

Physics

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(Chapter 4) (Laws of Motion) (Exercises)
(Class 11)

Question 4.20:

A batsman deflects a ball by an angle of 45° without changing its initial speed which is equal to 54 km/h . What is the impulse imparted to the ball? (Mass of the ball is 0.15 kg .)

Answer 4.20:

The given situation can be represented as shown in the following figure.

Where, AO = Incident path of the ball

OB = Path followed by the ball after deflection

$\angle AOB$ = Angle between the incident and deflected paths of the ball

$= 45^\circ$

$\angle AOP = \angle BOP = 22.5^\circ = \theta$

Initial and final velocities of the ball = v

Horizontal component of the initial velocity = $v \cos \theta$ along RO

Vertical component of the initial velocity = $v \sin \theta$ along PO

Horizontal component of the final velocity = $v \cos \theta$ along OS

Vertical component of the final velocity = $v \sin \theta$ along OP

The horizontal components of velocities suffer no change. The vertical components of velocities are in the opposite directions.

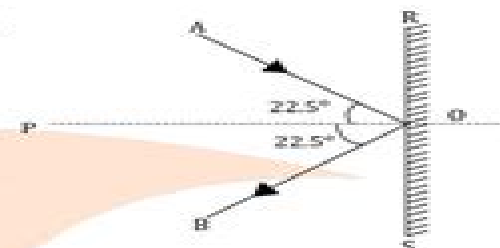
$\therefore$ Impulse imparted to the ball = Change in the linear momentum of the ball

$= mv \cos \theta - (-mv \cos \theta) = 2mv \cos \theta$

Mass of the ball, $m = 0.15 \text{ kg}$

Velocity of the ball, $v = 54 \text{ km/h} = 15 \text{ m/s}$

$\therefore$ Impulse = $2 \times 0.15 \times 15 \cos 22.5^\circ = 4.16 \text{ kg m/s}$



Question 4.21:

A stone of mass 0.25 kg tied to the end of a string is whirled round in a circle of radius 1.5 m with a speed of 40 rev/min in a horizontal plane. What is the tension in the string? What is the maximum speed with which the stone can be whirled around if the string can withstand a maximum tension of 200 N ?

Answer 4.21:

Mass of the stone, $m = 0.25 \text{ kg}$

Radius of the circle, $r = 1.5 \text{ m}$

Number of revolution per second,

$$n = \frac{40}{60} = \frac{2}{3} \text{ rps}$$

Angular velocity, $\omega = v/r = 2\pi n \dots (i)$

The centripetal force for the stone is provided by the tension T , in the string, i.e., $T = F_{\text{centripetal}}$

$$= \frac{mv^2}{r} = mr(i)^2 = mr(2\pi n)^2 = 0.25 \times 1.5 \times \left(2 \times 3.14 \times \frac{2}{3}\right)^2 = 65 \text{ N}$$

Maximum tension in the string, $T_{\text{max}} = 200 \text{ N}$

$$T_{\text{max}} = \frac{mv_{\text{max}}^2}{r}$$

$$\therefore V_{\text{max}} = \sqrt{\frac{T_{\text{max}} \times r}{m}} = \sqrt{\frac{200 \times 1.5}{0.25}} = \sqrt{1200} = 34.64 \text{ m/s}$$

Therefore, the maximum speed of the stone is 34.64 m/s .

Conceptual Physics 11th Edition Chapter 4 Answers

Gordon P. Ramsey



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