DPP - Daily Practice Problems

Name :

Date :

Start Time :

End Time :

PHYSICS 06

SYLLABUS : MOTION IN A PLANE-1 (Projectile Motion)

Max. Marks : 112 **Time : 60 min.**

GENERAL INSTRUCTIONS

- The Daily Practice Problem Sheet contains 28 MCQ's. For each question only one option is correct. Darken the correct circle/ bubble in the Response Grid provided on each page.
- You have to evaluate your Response Grids yourself with the help of solution booklet.
- Each correct answer will get you 4 marks and 1 mark shall be deduced for each incorrect answer. No mark will be given/ deducted if no bubble is filled. Keep a timer in front of you and stop immediately at the end of 60 min.
- The sheet follows a particular syllabus. Do not attempt the sheet before you have completed your preparation for that syllabus. Refer syllabus sheet in the starting of the book for the syllabus of all the DPP sheets.
- After completing the sheet check your answers with the solution booklet and complete the Result Grid. Finally spend time to analyse your performance and revise the areas which emerge out as weak in your evaluation.

DIRECTIONS (Q.1-Q.20) : There are 20 multiple choice questions. Each question has 4 choices (a), (b), (c) and (d), out of which **ONLY ONE** choice is correct.

Q.1 The path followed by a body projected along y axis is given by $y = \sqrt{3}\,x - (1/2)\,x^2$. If $g = 10\ m/s^2$, then the initial velocity of projectile will be – (x and y are in m)

(a) $3\sqrt{10}$ m/s (b) $2\sqrt{10}$ m/s

(c) $10\sqrt{3}$ m/s (d) $10\sqrt{2}$ m/s

Q.2 When the angle of elevation of a gun are 60º and 30º respectively, the height it shoots are h_1 and h_2 respectively, h_1/h_2 equal to –

(a) 3/1 (b) 1/3 (c) 1/2 (d) 2/1

Q.3 If t_1 be the time taken by a body to clear the top of a building and t_2 be the time spent in air, then $t_2 : t_1$ will be –

(a) 1 : 2 (b) 2 : 1 (c) 1 : 1 (d) 1 : 4

Q.4 The co-ordinates of a moving particle at any time t are given by $x = ct^2$ and $y = bt^2$. The speed of the particle is

(a) $2t\,(c + b)$ (b) $2t\sqrt{c^2 - b^2}$

(c) $t\sqrt{c^2 + b^2}$ (d) $2t\sqrt{c^2 + b^2}$

Q.5 The height y and the distance x along the horizontal at plane of the projectile on a certain planet (with no surrounding atmosphere) are given by $y = (8t - 5t^2)$ metre and $x = 6t$ metre where t is in second. The velocity with which the projectile is projected is

(a) 8 m/s (b) 6 m/s

(c) 10 m/s (d) Data is insufficient

RESPONSE GRID	1. ⓐⓑⓒⓓ	2. ⓐⓑⓒⓓ	3. ⓐⓑⓒⓓ	4. ⓐⓑⓒⓓ	5. ⓐⓑⓒⓓ

Space for Rough Work

Q.6 A body is thrown at an angle 30° to the horizontal with the velocity of 30 m/s. After 1 sec, its velocity will be (in m/s) ($g = 10\ m/s^2$)

(a) $10\sqrt{7}$ (b) $700\sqrt{10}$ (c) $100\sqrt{7}$ (d) $\sqrt{10}$

Q.7 A particle is moving in a plane with a velocity given by, $\vec{u} = u_0\,\hat{i} + (\omega a \cos \omega t)\,\hat{j}$, where $\hat{i}$ and $\hat{j}$ are unit vectors along x and y-axes respectively. If the particle is at the origin at t = 0, then its distance from the origin at time $t = 3\pi/2\omega$ will be

(a) $\sqrt{\left[\left(\frac{3\pi u_0}{2\omega}\right)^2 + a^2\right]}$ (b) $\sqrt{\left[\left(\frac{3\pi u_0}{2\omega}\right) + a^2\right]}$

(c) $\sqrt{\left[\left(\frac{3\pi u_0}{2\omega}\right)^2 + a\right]}$ (d) $\sqrt{\left[\left(\frac{4\pi u_0}{2\omega}\right)^2 + a^2\right]}$

Q.8 A ball thrown by one player reaches the other in 2 sec. The maximum height attained by the ball above the point of projection will be about-

(a) 2.5 m (b) 5 m (c) 7.5 m (d) 10 m

Q.9 Rishabh and Bappy are playing with two different balls of masses m and 2m respectively. If Rishabh throws his ball vertically up and Bappy at an angle θ, both of them stay in our view for the same period. The height attained by the two balls are in the ratio of

(a) 2 : 1 (b) 1 : 1 (c) 1 : cos θ (d) 1 : sec θ

Q.10 A projectile is thrown at an angle θ and $(90^0 - \theta)$ from the same point with same velocity 98 m/s. The heights attained by them, if the difference of heights is 50 m will be (in m)

(a) 270, 220 (b) 300, 250
(c) 250, 200 (d) 200, 150

Q.11 A particle is projected with a velocity u so that its horizontal range is twice the maximum height attained. The horizontal range is

(a) u^2/g (b) $2u^2/3g$ (c) $4u^2/5g$ (d) $u^2/2g$

Q.12 Mr C.P. Nawani kicked off a football with an initial speed 19.6 m/s at a projection angle 45°. A receiver on the goal line 67.4 m away in the direction of the kick starts running to meet the ball at that instant. What must be his speed so that he could catch the ball before hitting the ground ?

(a) 2.82 m/s (b) $2/\sqrt{2}$ m/s
(c) 39.2 m/s (d) 10 m/s

Q.13 A ball is thrown from ground level so as to just clear a wall 4 metres high at a distance of 4 metres and falls at a distance of 14 metres from the wall. The magnitude of velocity of the ball will be

(a) $\sqrt{182}$ m/s (b) $\sqrt{181}$ m/s
(c) $\sqrt{185}$ m/s (d) $\sqrt{186}$ m/s

Q.14 A ball is projected from O with an initial velocity 700 cm/s in a direction 37° above the horizontal. A ball B, 500 cm away from O on the line of the initial velocity of A, is released from rest at the instant A is projected. The height through which B falls, before it is hit by A and the direction of the velocity A at the time of impact will respectively be [given $g = 10\ m/s^2$, sin 37° = 0.6 and cos 37° = 8.0]

(a) 250 cm, 28° 42' (b) 255 cm, 27° 43'
(c) 245 cm, 20° 44' (d) 300 cm, 27° 43'

Q.15 A ball is thrown horizontally from a height of 20 m. It hits the ground with a velocity three times its initial velocity. The initial velocity of ball is

(a) 2 m/s (b) 3 m/s (c) 5 m/s (d) 7 m/s

Q.16 A projectile thrown from a height of 10 m with velocity of $\sqrt{2}$ m/s, the projectile will fall, from the foot of projection, at distance-($g = 10\ m/s^2$)

(a) 1 m (b) 2 m (c) 3m (d) $\sqrt{2}$ m

Q.17 Savita throws a ball horizontally with a velocity of 8 m/s from the top of her building. The ball strikes to her brother Sudhir playing at 12 m away from the building. What is the height of the building ?

(a) 11m (b) 10 m (c) 8 m (d) 7 m

Q.18 A body is projected downwards at an angle of 30° to the horizontal with a velocity of 9.8 m/s from the top of a tower 29.4 m high. How long will it take before striking the ground?

(a) 1s (b) 2s (c) 3s (d) 4s

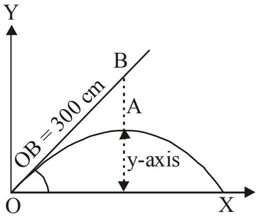
RESPONSE GRID					
	6. ⓐⓑⓒⓓ	7. ⓐⓑⓒⓓ	8. ⓐⓑⓒⓓ	9. ⓐⓑⓒⓓ	10. ⓐⓑⓒⓓ
	11. ⓐⓑⓒⓓ	12. ⓐⓑⓒⓓ	13. ⓐⓑⓒⓓ	14. ⓐⓑⓒⓓ	15. ⓐⓑⓒⓓ
	16. ⓐⓑⓒⓓ	17. ⓐⓑⓒⓓ	18. ⓐⓑⓒⓓ		

Space for Rough Work

Q.19 A ball is thrown from the top of a tower with an initial velocity of 10 m/s at an angle of 30º above the horizontal. It hits the ground at a distance of 17.3 m from the base of the tower. The height of the tower ($g = 10\ m/s^2$) will be

(a) 10m (b) 12m (c) 110m (d) 100m

Q.20 A ball 'A' is projected from origin with an initial velocity v_0 = 700 cm/sec in a direction 37º above the horizontal as shown in fig .Another ball 'B' 300 cm from origin on a line 37º above the horizontal is released from rest at the instant A starts. How far will B have fallen when it is hit by A ?



(a) 9 cm (b) 90 cm

(c) 0.9 cm (d) 900 cm

DIRECTIONS (Q.21-Q.23) : In the following questions, more than one of the answers given are correct. Select the correct answers and mark it according to the following codes:

Codes :

(a) 1, 2 and 3 are correct **(b)** 1 and 2 are correct

(c) 2 and 4 are correct **(d)** 1 and 3 are correct

Q.21 Choose the correct options

(1) A ball is dropped from the window of a moving train on horizontal rails, the path followed by the ball as observed by the observer on the ground is parabolic path.

(2) If T be the total time of flight of a current of water and H be the maximum height attained by it from the point of projection, then H/T will be (1/4) u sinθ

(u = projection velocity and θ = projection angle)

(3) A hunter aims his gun and fires a bullet directly at a monkey on a tree. At the instant bullet leaves the gun, monkey drops, the bullet misses to hit the monkey.

(4) If a baseball player can throw a ball at maximum distance = d over a ground, the maximum vertical height to which he can throw it, will be d

(Ball have same initial speed in each case)

Q.22 A ball projected with speed 'u' at an angle of projection 15º has range R. The other angle of projection at which the range will not be same with same initial speed 'u' is

(1) 45º (2) 35º

(3) 90º (4) 75º

Q.23 A projectile can have the same range R for two angles of projections. If t_1 and t_2 be the times of flight in two cases, then choose the incorrect relations –

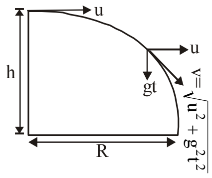
(1) $t_1t_2 \propto 1/R^2$ (2) $t_1t_2 \propto R^2$

(3) $t_1t_2 \propto 1/R$ (4) $t_1t_2 \propto R$

DIRECTIONS (Q.24-Q.26) : Read the passage given below and answer the questions that follows :

Velocity at a general point P(x, y) for a horizontal projectile motion is given by

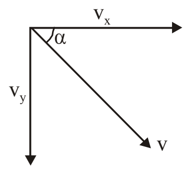
$$v = \sqrt{v_x^2 + v_y^2}\ ; \quad \tan\alpha = \frac{v_y}{v_x}$$



α is angle made by v with horizontal in clockwise direction

Trajectory equation for a horizontal projectile motion is given by $x = v_xt = ut$

$$y = -(1/2)\,gt^2$$



eliminating t, we get $y = -(1/2)\dfrac{gx^2}{u^2}$

RESPONSE GRID	19. ⓐⓑⓒⓓ	20. ⓐⓑⓒⓓ	21. ⓐⓑⓒⓓ	22. ⓐⓑⓒⓓ	23. ⓐⓑⓒⓓ

Space for Rough Work

Q.24 A ball rolls off top of a stair way with a horizontal velocity u m/s. If the steps are h m high and b meters wide, the ball will just hit the edge of n^{th} step if n equals to

(a) $\frac{hu^2}{gb^2}$ (b) $\frac{u^2g}{gb^2}$

(c) $\frac{2hu^2}{gb^2}$ (d) $\frac{2u^2g}{hb^2}$

Q.25 An aeroplane is in a level flying at an speed of 144 km/hr at an altitude of 1000 m. How far horizontally from a given target should a bomb be released from it to hit the target ?

(a) 571.43 m (b) 671.43 m

(c) 471.34 m (d) 371.34 m

Q.26 An aeroplane is flying horizontally with a velocity of 720 km/h at an altitude of 490 m. When it is just vertically above the target a bomb is dropped from it. How far horizontally it missed the target?

(a) 1000 m (b) 2000 m

(c) 100 m (d) 200 m

DIRECTIONS (Q.27-Q.28) : Each of these questions contains two statements: Statement-1 (Assertion) and Statement-2 (Reason). Each of these questions has four alternative choices, only one of which is the correct answer. You have to select the correct choice.

(a) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(b) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(c) Statement -1 is False, Statement-2 is True.

(d) Statement -1 is True, Statement-2 is False.

Q.27 **Statement -1 :** Two projectiles are launched from the top of a cliff with same initial speed with different angles of projection. They reach the ground with the same speed.

Statement -2 : The work done by gravity is same in both the cases.

Q.28 **Statement-1 :** A man projects a stone with speed u at some angle. He again projects a stone with same speed such that time of flight now is different. The horizontal ranges in both the cases may be same. (Neglect air friction)

Statement-2 : The horizontal range is same for two projectiles projected with same speed if one is projected at an angle θ with the horizontal and other is projected at an angle $(90° - \theta)$ with the horizontal. (Neglect air friction)

RESPONSE GRID	24. ⓐⓑⓒⓓ	25. ⓐⓑⓒⓓ	26. ⓐⓑⓒⓓ	27. ⓐⓑⓒⓓ	28. ⓐⓑⓒⓓ

DAILY PRACTICE PROBLEM SHEET 6 - PHYSICS			
Total Questions	28	Total Marks	112
Attempted		Correct	
Incorrect		Net Score	
Cut-off Score	28	Qualifying Score	42
Success Gap = Net Score – Qualifying Score			
Net Score = (Correct × 4) – (Incorrect × 1)			

Space for Rough Work

DAILY PRACTICE PROBLEMS

PHYSICS SOLUTIONS

06

1. **(b)** Given, that $y = \sqrt{3}\, x - (1/2)\, x^2$ ....(1)
The above equation is similar to equation of trajectory of the projectiles
$$y = \tan\theta\, x - 1/2 \frac{g}{u^2\cos^2\theta} x^2 \quad ....(2)$$
Comparing (1) & (2) we get
$\tan\theta = \sqrt{3} \Rightarrow \theta = 60°$
$$\text{and } 1/2 = (1/2)\frac{g}{u^2\cos^2\theta}$$
$\Rightarrow u^2\cos^2\theta = g \Rightarrow u^2\cos^2 60° = 10$
$\Rightarrow u^2 (1/4) = 10 \Rightarrow u^2 = 40 \Rightarrow u = 2\sqrt{10}$ m/s

2. **(a)** For angle of elevation of 60º, we have maximum height
$$h_1 = \frac{u^2\sin^2 60°}{2g} = \frac{3u^2}{8g}$$
For angle of elevation of 30º, we have maximum height
$$h_2 = \frac{u^2\sin^2 30°}{2g} = \frac{u^2}{8g};\ \frac{h_1}{h_2} = \frac{3}{1}$$

3. **(b)** Total time of flight = 2 × time taken to reach max. height
$\Rightarrow t_2 = 2t_1 \Rightarrow t_2/t_1 = 2/1$

4. **(d)** $v_x = dx/dt = 2ct,\ v_y = dy/dt = 2bt$
$$\therefore v = \sqrt{v_x^2 + v_y^2} = 2t\sqrt{c^2 + b^2}$$

5. **(c)** $v_y = dy/dt = 8 - 10\,t = 8$, when $t = 0$ (at the time of projection.)
$$v_x = dx/dt = 6,\ v = \sqrt{v_x^2 + v_y^2} = \sqrt{8^2 + 6^2} = 10 \text{ m/s}$$

6. **(a)** Horizontal component of velocity
$v_x = u_x = u\cos\theta = 30 \times \cos 30° = 15\sqrt{3}$ m/s
Vertical component of the velocity
$v_y = u\sin\theta - gt = 30\sin 30° - 10 \times 1 = 5$ m/s
$v^2 = v_x^2 + v_y^2 = 700 \Rightarrow u = 10\sqrt{7}$ m/s

7. **(a)** Let u_x and u_y be the components of the velocity of the particle along the x- and y-directions. Then
$u_x = dx/dt = u_0$ and $u_y = dy/dt = \omega a\cos\omega t$
Integration : $x = u_0\, t$ and $y = a\sin\omega t$
Eliminating t : $y = a\sin(\omega x/u_0)$
This is the equation of the trajectory
At $t = 3\pi/2\omega$, we have,
$x = u_0\, 3\pi/2\omega$ and $y = a\sin 3\pi/2 = -a$
∴ The distance of the particle from the origin is
$$\sqrt{x^2 + y^2} = \sqrt{\left[\left(\frac{3\pi u_0}{2\omega}\right)^2 + a^2\right]}$$

8. **(b)** $T = \dfrac{2u\sin\theta}{g} \Rightarrow 2 = \dfrac{2u\sin\theta}{g} \Rightarrow u\sin\theta = g$
$$H = \frac{u^2\sin^2\theta}{2g} = \frac{g^2}{2g} = \frac{g}{2} = 5\text{ m}$$

9. **(b)** Let u_1 and u_2 be the initial velocities respectively. If h_1 and h_2 are the heights attained by them, then
$$h_1 = \frac{u_1^2}{2g} \text{ and } h_2 = \frac{u_2^2\sin^2\theta}{2g} \quad ...(1)$$
The times of ascent of balls are equal,
we have $t = u_1/g = u_2\sin\theta/g$
$\therefore u_1 = u_2\sin\theta$ ... (2)
$$\text{From eq. (1) } \frac{h_1}{h_2} = \frac{u_1^2}{u_2^2\sin^2\theta} \quad ... (3)$$
$$\text{From (2) \& (3), } \frac{h_1}{h_2} = \frac{1}{1}$$

10. **(a)** $h_1 = \dfrac{u^2\sin^2\theta}{2g}$ and $h_2 = \dfrac{u^2\sin^2(90-\theta)}{2g}$
$\therefore h_1 + h_2 = u^2/2g\,(\sin^2\theta + \cos^2\theta)$
$$= u^2/2g = \frac{98^2}{2\times 10} = 490$$
$h_1 - h_2 = 50,\ \therefore h_1 = 270$ m and $h_2 = 220$ m

11. **(c)** Greatest height attained
$$h = \frac{u^2\sin^2\theta}{2g} \quad ... (1)$$
Horizontal range
$$R = \frac{u^2\sin 2\theta}{g} = \frac{2u^2\sin\theta\cos\theta}{g} \quad ... (2)$$
Given that R=2h
$$\Rightarrow \frac{2u^2\sin\theta\cos\theta}{g} = \frac{2u^2\sin^2\theta}{2g}$$
$\Rightarrow \tan\theta = 2$ ... (3)
Hence $\sin\theta = 2/\sqrt{5}$, $\cos\theta = 1/\sqrt{5}$,
∴ From (2) $R = 4u^2/5g$

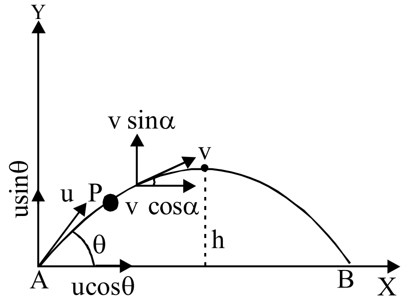
12. **(d)** $R = \dfrac{u^2\sin 2\theta}{g} = (19.6)^2\sin 90°/10 = 39.2$ m
Man must run (67.4m – 39.2 m) = 28.2 m in the time taken by the ball to come to ground. Time taken by the ball.

$$t = \frac{2u\sin\theta}{g} = \frac{2\times 19.6\sin 45^\circ}{9.8} = \frac{4}{\sqrt{2}} = 2.82 \text{ sec}$$

$$\text{Velocity of man} = \frac{28.2\text{m}}{2.82 \text{ sec}} = 10 \text{ m/s}$$

13. (a) Referring to (fig.) let P be a point on the trajectory whose co-ordinates are (4, 4). As the ball strikes the ground at a distance 14 metre from the wall, the range is 4 + 14 = 18 metre. The equation of trajectory is

$$y = x\tan\theta - (1/2)\, g\, \frac{x^2}{u^2\cos^2\theta}$$



$$\text{or} \quad y = x\tan\theta\left[1 - \frac{gx}{2u^2\cos^2\theta.\tan\theta}\right]$$

$$\text{or} \quad y = x\tan\theta\left[1 - \frac{2u^2}{g}\frac{x}{\sin\theta\cos\theta}\right]$$

$$= x\tan\theta\left[1 - \frac{x}{R}\right] \qquad \text{...(1)}$$

Here x = 4, y = 4 and R = 18

$$\therefore\ 4 = 4\tan\theta\left[1 - \frac{4}{18}\right] = 4\tan\theta\left(\frac{7}{9}\right)$$

or $\tan\theta = 9/7$, $\sin\theta = 9/\sqrt{130}$ and

$\cos\theta = 7/\sqrt{130}$

Again $R = (2/g)\, u^2 \sin\theta\cos\theta$

$= (2/9.8) \times u^2 \times (9/\sqrt{130}) \times (7/\sqrt{130})$

$$u^2 = \frac{18\times 9.8\times\sqrt{130}\times\sqrt{130}}{2\times 9\times 7} = \frac{98\times 13}{7} = 182,$$

$u = \sqrt{182}$ metre per second.

14. (b) The situation is shown in fig.

(a) Let the ball collide after t sec

From fig. OC = OB cos 37° = 500 cos 37°

= 500 × 0.8 = 400 cm ...(1)

Horizontal velocity = 700 × cos 37°

∴ OC = 700 × cos 37° × t

= 700 × 0.8 × t = 560 t ... (2)

From eqs. (1) and (2) 560 t = 400

or t = (5/7) sec.

Now $h = (1/2)\, g t^2 = (1/2) \times 1000 \times (5/7)^2 = 255.1$ cm

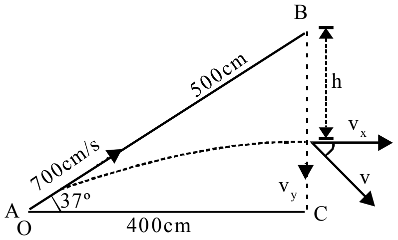
(b) Let at the time of impact, v_x and v_y be the horizontal and vertical velocities respectively, then

$v_x = 700 \times \cos 37^\circ = 700 \times 0.8 = 560$ cm/s

and $v_y = -700 \times \sin 37^\circ + 1000 \times (5/7)$

$= -700 \times 0.6 + (5000/7) = -420 + 714.3$

$= +294.3$ cm/sec (downward)



Velocity of the ball at the time of collision

$$v = \sqrt{(v_x^2 + v_y^2)}$$

$$\therefore\ v = \sqrt{[(560)^2 + (294.3)^2]} = 632.6 \text{ cm/sec}$$

$$\text{Again } \tan\theta = \frac{v_y}{v_x} = \frac{294.3}{560}$$

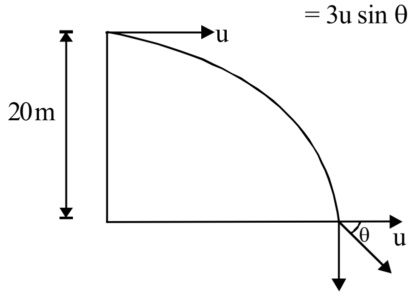
$$\text{or } \theta = \tan^{-1}\left(\frac{294.3}{560}\right) = 27^\circ 43'$$

15. (d) Initial velocity is constant let the ball touches the ground at an angle θ and velocity 3u

Hence 3u cos θ = u or cos θ = 1/3 or sin θ = $\sqrt{8}/3$

The vertical component of velocity at the ground

$$= 3u\sin\theta = \frac{3\sqrt{8}}{3} = \sqrt{8}\, u$$



For a freely falling body it covers 20 m to acquire velocity $\sqrt{8}$ u

$\therefore (\sqrt{8}\,u)^2 - 0 = 2 \times 9.8 \times 20$ or u = 7 m/s

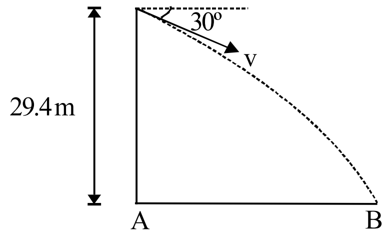
16. (b) The horizontal range of the projectile on the ground

$$R = u\sqrt{\frac{2h}{g}} \Rightarrow R = \sqrt{2}\sqrt{\frac{2\times 10}{10}} = \sqrt{2}.\sqrt{2} = 2\text{m}$$

17. (a) $R = ut \Rightarrow t = R/u = 12/8$

Now $h = (1/2)\, gt^2 = (1/2) \times 9.8 \times (12/8)^2 = 11$ m

18. (b) The situation is shown in the adjoining figure. The time taken by the body is equal to the time taken by the freely falling body from the height 29.4 m. Initial velocity of body



$u \sin\theta = 9.8 \sin 30^\circ = 4.9$ m/s

From the relation, $h = u \sin\theta\, t + (1/2)\, gt^2$,

we get $29.4 = 4.9\, t + (1/2) \times 9.8\, t^2 \Rightarrow t = 2$ sec

19. (b) The horizontal and vertical velocities of the bomb are independent to each other. The time taken by the bomb to hit the target can be calculated by its vertical motion. Let this time be t. Putting h = 490 m and g = 9.8 m/s^2 in the formula $h = 1/2\, gt^2$,

we have $490 = (1/2) \times 9.8 \times t^2$,

$\therefore t = \sqrt{\dfrac{2 \times 490}{9.8}} = 10$ sec

The bomb will hit the target after 10 sec of its dropping. The horizontal velocity of the bomb is 60 km/hr which is constant. Hence the horizontal distance travelled by the bomb in 10 sec (horizontal velocity × time)

= 60 km/hr × 10 sec

= 60 km/hr × 10/(60 × 60) hr = 1/6 km

Hence the distance of aeroplane from the enemy post is 1/6 km = 1000/6 m = 500/3 meter.

The trajectory of the bomb as seen by an observer on the ground is parabola. Since the horizontal velocity of the bomb is the same as that of the aeroplane, the falling bomb will always remain below the aeroplane. Hence the person sitting inside the aeroplane will observe the bomb falling vertically downward.

20. (a) The angle of projection of the ball is θ_0 (= 30°) and the velocity of projection is u (= 10 m/s). Resolving u in horizontal and vertical components,

we have horizontal component,

$u_x = u \cos\theta_0 = 10 \cos 30^\circ = 8.65$ m/s

and vertical component (upward),

$u_y = u \sin 30^\circ = 5.0$ m/s

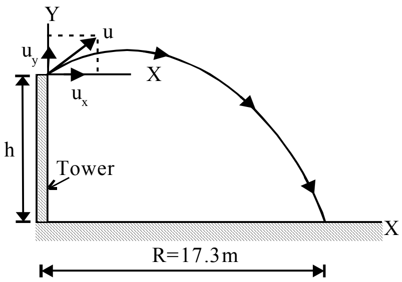
If the ball hit the ground after t sec of projection, then the horizontal range is $R = u_x \times t = 8.65\, t$ meter

$\therefore t = \dfrac{R}{8.65} = \dfrac{17.3\text{m}}{8.65\text{m/s}} = 2.0$ s

If h be the height of the tower,

then $h = u'_y\, t + (1/2)\, g\, t^2$,

where u_y' is the vertical component (downward) of the velocity of the ball.



Here $u_y = -u_y' = -5.0$ m/s and t = 2.0 s

$\therefore h = (-5.0) \times 2.0 + 1/2 \times 10 \times (2.0)^2$

= – 10 + 20 = 10 meter

21. (b) Let the ball B hits the ball A after t sec

The X-component of velocity of A is

$v_0 \cos 37^\circ = 700 \cos 37^\circ$

The X-compoment of position of B is 300 cos 37°

The collision will take place when the X-coordinate of A is the same as that of B.

As the collision takes place at a time t, hence

700 cos 37° × t = 300 cos 37°

or t = (300/700) = (3/7) sec

In this time the ball B has fallen through a distance

$y = -1/2\ gt^2$ (Free fall of body B)

$= -1/2 \times 980 \times (3/7)^2 = -90$ cm

Hence the ball B falls a distance 90 cm

22. (b)

(1) Because force is constant hence acceleration will be constant. When force is in oblique direction with initial velocity, the resultant path is parabolic path.

(2) Total time of flight = $T = \dfrac{2u\sin\theta}{g}$,

Maximum height attained $H = \dfrac{u^2 \sin^2\theta}{2g}$

Now $\dfrac{H}{T} = \dfrac{u \sin\theta}{4}$

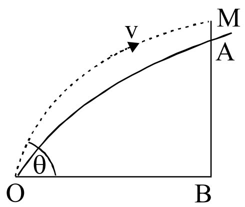
(3) Initially the height of the monkey = MB = y = x tan θ
Let the monkey drop to along line MA and the bullet reach along the parabolic path OA. If both reach at A simultaneously, the monkey is hit by the bullet.

$AB = x\tan\theta - \dfrac{gx^2}{2u^2\cos^2\theta}$,

$\therefore$ MA = MB – AB

$MA = x\tan\theta - x\tan\theta + \dfrac{gx^2}{2u^2\cos^2\theta}$

$= \dfrac{gx^2}{2u^2\cos^2\theta}$ ....(i)



Time taken by the bullet to reach point A,

$t = \dfrac{x}{u\cos\theta}$ ....(ii)

Hence from (1), $MA = (1/2) gt^2$
The monkey drops through distance $(1/2) gt^2$ in the same time. So the monkey is hit by the bullet.

(4) The range $R = \frac{u^2 \sin 2\theta}{g}$

$\therefore$ Maximum range $R_{max} = d = \frac{u^2}{g}$ ....(iii)

Height $H = \frac{u^2 \sin^2 \theta}{2g}$

$\therefore$ Maximum height

$H_{max} = \frac{u^2}{2g}$ ....(iv)

From (iii) & (iv), $H_{max} = d/2$

23. (a) Range of projectile, $R = \frac{u^2 \sin 2\theta}{g}$

The range is same for two angle θ_1 and θ_2 provided $\theta_2 = 90^\circ - \theta_1$

At an angle θ_1, range $R_1 = \frac{u^2 \sin 2\theta_1}{g}$

At an angle of projection θ_2,

Range $R_2 = \frac{u^2 \sin 2\theta_2}{g}$

$= \frac{u^2 \sin 2(90^\circ - \theta_1)}{g} = \frac{u^2 \sin 2\theta_1}{g}$

$\Rightarrow R_1 = R_2$
$\therefore$ other angle $= 90^\circ - \theta_1 = 90^\circ - 15^\circ = 75^\circ$

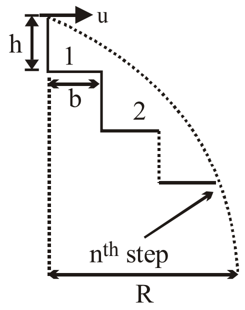
24. (a) $t_1 = \frac{2u \sin \theta}{g}$

$t_2 = \frac{2u \sin(90^\circ - \theta)}{g} = \frac{2u \cos \theta}{g}$

$t_1 t_2 = \frac{2}{g} \frac{u^2 \sin 2\theta}{g} = \frac{2}{g} . R$

where R is the range, Hence $t_1 t_2 \propto R$

25. (c) If the ball hits the n^{th} step, the horizontal and vertical distances traversed are nb and nh respectively.



Let t be the time taken by the ball for these horizontal and vertical displacement. Then velocity along horizontal direction remains constant = u ; initial vertical velocity is zero
$\therefore nb = ut$ ....(1)
$nh = 0 + (1/2) gt^2$ ....(2)
From (1) & (2) we get
$nh = (1/2) g (nb/u)^2$

$\Rightarrow n = \frac{2hu^2}{gb^2}$ (eleminating t)

26. (a) $y = (1/2) gt^2$ (downward)
$\Rightarrow 1000 = (1/2) \times 10 \times t^2 \Rightarrow t = 14.15$ sec

$x = ut = \left(\frac{144 \times 10^3}{60 \times 60}\right) \times 14.15 = 571.43$ m

27. (b) Horizontal component of velocity
$= 720 \times 5/8 = 200$ m/s
Let t be the time taken for a freely falling body from 490.
Then $y = (1/2) gt^2$
$\Rightarrow 490 = (1/2) \times 9.8 \times t^2 \Rightarrow t = 10$ second
Now horizontal distance = Velocity × time
$= 200 \times 10 = 2000$m
Hence the bomb missed the target by 2000 m

28. (a) Since $W = \Delta K$ implies that the final speed will be same.

29. (a) The time of flight depends only on the vertical component of velocity which remains unchanged in collision with a vertical wall.

30. (a) In statement-2, if speed of both projectiles are same, horizontal ranges will be same. Hence statement-2 is correct explanation of statement-1.