Motion in a Plane

2011

1. A missile is fired for maximum range with a initial velocity of $20ms^{-1}$. If $g = 10ms^{-2}$, the range of the missile is

a) 50 m b) 60 m c) 20 m d) 40 m

2. If a person can throw a stone to maximum height of h metre vertically, then the maximum distance through which it can be thrown horizontally by the same person is

a) $\frac{h}{2}$ b) h c) 2h d) 3h

2010

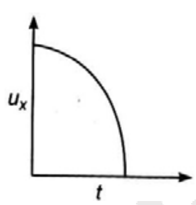
3. A ball is projected horizontally with a velocity of 5m/s from the top of a building 19.6m high. How long will the ball take to hit the ground

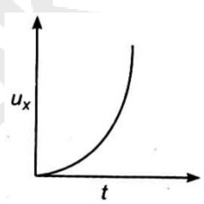
a) $\sqrt{2}s$ b) 2s c) $\sqrt{3}s$ d) 3s

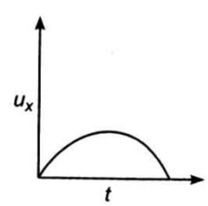
4. A particle is projected with a velocity v such that its range on the horizontal plane is twice the greatest height attained by it. The range of the projectile is (where g is acceleration due to gravity)

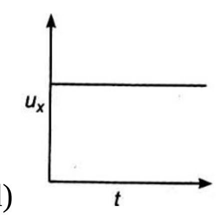
a) $\frac{4v^2}{5g}$ b) $\frac{4g}{5v^2}$ c) $\frac{v^2}{g}$ d) $\frac{4v^2}{\sqrt{5g}}$

5. Which of the following is the graph between the horizontal velocity (u_x) of a projectile and time (t), when it is projected the ground

a) 

b) 

c) 

d) 

6. A particle of mass m is projected with a velocity v at an angle of 60^0 with horizontal. When the particle is at its maximum height the magnitude of its angular momentum about the point of projection is

a) Zero b) $\frac{3mv^2}{16g}$ c) $\frac{\sqrt{3}mv^3}{16g}$ d) $\frac{3mv^3}{8g}$

7. **Assertion (A): Generally the path of a projectile from the earth is parabolic but it is elliptical for projectile going to a very large height**

Reason (R): The path of a projectile is independent of the gravitational force of earth

a) Both assertion and reason are true and reason is the correct explanation of assertion
b) Both assertion and reason are true but reason is not the correct explanation of assertion
c) Assertion is true but reason is false
d) Both assertion and reason are false

2008

8. **A projectile can have the same range R for two angles of projection. If t_1 and t_2 be the times of fights in the two cases, then the product of the two times of flights is proportional to**

a) R^2 b) $\frac{1}{R^2}$ c) $\frac{1}{R}$ d) R

9. **The maximum height attained by a projectile is increased by 5%. Keeping the angle of projection constant, what is the percentage increase in horizontal range**

a) 5% b) 10% c) 15% d) 20%

10. **A ball is projected from the ground at angle θ with the horizontal. After 1s it is moving at angle 45^0 with the horizontal and after 2s it is moving horizontally. What is the velocity of projection of the ball**

a) $10\sqrt{3}ms^{-1}$ b) $20\sqrt{3}ms^{-1}$ c) $10\sqrt{5}ms^{-1}$ d) $20\sqrt{2}ms^{-1}$

2007

11. **A fielder in a cricket match throws ball from the boundary line to the wicket keeper. The ball describes a parabolic path. Which of the following quantities remain constant during the motion in air (neglecting air resistance?)**

a) kinetic energy
b) vertical component of velocity
c) Horizontal component of velocity
d) speed

12. **A particle is thrown vertically upwards. Its velocity at half of the height is $10ms^{-1}$. Then the maximum height attained by it is (taking $g = 10ms^{-2}$)**

a) 16m b) 10m c) 8m d) 18m

2006

13. **Two stones are projected with same velocity v at an angle θ and $(90^0 - \theta)$. If H and H_1 are the greatest height in the two paths, what is the relation between R, H and H_1 ?**

a) $R = 4\sqrt{HH_1}$ b) $R = \sqrt{HH_1}$ c) $R = HH_1$ d) none of these

KEY

1) d   2) c   3) b   4) a   5) d   6) b

7) b   8) b   9) a   10) c   11) c   12) b   13) a

HINTS

1. For maximum range of projectile θ will be 45^0 by the law of projectile motion

$\therefore R_{\max} = \frac{u^2}{g}$

Given $u = 20ms^{-1}$ and $g = 10ms^{-2}$

$R_{\max} = \frac{(20)^2}{10} = \frac{400}{10}$

$R_{\max} = 40m$

2. Using the equation of motion, we get

$h = \frac{u^2}{2g}$

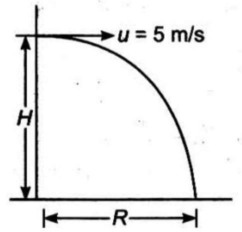
Thus, $u^2 = 2gh$

So the maximum horizontal distance would by given by

$R_{\max} = \frac{u^2}{g}$ (when $\theta = 45^0$)

Hence $R_{\max} = 2h$

3 The time taken to hit the ground is given by



$$T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2 \times 19.6}{9.8}} = 2s$$

4. R = 2H (given)

We know $R = 4H \cot\theta$

$$\Rightarrow \cot\theta = \frac{1}{2}$$

From triangle we can say that

$$\sin\theta = \frac{2}{\sqrt{5}}, \ \cos = \frac{1}{\sqrt{5}}$$

$\therefore$ range of projectile, $R = \dfrac{2v^2 \sin\theta \cos\theta}{g}$

$$= \frac{2v^2}{8} \times \frac{2}{\sqrt{5}} \times \frac{1}{\sqrt{5}} = \frac{4v^2}{5g}$$

5. Graph between horizontal velocity and time in a projectile motion is a straight line parallel to the time axis as the horizontal velocity remains constant with time

6. Maximum height, $H = \dfrac{v^2 \sin^2 60^0}{2g}$

$$= \frac{v^2}{2g} \times \frac{3}{4} = \frac{3v^2}{8g}$$

Momentum of particle at highest point

$$p = mv \cos 60^0 = \frac{mv}{2}$$

Angular momentum = pH

$$= \frac{mv}{2} \times \frac{3v^2}{8g}$$

$$= \frac{3mv^2}{16g}$$

12. It is given velocity at half the height is $10ms^{-1}$. By equation of motion, we have

$$v^2 = u^2 - 2gh$$

Where v is final velocity, g is acceleration due to gravity and s is displacement

At maximum height v = 0

$$\therefore u^2 = 2gs$$

$$\Rightarrow h = \frac{u^2}{2g}$$

At half the height

$$\Rightarrow h' = \frac{h}{2} = \frac{1}{2}\left(\frac{u^2}{2g}\right)$$

Now $100 - u^2 = 2\times(-g)\times\frac{u^2}{4g}$

$$\Rightarrow u = \sqrt{200}ms^{-1}$$

Maximum height attained

$$= \frac{200}{2\times10} = 10m$$

13. Range of projectile

$$R = \frac{2u^2\sin\theta\cos\theta}{g} \;\ldots\ldots\ldots\ldots \text{(i)}$$

Height $H = \frac{u^2\sin^2\theta}{2g}$ .... (ii)

$$H_1 = \frac{u^2\sin^2(90^0-\theta)}{2g} = \frac{u^2\cos^2\theta}{2g} \;\ldots\ldots \text{(iii)}$$

Then, $HH_1 = \frac{u^2\sin^2\theta u^2\cos^2\theta}{2g\times2g}$

From eq (i) we get

$$R^2 = \frac{4u^2,\sin^2\theta u^2\cos^2\theta\times4}{2g\times2g}$$

$R = \sqrt{16HH_1}$ {from eq (iv)}

$$= 4\sqrt{HH_1}$$