Free Fall Equations … Set 1

1) A stone is dropped from the top of a cliff. It is seen to hit the ground below after 3.50 s. How high is the cliff? [60.0 m]

2) Calculate how long it took King Kong to fall straight down from the top of the Empire State Building (380 m high). What was his velocity just before "landing"? [8.81 s; 86.3 m/s]

3) A car rolls gently ($v_0 = 0$) off a vertical cliff. How long does it take to reach a speed of 90 km/hr? [2.6 s]

4) A foul ball is hit straight up into the air with a speed of 25 m/s. (a) How high does it go? [31.9 m] (b) How long is it in the air, that is, how long does it take to go up and come back down again? [5.1 s]

5) A ball is thrown vertically downward with a velocity of 15 m/s from the roof of a building that is 22 m high. How long does it take to hit the ground below? How fast was it going when in hit? [1.08 s; 25.6 m/s]

6) A ball is thrown vertically upward with a velocity of 15 m/s from the roof of a building that is 22 m high. How long does it take to hit the ground below? How fast was it going when in hit? [4.14 s; 25.6 m/s]

7) A ball player catches a ball 3.3 s after throwing it vertically upward. With what speed did he throw it, and what height did it reach? [16.2 m/s; 13.3 m]

8) A coin is tossed vertically upward and reaches a maximum height of 0.90 m before it comes back down. With what velocity was it thrown, and how long was it in the air? [4.2 m/s; 0.86 s]

9) The best rebounders in basketball have a vertical leap (that is, the vertical movement of a fixed point on their body) of about 120 cm.
(a) What is their initial "launch" speed off the ground? [4.85 m/s]
(b) How long are they in the air? [0.99 s]

10) An arrow is shot straight up with an initial velocity of 50 m/s.
(a) Find the time to reach the highest point. [5.1 s]
(b) How high does the arrow go? [127.6 m]
(c) Find the arrow's height when the velocity is 25 m/s. [95.7 m]

11) An arrow is shot vertically upward from the top edge of a 300 m cliff with a speed of 50 m/s, and it just misses the edge on the way down. What is its speed when it hits the base of the cliff? [91.5 m/s]

12) A mischievous Padua student is standing next to the school building when he grabs his girlfriend's purse and throws it up onto the roof. (He's really sweet on her and this is how he shows his affection!) He throws the purse with an initial upward velocity of 16.5 m/s. The roof is 11.0 m high. How long was the purse in flight? [2.45 s]

13) The acceleration due the gravity on the Moon is $1/6^{th}$ of what it is on Earth. If you can throw a baseball on Earth to reach a maximum height of 20 m, how high could you throw a baseball on the Moon? [120 m] If you caught it when it came back down, how much time would elapse between your throw and catch? [12.1 s]

Free Fall Equations … Set 1

Challenge Problems:

14) A girl, standing still, tosses a ball vertically upwards. One second later she tosses up another ball at the same velocity. The balls collide 0.5 s after the second ball is tossed. With what velocity were they tossed? [9.8 m/s]

15) A brick is dropped from the roof of a building. On the way down it passes a 2 m high window and is observed to pass from the top to the bottom of the window in 0.25 s. (a) How fast was it moving when it passed the top of the window? [6.8 m/s] (b) How far below the roof of the building is the top of the window? [2.3 m]

16) A rocket is launched vertically. It burns its fuel in 4.5 s. and while it is burning fuel it accelerates upward at a rate of 15.5 m/s^2. What maximum height off the ground does the rocket reach? [405.1 m] What is its total flight time? [20.7 s]

17) A blue ball is thrown upward with a velocity of 9 m/s upward from the top of a high cliff. At the same time, a red ball is dropped from the same spot. The red ball is observed to hit the ground below exactly one second before the blue ball. How high is the cliff? [128.7 m]

18) A ball is dropped off a high cliff, and 2 s later another ball is thrown vertically downward with an initial speed of 30 m/s. How long will it take the second ball to overtake the first? [1.88 s]