls will be identical?
    A. The displacement profiles
    B. The velocity profiles
    C. The acceleration profiles
    D. None of the profiles pairs will be identical.

12. Sketch the velocity profile for Ball A, thrown straight up.