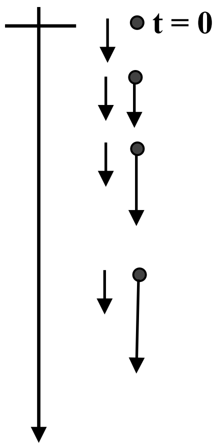
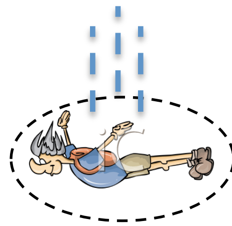
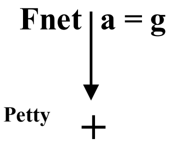
Unit 6 Worksheet 1 Key

1. A body falls freely from rest on Earth. Find:







g = +10 m/s^2

A. its displacement at t = 3s

$\Delta y = Vy_o\, t + 1/2\, g\, t^2$ $\Delta y = (0 \text{ m/s})(3\text{s}) + 1/2\,(10 \text{ m/s}^2)(3\text{s})^2$ $\boxed{\Delta y = 45 \text{ m}}$

B. the time for it to reach a speed of 25 m/s

$Vy = \cancelto{0}{Vy} + g\, t$

$Vy = g\, t$ $t = Vy / g$ $t = 25 \text{ m/s} / 10 \text{ m/s}^2$ $\boxed{t = 2.50 \text{ s}}$

C. the time required for it to fall 300 m

$\Delta y = 300.\text{ m}$ $V_{yo} = 0.0 \text{ m/s}$ $g = 10. \text{ m/s}^2$ $\Delta t = ?$

$\Delta y = \cancelto{0}{Vy_o}\, t + 1/2\, g \Delta t^2$ $\Delta y = 1/2\, g\, \Delta t^2$ $2\, \Delta y = g\, \Delta t^2$

$\Delta t^2 = 2\, \Delta y / g$ $\Delta t = \sqrt{2\, \Delta y / g}$

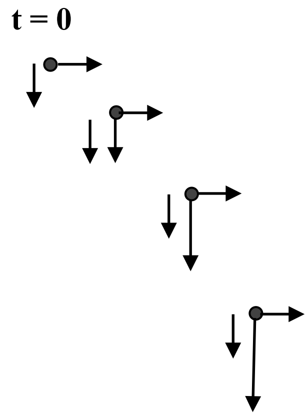
$\Delta t = \sqrt{(2 * 300\text{m} / (10 \text{ m/s}^2))}$ $\boxed{t = 7.75 \text{ s}}$

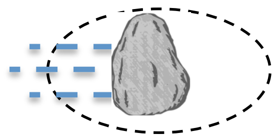
D. its speed after falling 70 m

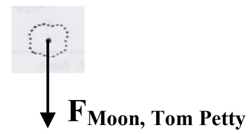
$V_y{}^2 = \cancelto{0}{V_{yo}}{}^2 + 2\, g\, \Delta y$ $Vy = \sqrt{2\, g\, \Delta y}$

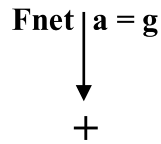
$V_y = \sqrt{2(10 \text{ m/s}^2)(70\text{m})}$ $\boxed{Vy = 37.4 \text{ m/s}}$

2. A stone is thrown horizontally at 22 m/s from the top of a 150-m cliff.









b. How high is the stone after 1.5 s? (Give the distance from the foot of the cliff.)
c. What is the range?

a. How long is it in the air?

$\Delta y = \cancelto{0}{V_{y0}}\, t + 1/2\ g\ t^2$ $\qquad \Delta y = 1/2\ (1.70\ \text{m/s}^2)(3\text{s})^2$ $\qquad \boxed{\Delta y = 7.65\ \text{m}}$

B. the time for it to reach a speed of 25 m/s

$V_y = \cancelto{0}{V_{y0}} + g\ t$ $\qquad V_y = g\ t$ $\qquad t = V_y / g$

$t = 25\ \text{m/s}\ /\ 1.70\ \text{m/s}^2$ $\qquad \boxed{t = 14.7\ \text{s}}$

C. the time required for it to fall 300 m

$\Delta y = \cancelto{0}{V_{y0}}\, t + 1/2\ g\ t^2$ $\qquad \Delta y = 1/2\ g\ t^2$ $\qquad 2^*\Delta y = g\ t^2$

$t^2 = (2^*\Delta y)\ /\ g$ $\qquad t = \sqrt{(2^*\Delta y_2/g)}$ $\qquad t = \sqrt{(2^*300\text{m}\ /\ 1.70\ \text{m/s}^2\ )}$

$\boxed{t = 18.8\ \text{s}}$

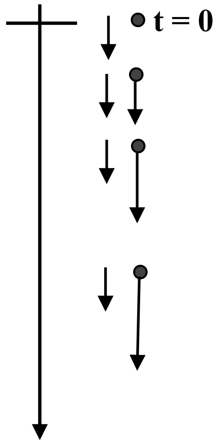
D. its speed after falling 70 m

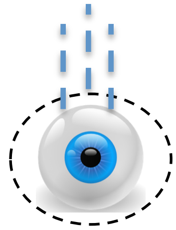
$V_y^{\,2} = \cancelto{0}{V_{y0}}^{\,2} + 2\ g\ \Delta y$ $\qquad V_y = \sqrt{2\ g\ \Delta y}$

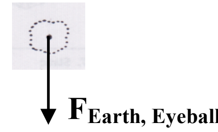
$Vy_f = \sqrt{(2 * 1.70 \text{ m/s}^2 * 70\text{m})}$

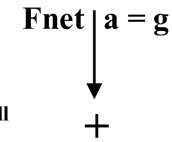
$\boxed{Vy_f = 15.4 \text{ m/s}}$

3. A ball is dropped from rest at a height of 80 m above the ground.









A. What is its speed just as it hits the ground?

$V_y{}^2 = \cancelto{0}{V_{y0}}{}^2 + 2g\,\Delta y$ $\qquad V_y = \sqrt{2g\,\Delta y}$ $\qquad Vy_f = \sqrt{(2 * 10\ m/s^2 * 80m)}$

$\boxed{V_y = 40\ m/s}$

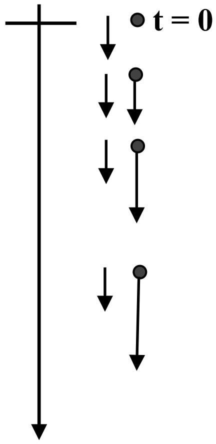
B. How long does it take for it to reach the ground?

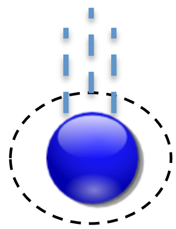
$V_y = \cancelto{0}{V_{y0}} + g\,t$ $\qquad V_y = g\,t$ $\qquad t = V_y / g$

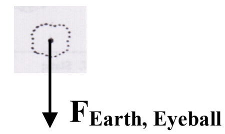
$t = 40\ m/s / 10\ m/s^2$

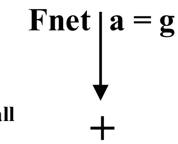
$\boxed{t = 4.0\ s}$

4. A marble dropped from a bridge strikes the water in 6.0 s. Calculate:









A. the speed with which it strikes the water

$Vy_f = \cancel{Vy_i}^{\,0} + g\,t$ $\qquad$ $Vy_f = (10\ \text{m/s}^2)(6.0\text{s})$ $\qquad$ $\boxed{V_f = 60.0\ \text{m/s}}$

B. the height of the bridge

$Vy_f^{\,2} = \cancel{Vy_i^{\,2}}^{\,0} + 2g\,\Delta y$ $\qquad$ $Vy_f^{\,2} = 2\,g\,\Delta\,y$ $\qquad$ $\Delta\,y = Vy_f^{\,2} / 2\,g$

$\Delta\,y = (60.\ \text{m/s})^2 / (2{*}10\ \text{m/s}^2)$ $\qquad$ $\boxed{\Delta\,y = 180\text{m}}$

Free Fall with Vy_i not = 0 m/s

5. A body is thrown downward with an initial speed of 20 m/s on Earth. What is the:

A. acceleration of the object

Only force acting on object is the Force of Earth on Ball. F(net) = ma = Fe = mg. Mass does not change so a = g.

$\boxed{a = g = 10 \text{ m/s}^2}$

B. displacement after 4 s

$\Delta y = ?$ $V_{yi} = 20.0$ m/s $g = 10.$ m/s^2 $\Delta t = 4.0\ s$

$\Delta y = Vy_i\, t + 1/2\, g\, \Delta t^2$ $\Delta y = (20 \text{ m/s})(4\text{s}) + 1/2\,(10 \text{ m/s}^2)(4\text{s})^2$ $\boxed{\Delta y = 160\text{m}}$

C. time required to reach a speed of 50 m/s

$Vy_f = Vy_i + g\,\Delta t$ $Vy_f - Vy_i = g\,\Delta t$ $\Delta t = (Vy_f - Vy_i)/g$

$\Delta t = (50 \text{ m/s} - 20 \text{ m/s}) / 10 \text{ m/s}^2$ $\boxed{\Delta t = 3.00 \text{ s}}$

D. time required to fall 300 m (Hint: factor the quadratic) $\boxed{\Delta y = V_i\, t + 1/2\, g\, t^2}$

Using Quadratic Formula you can solve the formula above for time. I prefer to stay far away from the quadratic formula if I can so here is my solution.

VERSION 1 SOLUTION – Factoring it

$\Delta y = Vy_i\, t + 1/2\, g\, t^2$ $0 = 1/2\, g\, t^2 + Vy_i\, t - \Delta y$

$0 = 1/2 * 10 \text{ m/s}^2 * t^2 + 20 \text{ m/s}\ t - 300\text{m} \rightarrow 0 = 5 \text{ m/s}^2 * t^2 + 20 \text{ m/s}\ t - 300\text{m}$

$0 = 5\,(1 \text{ m/s}^2 * t^2 + 4 \text{ m/s}\ t - 60 \text{ m}) \rightarrow 0 = 5\,(t - 6) * (t + 10)$

$0 = (t - 6)$ $0 = (t + 10)$ $\boxed{t = 6.00 \text{ s or } -10.0 \text{ s}}$

ALTERNATE SOLUTION

$Vy_f^2 = Vy_i^2 + 2g\,\Delta y$ $\quad Vy_f = \sqrt{Vy_i^2 + 2\,g\,\Delta y}$ $\quad Vy_f = \sqrt{((20\text{ m/s})^2 + 2*10\text{ m/s}^2 *300\text{m}))}$

$\boxed{Vy_f = 80.0\text{ m/s}}$

$Vy_f = Vy_i + g\,t$ $\quad Vy_f - Vy_i = g\,t$ $\quad t = (Vy_f - Vy_i)\,/\,g$ $\quad t = (80\text{ m/s} - 20\text{ m/s})\,/10\text{ m/s}^2$

$\boxed{t = 6.00\text{ s}}$

ALTERNATE ALTERNATE SOLUTION

D. time required to fall 300 m

$\Delta y = Vy_i\,t + 1/2\,g\,t^2$ $\qquad 0 = 1/2\,g\,t^2 + Vy_i\,t - \Delta y$

$$t = \frac{-Vy_i \pm \sqrt{Vy_i^2 - 4 * 1/2\,g\,(-\Delta y)}}{2 * 1/2\,g}$$

$$t = \frac{-(20\text{ m/s}) \pm \sqrt{(20\text{m/s})^2 - (4 * 1/2 * 10\text{ m/s}^2 * (-300\text{m}))}}{2 * (1/2 * 10\text{ m/s}^2)}$$

$\boxed{t = 6.00\text{ s or -10.0 s}}$

E. speed after falling 100 m

$Vy_f^2 = Vy_i^2 + 2g\,\Delta y$ $\qquad Vy_f = \sqrt{Vy_i^2 + 2\,g\,\Delta y}$

$Vy_f = \sqrt{((20\text{ m/s})^2 + 2(10\text{ m/s}^2)(100\text{m})}$

$\boxed{Vy_f = 49.0\text{ m/s}}$

Free Fall with Vy_i not = 0 m/s

6. A student throws his worthless lab partner off a 120 m high bridge with an initial downward speed of 10 m/s

A. How long does it take the deadbeat to hit the ground below?

VERSION 1 SOLUTION – Factoring it

$\Delta y = Vy_i\, t + 1/2\, g\, t^2$

$0 = 1/2\, g\, t^2 + Vy_i\, t - \Delta y$

$0 = 1/2 * 10\ m/s^2 * t^2 + 10\ m/s\ t - 120m$

$0 = 5\ m/s^2 * t^2 + 10\ m/s\ t - 120m$

$0 = 5\ (1\ m/s^{2} * t^2 + 2\ m/s\ t - 24\ m)$

$0 = 5\ (t + 6) * (t - 4)$

$0 = (t + 6)$

$0 = (t - 4)$

$\boxed{t = 4.00\ s\ \text{ or }\ -6.00\ s}$

ALTERNATE SOLUTION – Using zee Quadratic Formula

$\Delta y = V_{iy}\, t + 1/2\, g\, t^2$

$0 = 1/2\, g\, t^2 + V_{iy}\, t - \Delta y$

$$t = \frac{-V_i \pm \sqrt{V_{iy}^2 - 4 * 1/2\, g\, (-\Delta y)}}{2 * 1/2\, g}$$

$$t = \frac{-(10\ m/s) \pm \sqrt{(10\ m/s)^2 - 4 * 1/2\ (10\ m/s^2)\ (-(120m))}}{2 * 1/2\ (10\ m/s^2)}$$

$\boxed{t = 4.00\ s\ \text{or}\ -6.00\ s}$

B. How fast is he going at the moment of impact?

$Vy_f = Vy_i + g\, t$

$Vy_f = (10\ m/s) + (10\ m/s^2)(4s)$

$\boxed{Vy_f = 50.0\ m/s}$

Free Fall with V_i not = 0 m/s

ALTERNATE ^{2} SOLUTION

6. A student throws his worthless lab partner off a 120 m high bridge with an initial downward speed of 10 m/s

A. How long does it take the deadbeat to hit the ground below?

Using Quadratic Formula you can solve the formula above for time. I prefer to stay far away from the quadratic formula if I can so here is my solution.

$Vy_f^2 = Vy_i^2 + 2g\,\Delta y$ $\qquad Vy_f = \sqrt{Vy_i^2 + 2g\,\Delta y}$ $\qquad V_f = \sqrt{((10\text{m/s})^2 + 2 * 10\text{ m/s}^2 * 120\text{m})}$

$\boxed{Vy_f = 50\text{ m/s}}$

$Vy_f = Vy_i + g\,t$ $\qquad Vy_f - Vy_i = g\,t$ $\qquad t = (Vy_f - Vy_i)/\,g$

$t = (50\text{ m/s} - 10\text{ m/s})/\,10\text{ m/s}^2$ $\qquad \boxed{t = 4.00\text{ s}}$

B. How fast is he going at the moment of impact?

See above solution for a way to find the Final Velocity.

Free Fall with Vy_i not = 0 m/s

7. When a kid drops a rock off the edge of a cliff, it takes 4.0 s to reach the ground below. When he throws the rock down, it strikes the ground in 3.0 s. What initial speed did he give the rock?

How long does it take the deadbeat to hit the ground below?

Distance to ground:

Δy = ? Vy_o= 0 m/s g = 10. m/s^2 Δt = 4.0 s

$\Delta y = \cancel{V_{0y}}^{\,0}\, t + 1/2\, g\, t^2$ Δy = (0 m/s)(4.0s) + 1/2 (10 m/s^2)(4.0s)^2 $\boxed{\Delta y = 80.0\text{m}}$

Δy = 80. m Vy_0 = ? g = 10. m/s^2 Δt = 3.0 s

$$\Delta y = Vy_o\, t + 1/2\, g\, t^2$$

$$\Delta y - 1/2\, g\, t^2 = Vy_o\, t$$

$$Vy_o = (\Delta y - 1/2\, g\, t^2)/\, t$$

$$Vy_o = ((80.\text{m}) - 1/2\ (10\ \text{m/s}^2)\ (3.0\ \text{s})^2)/\ 3.0\ \text{s}$$

$\boxed{Vy_o = 11.7\ \text{m/s}}$