Chapter#4

Dynamics II

Q:1. Why long spanner is used to open or tight nuts of vehicle's tire? While tightening a small nut, extra-long wrench is not suitable. Why?

A long spanner provides a greater moment of force ($\tau = r \times F$) than a short one hence less force is applied. That's why long spanner is used to open or tight nuts of vehicle's tire. If we use extra-long wrench for tightening a small bolt, a large torque will produce. This may damage or break the bolt. So extra-long wrench is not suitable for tightening a small nut.

Q:2. Why door knobs are fixed at the edge of door? What will happen if the door knob is at the middle of the door?

Door knobs are fixed at the edge of door because doors are opened through the application of torque($\tau = r \times F$). To make it as easy as possible to open the door, the knobs are placed as far from the hinge as is feasible. This maximizes the moment arm, reducing the amount of force needed to open the door.

If the door knob is at the middle of the door then greater force is required as compared to the door knob at the edge of the door. Because the knob at the middle of the door decreases the moment arm which means greater force is required to open the door.

Q:3. If you drop a feather and a bowling ball from the same height, which one will reach the terminal velocity first? Which one of them will hit the ground first?

A feather has a much larger surface area relative to its mass compared to a bowling ball. This means the feather experiences a much higher air resistance relative to its weight. Thus, the feather will reach its terminal velocity (Uniform velocity) first. So feather's height is greater than ball's height of attaining terminal velocity (Uniform velocity). When object is moving with uniform velocity then

$S = vt$ $\quad$ S ∝ t

This equation shows that ball hit the ground first because its distance from earth is less than feather.

Q:4. Why do ice skates effortlessly slide on ice, while your shoes cause skidding?

Skates slide effortlessly on ice because of the combination of pressure and frictional force. When a skater pushes forward, the friction between the skate blade and the ice generates heat, creating a thin layer of almost liquid water that reduces friction, allowing the skater to glide smoothly. On the contrary, shoes cause skidding because the friction coefficient between the shoe soles and the ice is not sufficient to prevent slipping.

For example, while walking, the frictional force is necessary to keep your foot in place as it pushes off and for the front foot to slow down the forward motion of your center of gravity. Skates, on the other hand, have thin, sharp blades that concentrate the weight of the skater onto a tiny area, generating enough pressure to create a slippery surface of water, minimizing friction and enabling smooth movement on ice.

Q:5. Explain why it's easier to push a car on flat tires than inflated ones. What happens to the frictional force between the tires and the road?

When the car's tires are flat, the contact area between the tires and the road increases significantly. The frictional force between the tires and the road is directly proportional to the normal force acting

on the tires. With a larger contact area due to flat tires, the normal force increases, leading to a higher frictional force. This increased frictional force makes it easier to push the car as the tires grip the road better and provide more static friction.

Q:6. When standing on a crowded school bus, which stance would provide better stability and prevent you from being pushed over: legs joined or legs spread apart?

Legs spread apart would provide better stability and prevent you from being pushed over. Because it lowers yours center of gravity and wider the base of support contributing to increase stability. It means that it takes more force to move your center of gravity outside your base of support. Legs joined would provide less stability. Because this high your center of gravity and narrower the base of support contributing to decrease in stability.

Q:7. Why a moving bicycle is easier to balance? Relate this to the principles of rotational motion.

A moving bicycle is easier to balance because the spinning wheels have higher angular velocity and momentum. This angular momentum makes it difficult for external force (like push or a tilt) to change in their orientation and helps keep the bike upright. The faster the wheels spin, the stronger this stabilizing effect is, making it easier for the rider to maintain balance.

Q:8. Why is a pencil standing on its tip unstable, and what factors affect the stability of an object balanced on a point?

A pencil standing on its tip is unstable because it has a high center of gravity and a very small base of support. Stability is affected by the position of the center of gravity, the size of the base of support, and the line of action. For an object to be stable its center of gravity should be low and its base of support should be wide, ensuring that the line of action remains within the base.

Q:9. While driving what happens if the driver takes the curve too fast? How does centripetal force play a role in keeping the car from skidding off the road?

When a driver takes a curve too fast, several things can happen. One of the primary risks is that the car may skid off the road due to inertia and lack of centripetal force $\left(F_c = \frac{mv^2}{r}\right)$ it keeps the car moving in a curved path by acting toward the center of the curve. It is provided by the friction between the tires and the road surface.

Q:10. Consider a situation where you swing a ball connected to a string in a circle. How does the tension in the string vary as the ball moves across different points in its circular path, and what forces are involved?

As the ball moves in a circle, the tension in the string varies. At the top of the circle, tension is lowest as it only opposes gravity. At the bottom, tension is highest, countering gravity and providing centripetal force. Throughout, forces involved are tension, gravity and centripetal force.

Q:11. Why is it important for communication satellites in geostationary orbit to maintain a specific speed?

Communication satellites in geostationary orbit must maintain a specific speed equal to the speed of rotation of the Earth. This ensures they remain fixed (Stationary) relative to a specific point on the Earth's surface, allowing uninterrupted communication with ground-based receivers.