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PHY 103W

Part A

Ans: to the que: NO-1

(a)

Projectile motion is the motion of an object thrown or projected into the air, subject to only the acceleration of grabity.

Ans to the que: NO-1

(b)

The expression for horizontal range is -

Let total time of flight of a projectile is T.

Then,

$$V_y = V_{y_0} - g\left(\frac{T}{2}\right)$$

$$\Rightarrow 0 = V_0 \sin\theta - g \times \frac{T}{2}$$

$$\Rightarrow \frac{T}{2} \times g = V_0 \sin\theta,$$

$$\Rightarrow T = \frac{2V_0 \sin\theta}{g}.$$

Here,

V_{y_0} = initial velocity in Y-axis

T = time of flight

V_{y_0} = velocity in maximum height

θ = angle of the initial velocity from the horizontal plane

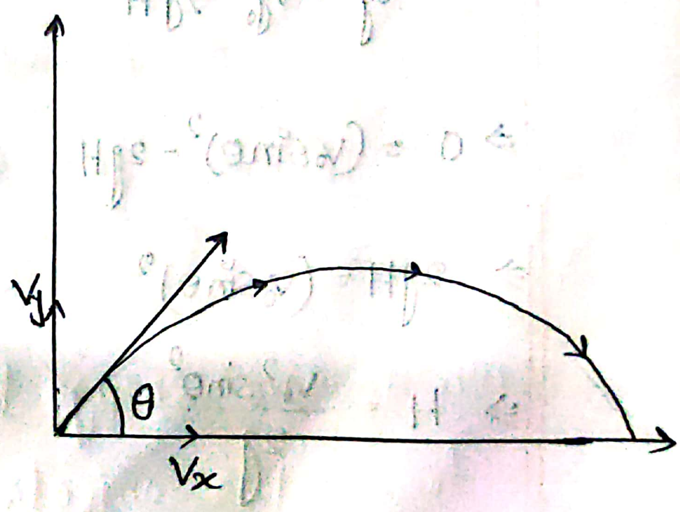
Let the horizontal range, R;

$$\therefore R = V_{x_0} \times T$$

$$= V_0 \cos\theta, \times \frac{2V_0 \sin\theta}{g}$$

$$= \frac{V_0^2\, 2\sin\theta \cdot \cos\theta}{g}$$

$$R = \frac{V_0^2 \sin 2\theta}{g}$$



So, the horizontal range of a projectile in, $R = \dfrac{V_0^2 \sin 2\theta}{g}$

Let,

Constant velocity of a projectile in x-axis and Y-axis -

$V_x = V_0 \cos\theta$

and. $V_y = V_0 \sin\theta - gt$

Therefore, the initial velocity of Y-axis -

$V_{y_0} = V_0 \sin\theta$

we know that,

$V_y^2 = V_{y_0}^2 - 2gH$

Here,

H = maximum height of the projectile

$\Rightarrow 0 = (V_0 \sin\theta)^2 - 2gH$

$\Rightarrow 2gH = (V_0 \sin\theta)^2$

$\Rightarrow H = \frac{V_0^2 \sin\theta^2}{2g}$

So, maximum height of a projectile is, $H = \frac{V_0^2 \sin\theta^2}{2g}$

Ans: to the que: NO-2

(a)

A conservative force is a force with the property that the total work done in moving a particle between two points is independent of the path taken. If a particle travels in a closed loop, the total work done by a conservative force is zero.

Ans: to the qus: NO-2

(b)

Given that,

$F(x) = (6x^2+2x)\ N$

we know, the total work,

$$W = \int_{x_0}^{x_f} F(x)\,dx$$

Here,

x_f = Upper bound = 2

x_0 = Lower bound = -1

$$= \int_{-1}^{2} (6x^2+2x)\,dx$$

$$= \left[6 \times \frac{x^3}{3} + 2 \times \frac{x^2}{2}\right]_{-1}^{2}$$

$$= \left[2x^3 + x^2\right]_{-1}^{2}$$

$$= (16+4) - (-2+1)$$

$$= 21 j$$

$$\therefore W = 21 j$$

So the work done by the particle moves from $x = -1$ to $x = 2m$ is $21 j$.

Ans to the que: No-3

(a)

When wave energy like sound or radio waves travels from two objects, the wavelength can seem to be changed if one or both of them are moving. This is called Doppler effect. The Doppler effect causes the received frequency of a source to differ from the sent frequency if there is motion that is increasing or decreasing the distance between the source and the receiver.

Ans: to the que: NO-3

(b)

The approching frequency,

$$f_a' = \frac{V}{(V-V_s)} \times f \quad \ldots (i)$$

Here,

V = Velocity of sound wave = 340 m/s

The passing frequency,

V_s = Velocity of source = 72 km/h = $20ms^{-1}$

$$f_b' = \frac{V}{V+V_s} \times f \quad \ldots (ii)$$

f = actual frequency

(i) - (ii)

$$f_a' - f_b' = \left(\frac{V}{V-V_s} \times f\right) - \left(\frac{V}{V+V_s} \times f\right)$$

$$\Rightarrow 500 = f\left(\frac{340}{340-20} - \frac{340}{340+20}\right)$$

$$\Rightarrow 500 = f\left(\frac{17}{144}\right)$$

$$\Rightarrow f = 4235.29\ Hz$$

So, the frequency of the whistle is 4235.29 Hz.