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# MECHANICS ASSIGNMENT

**1.** A ball is dropped from 4m above the ground. If it begins at rest, how long does it take to hit the ground?

Soln:- We have, $s = ut + \frac{1}{2}at^2$

Here, $u = 0$ (begins at rest)
$a = g = 9.8\,m/s$ (acceleration due to gravity)
$s = 4m$
$t = ?$

So,
$$4 = 0 \times t + \frac{1}{2} \times 9.8 \times t^2$$

or, $t^2 = \frac{4}{4.9}$

$\therefore t = 0.9\,s$

**2.** A ball is thrown upward at 4 m/s starting from ground level. How long does it take for the ball to return to the ground?

Soln:- We have, $s = ut + \frac{1}{2}at^2$

Here, $s = 0$ (displacement)
$u = 4m/s$ (initial velocity)
$a = g = 9.8\,m/s$ (acc. due to gravity)

So,
$$0 = 4 \times t + \frac{1}{2} \times (-9.8) \times t^2$$

or, $0 = t(4 - 4.9t)$

$\therefore$ either, $t = 0$ (Rejected) or $t = 0.816\,s$

$\therefore$ Time taken, $t = 0.82\,s$

3. If a ball that is 4 meters above the ground is thrown horizontally at 4 meters ~~abo~~ per second, how long will it take for the ball to hit the ground?

Soln:- We know,

Time of flight, $T = \dfrac{u\sin\theta + \sqrt{u^2\sin^2\theta + 2gH}}{g}$

Here, $\theta = 0$ (horizontal throw)

$u = 4 m/s$ (initial velocity)

$H = 4 m$ (above the ground)

$g = 9.8 m/s$ (acc. due to gravity)

So, $T = \dfrac{\sqrt{2 \times 9.8 \times 4}}{9.8} = 0.90 s$

$\therefore T = 0.9 s$

4. In q. 3, how ~~long~~ far will the ball travel in the horizontal direction before it hits the ground?

Soln:- We know,

$x = uT$

Here, $u = 4 m/s$ (initial velocity)

$T = 0.9 s$ (as calculated above)

$x = 4 \times 0.9$

$\therefore x = 3.6 m$

$\therefore$ Distance travelled is 3.6 m.

5. Drop a ball from a height of 2 meters and, using a stopwatch, record the time it takes to reach the ground.

| Test number | Time (seconds) |
| --- | --- |
| 1. | 0.62 |
| 2. | 0.70 |
| 3. | 0.64 |
| Average | 0.65 |

Now, use a kinematic equation to find the final velocity of the ball. Use this final velocity to show that the energy is conserved from Time 1 (just befor ball is released) to Time 2 (just before ball hits the ground). Use equations below for potential energy and kinetic energy. (h= height of ball; m= mass of ball).

$$P.E. = mgh$$
$$K.E. = \frac{1}{2}mv^2$$

Soln:- Here, final velocity, $(v = u + at)$

$$v = 0 - gt$$

or, $v = -9.8 \times 0.65$

$\therefore v = -6.3$ m/s

At $T_1$, total energy, $= mgh + \frac{1}{2}mv^2$

$= m(9.8 \times 2 + 0)$

$\therefore E_{T_1} = 19.6\,m$ J

($\because$ before ball is releases, $v = u = 0$)

At $T_2$, total energy $= mgh + \frac{1}{2}mv^2$

$= m(0 + \frac{1}{2} \times (6.3)^2)$

$\therefore E_{T_2} = 19.8\,m$ J

$\therefore E_{T_1} \approx E_{T_2}$. This proves energy is conserved