F. Acceleration due to Gravity

On Earth, a free-falling object has a constant acceleration.

It's given a special symbol: $\vec{g}$ (or g) $-9.8\ m/s^2$ — always negative (acting down)

Example 5: The Demon Drop elevator ride at Cedar Point, Ohio, is free-falling for 1.5 seconds. (no initial velocity)

a) What is the velocity at this time?

$\vec{a} = \vec{g} = -9.8\ m/s^2$

$t = 1.5s$

$\vec{V}_0 = 0$

$\vec{V}_f = ?$

$\vec{V}_f = \vec{V}_0 + \vec{a}t$

$= 0 + (-9.8)(1.5)$

$\vec{V}_f = -14.7\ m/s$ — negative! elevator is moving down.

b) How far does it fall?

$\vec{d} = ?$

$\vec{d} = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$ $\left[\text{or } \vec{d} = \frac{1}{2}(\vec{V}_f + \vec{V}_0)t\right]$

$= 0(1.5) + \frac{1}{2}(-9.8)(1.5)^2$

$= -11.025\ m$

$\vec{d} = -11\ m$ or $\vec{d} = -11.0\ m$ — negative; final position is below the initial position.

Example 6: A man falls 1.0 m to the floor.

a) How long does the fall take?

$\vec{V}_0 = 0$ (fell)

$\vec{a} = \vec{g} = -9.8\ m/s^2$

$\vec{d} = -1.0\ m$ *

$t = ?$

$\vec{d} = \vec{V}_0 t + \frac{1}{2}\vec{a}t^2$

$-1.0 = (0)(t) + \frac{1}{2}(-9.8)t^2$

$\frac{-1.0}{-4.9} = \frac{-4.9t^2}{-4.9}$

$\sqrt{0.2041} = \sqrt{t^2}$

$0.45175 = t$

$t = 0.45\ s$ or $t = 0.452\ s$

b) How fast is he going when he hits the floor?

Not zero

We want $\vec{V}_f$ the instant he hits the floor.

$\vec{V}_f = ?$

$\vec{V}_f^2 = \vec{V}_0^2 + 2\vec{a}\vec{d}$

$= 0^2 + 2(-9.8)(-1.0)$

$\sqrt{\vec{V}_f^2} = \sqrt{19.6}$

$\vec{V}_f = 4.4272$

$V_f = -4.47\ m/s$ — we must include the negative (down)

Practice: ~~p.75 #24, p.77 #25, p.79 #27, 28, 30~~

p. 75 # 24

p. 77 # 25

p. 79 # 27-30

p. 81 # 31

p. 84 # 25a } challenging

p. 85 # 28 }