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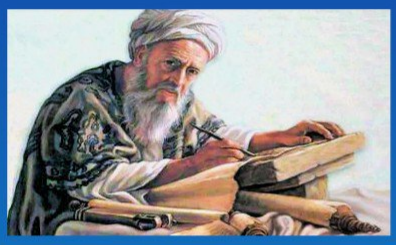
SEVEN MUSLIMS NOTES

PHYSICS 11

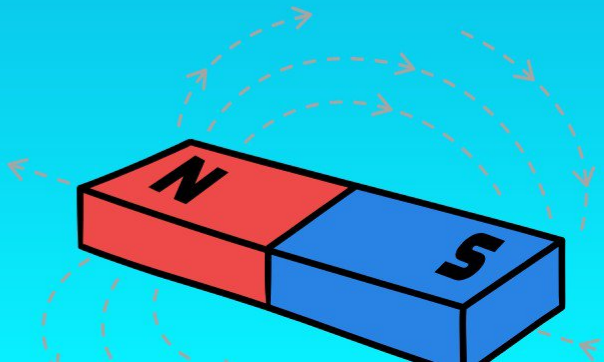


Al-Biruni (973–1048) calculated the Earth's radius and worked on the physics of planetary motion.

Best Regards to

Sir Muhammad Ali

(Physics Lecturer KIPS College)



ANGULAR MOTION

EXERCISE SHORT QUESTIONS

5.1. Explain the difference between tangential velocity and angular velocity. If one of these is given for a wheel of known radius, how will you find the other?

	Tangential velocity	Angular velocity
1.	Linear velocity of a particle moving along a circular path is called tangential velocity.	The time rate of change of angular displacement is called angular velocity.
2.	It is denoted by v.	It is denoted by ω.
3.	Its direction is along the tangent on any point of the circle.	Its direction is along the axis of rotation.
4.	Its unit is m/s.	Its unit is rad/s.

If one of these is given for a wheel of known radius, we can find the other by using formula $v = r\omega$

5.2. Explain what is meant by centripetal force and why it must be furnished to an object if the object is to follow a circular path?

"The force needed to bend the normally straight path of a particle into a circular path is called centripetal force."

To move an object in a circular path, it must be furnished to the object because without this, the object will move along the tangent.

5.3. What is meant by moment of inertia? Explain its significance.

" The product of mass of an object and square of its perpendicular distance from axis of rotation is called moment of inertia."

Significance:

Moment of inertia plays the same role in angular motion as mass plays in linear motion.

5.4. What is meant by angular momentum? Explain the law of conservation of angular momentum.

Angular momentum:

"The quantity of angular motion possessed by a body is called its angular momentum."

Law of conservation of Angular Momentum:

"If no external torque acts on a body, then the total angular momentum of a system Remains constant."

Mathematically

$$L_{tot} = L_1 + L_2 + L_3 + \ldots = \text{constant}$$

OR $$I_1\omega_1 = I_2\omega_2$$

5.5. Show that the orbital angular momentum L= mr

For orbital motion of a particle

$$L_o = r \times p$$

$$L_o = rp\sin\theta$$

The angle between r and p is 90°

$$L_o = r\,(mv)\sin 90$$

$$L_o = mvr \qquad \text{Hence proved}$$

5.6. Describe what should be the minimum velocity, for a satellite, to orbit close to the earth around it.

"The minimum velocity necessary to put a satellite into an orbit around the earth is called critical velocity."

For a close orbiting satellite, the centripetal acceleration provided by the gravity is given as

$$a_c = g$$

$$g = \frac{v^2}{R}$$

$$v = \sqrt{gR}$$

$$= \sqrt{9.8 \times 6.4 \times 10^6} = 7.9 \text{ km/s}$$

That is the minimum velocity for a close orbiting satellite.

5.7. State the direction of the following vectors in simple situations; angular momentum and angular velocity.

The direction of angular momentum and angular velocity is along the axis of rotation which is determined by right hand rule.

Right Hand Rule:

"Grasp the axis of rotation with your right hand in such a way that curling fingers are in the direction of rotation then erected thumb points the direction of angular momentum and angular velocity."

5.8. Explain why an object, orbiting around the earth, is said to be freely falling. Use your explanation to point why objects appear weightless under certain circumstances.

When an object is thrown parallel to the horizontal surface of earth in the absence of air resistance with large speed such that, curvature of its path matches the curvature of earth, it starts orbiting around the earth. Such an object is all time falling freely towards the center of earth with acceleration equals to the gravitational acceleration of earth.

Weightlessness:

The object falling freely in space under the action of gravity is said to be in a state of weightlessness and anything inside it will appear weightless. Such a system is called gravity free system.

5.9. When mud flies off the tyre of a moving bicycle, in what direction must it fly? Explain.

The mud flies off along the tangent to the path. When the speed of the tyre increases, the adhesive force between the mud and the tyre is not sufficient to provide necessary centripetal force so the mud leaves the tyre and moves along the tangent to tyre.

5.10. A disc and a hoop start moving down from the top of an inclined plane at the same time. Which one will be moving faster on reaching the bottom?

Speed of the hoop v_h at the bottom of inclined plane is

$$v_h = \sqrt{gh}$$

Speed of the disc v_d at the bottom of inclined plane is

$$v_d = \sqrt{\frac{4gh}{3}} = \sqrt{\frac{4}{3}}\sqrt{gh} = 1.15\ v_h$$

$$v_d > v_h$$

Thus the disc will move faster than the hoop.

5.11. Why does a diver change his body positions be fore and after diving into the pool?

A diver changes his body positions before and after diving into the pool to make extra somersaults. When a diver lifts off from the diving board, his legs and arms are fully extended. In this case, moment of inertia is large but angular velocity is small. When the legs and the arms of the diver are drawn into the close tuck position, his moment of inertia reduces and his angular velocity is increased to keep the angular momentum constant.

5.12. A student holds two dumb-bells with stretched arms while sitting on a turn table. He is given a push until he is rotating at certain angular velocity. The student then pulls the dumb-bells towards his chest. What will be the effect on rate of rotation?

The rate of rotation will increase when the student pulls the dumb-bells towards his chest.

Explanation:

When student holds two dumb-bells by stretching his arms, then value of momentum of inertia is increased because of which angular speed is decreased. When the student pulls the dumb-bells towards his chest, moment of inertia decreases and angular velocity is increased. But during this whole process total angular momentum remains conserve.

5.13. Explain how many minimum numbers of geostationary satellites are required for global coverage of T.V transmission?

A satellite in geostationary orbit can cover 120° longitude of the earth so minimum three geostationary satellites are required to cover whole earth's surface for global coverage of T.V transmission.