PHYSICS 11

Free Fall

Characteristics/properties of an object experiencing a free fall:

- Initial velocity is zero:
- Acceleration is only the one due to gravity:
- Assume the object is on Earth, falling in vacuum, so there is not friction, wind, or external forces acting on the object and there are no obstacles in the path of the object. The only force acting on the object is the gravitational pull of the Earth.

Example: An object is dropped from 15m above ground. What is its final velocity just before it hits the ground?

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

$\vec{d} = -15m$ ($\leftarrow$ it is displaced downwards)

$\vec{v}_i = 0\ m/s$

R: $\vec{v}_f = ?\ [m/s]\ [down]$

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

S: $v_f^2 = 0^2 + 2(-9.8)(-15)$

$\sqrt{v_f^2} = \sqrt{294}$

$v_f = \pm 17\ m/s$

S: The object hits the ground at velocity 17 m/s [down].

Vertical Motion

- Same assumptions and characteristics as a free-fall motion **except** the non-zero initial velocity.

Example: An object is thrown straight up with velocity of 20 m/s [up].

A) What is its maximum height above its launching point?

B) How long is the object in the air if it lands at exactly same level it was launched from?

A) G: $\vec{a} = -9.8\ m/s^2$

↑ + $\vec{v}_i = 20\ m/s$ [up]

↓ − $\vec{v}_f = 0\ m/s$ [up] → the object stops before it starts falling down

R: $h_{max} = ?$ [m]

A: $h_{max} = d_y$

$$\frac{v_f^2 - v_i^2}{2a} = d$$

S: $d = \frac{0^2 - 20^2}{2(-9.8)}$

$d = \frac{400}{19.6}$

$d \doteq 2.0 \times 10^1\ m$

S: The object's maximum height is 2.0×10^1 m.

B) R: $t_{air} = ?$ [s]

A: $t_{air} = 2 \cdot t_{hmax}$

$t_{hmax} = \frac{v_f - v_i}{a}$ (from $v_f = v_i + at$)

S: $t_{hmax} = \frac{0 - 20}{-9.8} \doteq 2.0408\ s$

$t_{air} = 2(2.0408) \doteq \underline{4.1\ s}$

S: The object is in the air for approximately 4.1 s.

HW: Textbook p 74 #42-46, p 75 #47-52 and p 80 #53-73