**D = ½ g t2 or D = ½ a t2**

1. What is meant by a “freely falling” object?

2. The acceleration of free-fall is about 10 m/s2. Why does the “seconds” unit appear twice?

3. For a freely falling object dropped from rest, how far will it fall after three seconds? How far will it fall after six seconds?

4. You throw a ball into the air and it reaches a height of 31.25 meters. It takes 2.5 seconds for the ball to fall back to the ground. What is the acceleration in m/s2 of the ball from the highest point it reached to the ground?

5. An arrow is shot straight up in the air with an initial speed of 1.6 x 102 m/s. How high does it go if it takes 0.46 x 101 s to reach that point? (Neglect air resistance)

6. A climber near the summit of a vertical cliff accidentally knocks loose a large rock. She sees it shatter at the bottom of the cliff 8 seconds later. How high is she when she hits the rock?

7. Using question 6, what was the speed of impact when the rock shattered on the ground?

8. Very few athletes can jump more than (0.6 m) high (*2 feet*). How much time does an athlete spend moving upward in a 0.6 m vertical leap? Then, double this value for the “hang time” – the time the athlete’s feet are off the ground.

9. Explain why a flat sheet of paper dropped from a height of 2 meters will not accelerate at the same rate as a crumpled up sheet of paper.

**Graphing Motion**

D

A. Use the graph to answer questions 1-3

Time (seconds)

Distance (meters)

1. Which line segment(s) show constant speed? Explain.

C

B

A

2. Between what points does the object show no motion? Explain.

3. If each line on the distance axis of the graph represents 10 meters and each line on the time axis 1 second, calculate the average speed of the line from A to D.

D

B. Use the graph to answer questions 4-6

Time (seconds)

4. Which line segment(s) show constant acceleration? Explain.

speed

(m/s)

C

B

A

5. Between what points does the object show no acceleration? Explain.

6. If each line on the speed axis of the graph represents 10 meters/second and each line on the time axis 1 second, calculate the average acceleration of the line from A to D.

7. A cyclist must travel 800 km. How many days will the trip take if the cyclist travels 8 hours per day at an average speed of 16 km/h?

ANSWERS

1. What is meant by a “freely falling” object?

*Only gravity acts on the object … air resistance (a form of friction) can oppose the fall.*

2. The acceleration of free-fall is about 10 m/s2. Why does the “seconds” unit appear twice?

a *= ∆v/t = m/s/s … every second, the velocity of a falling object increases by 10 m/s. Therefore, after 1 s, the velocity is 10 m/s, after 2 s, the velocity is 20 m/s, and so forth.*

3. For a freely falling object dropped from rest, how far will it fall after three seconds? How far will it fall after six seconds?

*d = ½ gt2 = ½ (10 m/s2)(3 s)2 = 45 m*

*d = ½ gt2 = ½ (10 m/s2)(6 s)2 = 180 m*

4. You throw a ball into the air and it reaches a height of 31.25 meters. It takes 2.5 seconds for the ball to fall back to the ground. What is the acceleration in m/s2 of the ball from the highest point it reached to the ground?

*d = ½ at2  → a = 2d/t2 = (2)(31.25 m) / (2.5)2 = 10 m/s2*

5. An arrow is shot straight up in the air with an initial speed of 1.6 x 102 m/s. How high does it go if it takes 0.46 x 101 s to reach that point? (Neglect air resistance)

*The distance going up is the same as that returning to the ground. The acceleration is gravity.*

*d = ½ at2 = ½ (10 m/s2)(4.6 s)2 = 105.8 m*

6. A climber near the summit of a vertical cliff accidentally knocks loose a large rock. She sees it shatter at the bottom of the cliff 8 seconds later. How high is she when she hits the rock?

*d = ½ gt2 = ½ (10 m/s2)(8 s)2 = 320 m*

7. Using question 6, what was the speed of impact when the rock shattered on the ground?

*Instantaneous Velocity → v = gt = (10 m/s2)(8 s) = 80 m/s*

8. Very few athletes can jump more than (0.6 m) high (*2 feet*). How much time does an athlete spend moving upward in a 0.6 m vertical leap? Then, double this value for the “hang time” – the time the athlete’s feet are off the ground.

*d = ½ at2 → t = √2d/g = √(2)(0.6 m)/(10 m/s2) = 0.35 s*

*Hang Time includes the time it takes to reach the highest point AND the time to fall back to the ground. This is TWICE the leap time. Therefore, (0.35 s) x 2 = 0.70 s*

9. Explain why a flat sheet of paper dropped from a height of 2 meters will not accelerate at the same rate as a crumpled up sheet of paper.

*Air resistance, which a form of friction that opposes motion*

**Graphing Motion**

D

A. Use the graph to answer questions 1-3

Time (seconds)

1. Which line segment(s) show(s) constant speed? Explain.

Distance (meters)

C

B

*AB and CD*

A

2. Between what points does the object show no motion? Explain.

*BC … the distance does not change between those points*

3. If each line on the distance axis of the graph represents 10 meters and each line on the time axis 1 second, calculate the average speed of the line from A to D.

*Average speed is the total distance / total time*

*distance from A – D = 65 m – 10 m = 55 m*

*time from A – D = 14 s – 1 s = 13 s*

*v = d / t = 55 m / 13 s = 4.2 m/s*

D

B. Use the graph to answer questions 4-6

Time (seconds)

4. Which line segment(s) show constant acceleration? Explain.

speed (m/s)

C

B

*AB and CD*

A

5. Between what points does the object show no acceleration? Explain.

*BC … there is no change in speed between those two points*

6. If each line on the speed axis of the graph represents 10 meters/second and each line on the time axis 1 second, calculate the average acceleration of the line from A to D.

a *= ∆v/t = (65 m/s - 10 m/s)/(14 s – 1 s) = 4.2 m/s2*

7. A cyclist must travel 800 km. How many days will the trip take if the cyclist travels 8 hours per day at an average speed of 16 km/h?

*V = d/t → the distance each day = vt = (16 km/h)(8 hr) = 128 km/day*

*800 km / 128 km/day = 6.25 days*