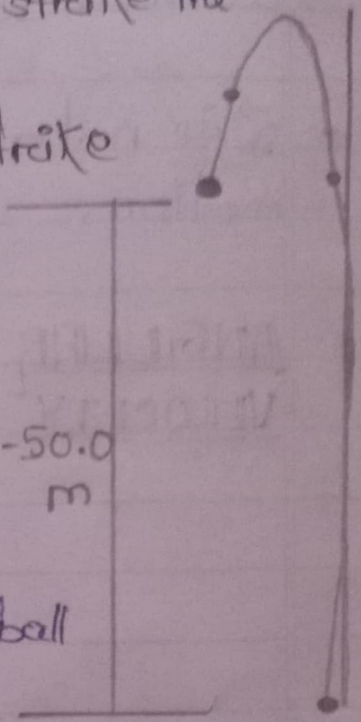
HW 3/7/21

ODM CONNECT APP HOMEWORK

Free Fall

1. A ball is thrown upward with an initial velocity of 10.0 m/s from the top of a 50.0 m tall building.
   a) with what velocity will the ball strike the ground?
   b) How long does it take the ball to strike the ground?



Ans) Given: $y = -50.0\,m$ (displacement),
$v_0 = +10.0\,m/s$
Find: (a) v, (b) t
The y in the kinematic equations stands for displacement from the launch point, not distance. When the ball strikes the ground, it will displace $-50.0\,m$, or 50 m below the launch point.

a) $v^2 = v_0^2 - 2gy = (+10.0\,m/s)^2 - 2(9.80\,m/s^2)(-50.0\,m)$
$= 1.08 \times 10^3\,m^2/s^2$
so $v = \sqrt{1.08 \times 10^3\,m^2/s^2} = \pm 32.9\,m/s$
The positive answer is discarded since the ball is falling when it lands (moving downward)
Therefore $v = -32.9\,m/s$

b) From $v = v_0 - gt$, we have
$$t = \frac{v_0 - v}{g} = \frac{(+10.0\,m/s - (-32.9\,m/s)}{9.80\,m/s^2}$$
$$= \frac{42.9\,m/s}{9.80\,m/s^2} = 4.38\,s$$

2. A stone is dropped freely in the river from a bridge. It takes 5s to touch the water surface in the river. Calculate:
(i) the height of the bridge from the water level,
(ii) the distance covered by stone in the last second
($g = 9.8\ m\ s^{-2}$)

Ans) $u = 0$, $g = 9.8\ ms^{-2}$, $t = 5s$

(i) From equation of motion, $h = ut + \frac{1}{2}gt^2$;

$\Rightarrow h = 0 \times 5 + \frac{1}{2} \times 9.8 \times (5)^2 = 9.8 \times \frac{25}{2} = 122.5\ m$

(ii) Distance covered in last second, $S_{(t)} = u + \frac{g}{2}(2t - 1)$

$= 0 + \frac{1}{2} \times 9.8 \times (2 \times 5 - 1) = 44.1\ m$

3. A tennis ball is struck with a racket, firing it straight upward at 22 meters per second. After how much time will it be falling at 15 meters per second?

Ans) Case 1-

Given: $u = 22\ m/s$, $v = 0$, $g = -9.8$

To find: t_1

$\Rightarrow v = u + gt_1$

$\Rightarrow 0 = 22 + (-9.8) \times t_1$

$\Rightarrow 0 = 22 - 9.8 \times t_1$

$\Rightarrow 9.8 t_1 = 22$

$\Rightarrow t_1 = \frac{22}{9.8}$

$\Rightarrow t_1 = 2.24$ secs

case 2 -

Given: $u = 0$, $v = 15$ m/s, $g = 9.8$

To find: t_2

$\Rightarrow v = u + gt_2$

$\Rightarrow 15 = 0 + 9.8t_2$

$\Rightarrow 15 = 9.8t_2$

$\Rightarrow t_2 = \frac{15}{9.8}$

$\Rightarrow t_2 = 1.53$ secs

So $t = t_1 + t_2 = (2.24 + 1.53)$ secs

$= 3.77$ secs $= 3.8$ secs

$\therefore$ After 3.8 secs it will be falling at 15 m/s.