Grade 10 Chapter 1 Workbook Questions

St John Baptist De La Salle Catholic School, Addis Ababa

22/23 Academic Year

Questions

1. Define the following terms and explain what relationships they have with respects to projectile motion.

   (i) Trajectory

   (ii) Projectile

   (iii) Air resistance

   (iv) Kinematics

   (v) Drag

2. During a fireworks display, a shell is shot into the air with an initial speed of $64.0 m/s$ at an angle of 65.0^0 above the horizontal. The fuse is timed to ignite the shell just as it reaches its highest point above the ground.

   (i) Calculate the vertical distance above the ground at which the shell explodes.

   (ii) How much time passed between the launch of the shell and the explosion?

   (iii) What is the horizontal displacement of the shell when it explodes?

   (iv) If the shell didn't explode, calculate the velocity it will have just before touching the ground.

3. Suppose a large rock is ejected during a tectonic activity with a speed of $35.0 m/s$ and at an angle 38^0 above the horizontal. The rock strikes a plateau at an altitude 400.0 m lower than its starting point.

   (i) Calculate the time it takes the rock to follow this path.

   (ii) What are the magnitude and direction of the rock's velocity at impact.

   (iii) What is the highest vertical range of distance it achieves during its trajectory?

4. A person standing on the edge of the rooftop of a skyscraper accidentally throws his phone straight up with an initial velocity of $20.0 m/s$. The rock misses the edge as it falls back to earth. Calculate the position and velocity of the rock 1.00 s, 2.00 s, and 3.00 s after it is thrown, neglecting the effects of air resistance.

5. Helicopters have a small propeller on their tail to keep them from rotating in the opposite direction of their main lifting blades. Explain in terms of Newton's third law why the helicopter body rotates in the opposite direction to the blades.

6. An ultracentrifuge accelerates from rest to 80,000 rpm in 4.00 min.

   (i) What is its angular acceleration in rad/s^2?

(ii) What is the tangential acceleration of a point 6.50 cm away from the axis of rotation?

(iii) What is the radial acceleration in m/s^2 and multiples of g of the point in (ii) at full rpm?

7. Veronica exerts a force of 180 N tangential to a 0.4-m radius 60.0-kg grindstone that is geometrically a solid disk.

   (i) What torque is veronica exerting on the grindstone?

   (ii) If the grindstone generates no opposing friction, what is its rotational acceleration?

   (iii) What is the angular acceleration if there is an opposing frictional force of 18.0 N exerted 2 cm from the axis?

8. Calculate the angular momentum of a ballerina spinning at 7.00 rev/s given her moment of inertia is $6kg - m^2$.

   (i) She reduces her spin rate by extending her arms and increasing her moment of inertia. Find the value of her moment of inertia if her angular velocity decreases to 3 rev/s.

   (ii) Suppose instead she keeps her arms in and allows friction of the ice to slow her to 2.00 rev/s. What average torque was exerted if this takes 15.0 s?

9. Given that the mass of the Earth is around 5.96×10^{24} kg, answer the following questions.

   (i) Calculate the angular momentum of Earth on its axis.

   (ii) What is the angular momentum of Earth in its orbit around the Sun?

   (iii) Calculate the rotational kinetic energy of Earth on its axis.

   (iv) What is the rotational kinetic energy of Earth in its orbit around the Sun?

10. While getting ready for a free-kick, Addis rotates his leg about the hip joint. The moment of inertia of the leg is $2.8kg - m^2$ and its rotational kinetic energy is 175 J.

    (i) What is the angular velocity of the leg?

    (ii) What is the velocity of tip of Addis's shoe if it is 1.2 m from the hip joint?

    (iii) Explain how the football can be given a velocity greater than the tip of the shoe (necessary for a decent kick distance). (*Hint: think of the effect time has while kicking a ball.*)

11. The Moon and Earth rotate about their common center of mass, which is located about 4700 km from the center of Earth. (This is 1690 km below the surface of the Earth.)

    (i) Calculate the magnitude of the acceleration due to the Moon's gravity at that point.

    (ii) For a hypothetical asteroid of mass 9000 kg, estimate the force exerted on it by the moon if it is at that point.

12. State three of Kepler's laws and the physical reasoning behind each law.

13. We know that the Moon orbits Earth each 27.3 days and that it is an average distance of 3.84×10^8m from the center of Earth.

    (i) A geosynchronous Earth satellite is one that has an orbital period of precisely 1 day. Such orbits are useful for communication and weather observation because the satellite remains above the same point on Earth (provided it orbits in the equatorial plane in the same direction as Earth's rotation). Calculate the radius of such an orbit.

    (ii) Calculate the period of an artificial satellite orbiting at an average altitude of 2000 km above Earth's surface.