SOLUTIONS

Senior Physics

# Kinematics Problems

**Full and proper solutions are required for all problems.**

1. Calculate the speed that a ball must be thrown vertically upward in order to rise to a maximum height of 16 m. How long will that ball take to rise this high?

*Ans. 18 m/s; 1.8 s*

$v_2 = 0$ ↑(+) $a_g = -9.8\ m/s^2$

↑ $v_1 = ?$ $\Delta d = +16\ m$

$v_2^2 = v_1^2 + 2a\Delta d$

$-v_1^2 = 2(-9.8)(16)$

$v_1^2 = \cancel{156.8}\ 313.6$

$v_1 = 17.7\ m/s$

$v_2 = v_1 + a\Delta t$

$0 = v_1 + a\Delta t$

$\Delta t = \dfrac{-v_1}{a_g} = \dfrac{-17.7}{-9.8}$

$\Delta t = 1.8\ s$

2. A falling stone takes 0.30 s to travel past a window that is 2.2 m tall. From what height above the top of the window did the stone fall?

window ↓+

$\Delta d = v_1\Delta t + \frac{1}{2}a\Delta t^2$

$2\Delta d = 2v_1 t + at^2$

$v_1 = \dfrac{2\Delta d - at^2}{2t}$

$= \dfrac{2(2.2) - (9.8)(0.3)^2}{2(0.3)}$

$v_1 = 5.86\ m/s$

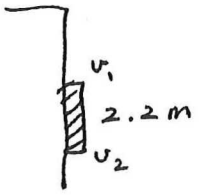
$v_1 = ?$

$v_2 = ?$

$a = 9.8\ m/s^2$

$\Delta d = 2.2\ m$

$t = 0.3\ s$




above window

$v_1 = 0$

$v_2 = 5.86\ m/s$

$a = 9.8\ m/s^2$

$\Delta d = ?$

$t$ (no need for it)

$v_2^2 = v_1^2 + 2a\Delta d$

$\Delta d = \dfrac{v_2^2 - v_1^2}{2a}$

$= \dfrac{(5.86)^2 - 0}{2(9.8)}$

$\therefore \Delta d = 1.75\ m$ above window

3. A stone is dropped into the water from a bridge 44 m above the water. Another stone is thrown vertically downward 1.0 s after the first was dropped. Both stones strike the water at the same time. What was the initial speed of the second stone? *Ans. 12 m/s*

↓ +

**stone 1**

$\Delta d = 44\ m$

$a = 9.8\ m/s^2$

$v_1 = 0$

$t_1 = ?$

$\Delta d = v_1 \Delta t + \frac{1}{2} a \Delta t^2$

$\Delta t = \sqrt{\frac{2\Delta d}{a}}$

$\boxed{\Delta t = 3.0\ s}$

**stone 2**

$\Delta d = 44\ m$ $\quad v_1 = ?$

$a = 9.8\ m/s^2$

$t_2 = t_1 - 1\ s$

$t_2 = 3.0 - 1.0$

$= 2.0\ s$

$\Delta d = v_1 \Delta t + \frac{1}{2} a \Delta t^2$

$v_1 = \frac{\Delta d - \frac{1}{2} a \Delta t^2}{\Delta t}$

$\boxed{v_1 = 12\ m/s}$

4. The acceleration due to gravity on the Moon is about one sixth what it is on Earth. If an object is thrown vertically upward on the Moon, how many times higher will it go than it would on Earth, assuming the same initial velocity?

$a_M = \frac{1}{6} a_E \Longrightarrow a_E = 6 a_M$

$v_2 = 0$ at max height

$v_{1M} = v_{1E}$

$v_2^2 = v_1^2 + 2a\Delta d$

$-v_1^2 = 2 a_E \Delta d_E = 2 a_M \Delta d_M$

$\therefore \quad 2 a_E \Delta d_E = 2 a_M \Delta d_M$

$6 a_M \Delta d_E = a_M \Delta d_M$

$\Delta d_M = 6 \Delta d_E$

$\therefore$ object goes 6 times higher on the Moon.