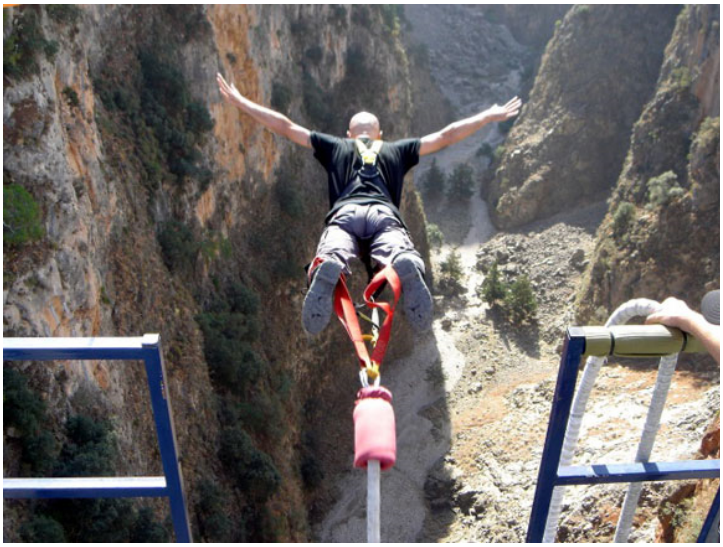
L06 – Vertically Accelerated Motion

AGENDA:

- Attendance
- Lesson: Vertical Accelerated Motion
- Practice: Pg 63 #3, 5, 6, 7, 10, 15, 16



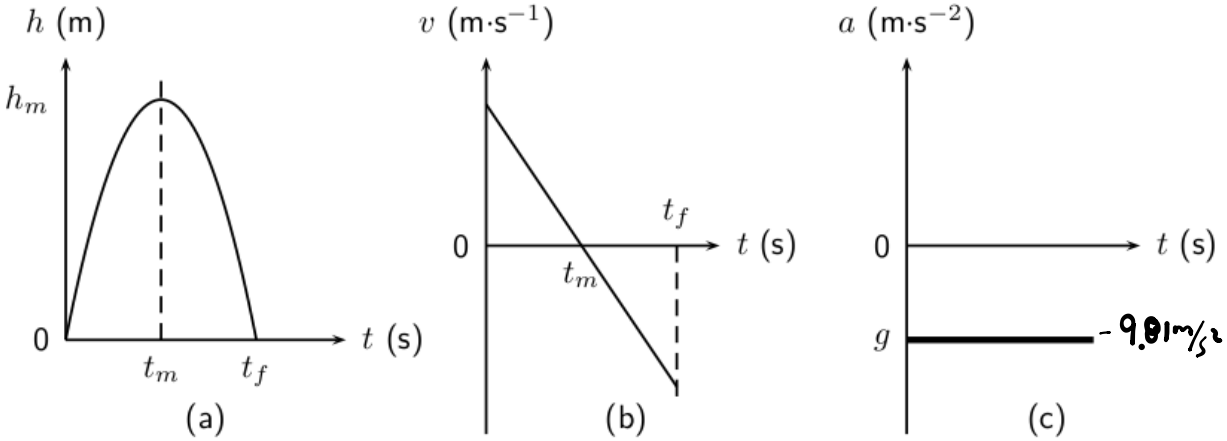
Free Fall on the moon vs. Free Fall on Earth

Vertical Motion and Gravity

1. An object does **NOT** have zero velocity before hitting the ground. Chances are that is actually moving VERY fast.

2. If an object is thrown upward, at it's maximum height it has a velocity of 0m/s [Up] before the velocity becomes negative and the object starts falling.

3. An object takes the same amount of time to reach it's maximum height as it takes to fall back to its original height.



Common Question Type #1 - Maximum Height

Q1: A clown throws a ball upward at 10.00 m/s. What is the maximum height that the ball reaches above its launch point?

$\vec{v}_i = 10$ m/s [up]

$\Delta\vec{d} = ?$

$\vec{a} = -9.81$ m/s^2 [Earth]

$\vec{v}_f = 0$ m/s @ max height

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = (10)^2 + 2(-9.81)d$

$0 = 100 - 19.62d$

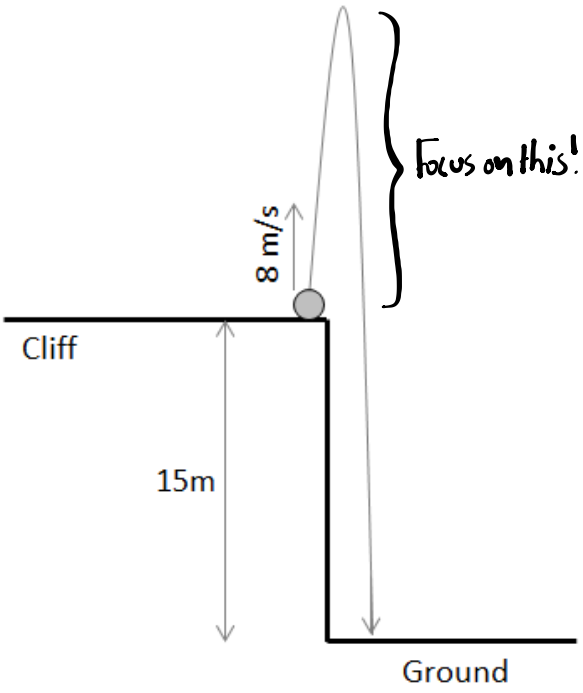
$+19.62d \quad +19.62d$

$19.62d = 100$

$\div 19.62 \quad \div 19.62$

$d = 5.0968...$ m

Q2: A ball is thrown vertically upward at 8 m/s from the top of a 15m cliff face. The ball goes upward, then lands on the ground beneath the cliff, per the diagram below. What is the maximum height of the ball above the ground during this time?



$\vec{v}_i = 8$ m/s (up)

$\vec{a} = -9.81$ m/s^2 (up) ← Earth!

$\vec{v}_f = 0$ m/s @ top

$\Delta\vec{d} = ?$

$v_f^2 = v_i^2 + 2ad$

$(0)^2 = (8)^2 + 2(-9.81)d$

$0 = 64 - 19.62d$

$+19.62d \quad +19.62d$

$19.62d = 64$

$\div 19.62 \quad \div 19.62$

$\Delta d = 3.26$m above cliff.

$+15$

$= 18.26$m above ground.

Common Question Type #2 - Total Flight Time.

Q3: A ball is launched vertically upward at 15.0 m/s before returning to the ground. What is its total flight time?

$\vec{v}_i = 15 m/s [up]$

$\vec{a} = -9.81 m/s^2 [up]$

$\Delta\vec{d} = 0m$ (Returns to same point)

$t = ?$

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

$0 = (15)t + \frac{1}{2}(-9.81)t^2$

$\div t \quad \div t \quad \div t$

$0 = 15 - 4.905t$

$+4.905t \quad +4.905t$

$4.905t = 15$

$\div 4.905 \quad \div 4.905$

$t = 3.058 s$

Q4: A ball is launched vertically upward at 100 km/h before returning to the ground. What is its total flight time?

$$\frac{100 km}{h} \times \frac{1\ h}{3600 s} \times \frac{1000 m}{1 km} = 27.\bar{7} m/s$$

$\vec{v}_i = 27.\bar{7} m/s$

$\vec{a} = -9.81 m/s^2$

$\Delta\vec{d} = 0m$

$t = ?$

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

$0 = (27.\bar{7})(t) + \frac{1}{2}(-9.81)(t^2)$

$\div t \quad \div t \quad \div t$

$0 = 27.\bar{7} - 4.905t$

$+4.905t \quad +4.905t$

$4.905t = 27.\bar{7}$

$\div 4.905 \quad \div 4.905$

$t = 5.663 s$

Uncommon Question Types

Q5: Having scored a touchdown, a football player spikes the ball in the end zone. If the ball was thrown down with an initial velocity of 2.0 m/s from a height of 1.75 m, determine how long is it in the air.

(HINT: This requires 2 steps)

$\vec{v}_i = -2\ m/s$

$\vec{a} = -9.81\ m/s^2$

$\Delta\vec{d} = -1.75\ m$

$t = ?$

Attempt #1

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

$-1.75 = (-2)t + \frac{1}{2}(-9.81)t^2$

Quadratic!
Can't solve without Ma20-1.

Attempt #2

$\vec{v}_i = -2\ m/s$

$a = -9.81\ m/s^2$

$\Delta d = -1.75\ m$

$\vec{v}_f = ?$

$v_f^2 = v_i^2 + 2ad$

$= (-2)^2 + 2(-9.81)(-1.75)$

$= 4 + 34.335$

$v_f^2 = 38.335$

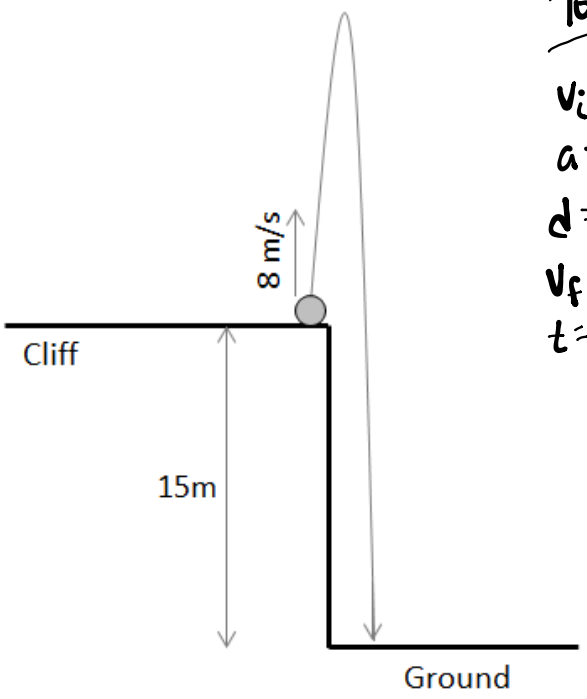
$v_f = -6.1915\ m/s$

$a = \frac{v_f - v_i}{t}$ $\quad -9.81 = \frac{-6.1915 - (-2)}{t}$

$-9.81 = \frac{-4.1915}{t}$

$t = 0.427s$

Uncommon Question Types



Total flight

$v_i = +8\ m/s$

$a = -9.81\ m/s$

$d = -15m$

$v_f = ?$

$t = ?$

① $v_f = ?$

$v_f^2 = v_i^2 + 2ad$

$= (8)^2 + 2(-9.81)(-15)$

$= 64 + 294.3$

$v_f^2 = 358.3$

$v_f = -18.9288\ m/s$

② $t = ?$

$a = \frac{v_f - v_i}{t} \Rightarrow t = \frac{v_f - v_i}{a}$

$t = \frac{-18.9288 - (+8)}{-9.81}$

$t = 2.745s$

Q6: What is the total flight time of the ball?

Q7: What is the speed of the ball when it impacts the ground?

Practice

Pg. 63 #3, 5, 6, 7, 10, 15, 16