2 - Mechanics

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2 Mechanics

2.1 Newtons Laws of Motion

- (1998) State Newton's laws of motion.
- (1998) A ball of mass 0.4 kg is dropped vertically from a height of 2.5 m on to a horizontal table and bounces to a height of 1.5 m.
  - Find the kinetic energy of the ball just before striking the table.
  - Find the kinetic energy just after impact.
  - Suggest reasons for the difference between these two values of kinetic energy.
  - What height would you expect the ball to reach after its next bounce from the table?
- (1998) A jet of water flowing with a velocity of 20 ms^{-1} from a pipe of cross-sectional area, 5.0×10^{-3} m^2 , strikes a wall at right angles and loses all its velocity.
  - What is the mass of water striking the wall per second?
  - What is the change in momentum per second of the water hitting the wall?
  - What is the force exerted on the wall?
- (1999) Define momentum
- (1999) Define impulse of a force
- (1999) A jet of water emerges from a hose pipe of a cross-sectional area 5.0×10^{-3} m^2 with a velocity of 3.0 m/s and strikes a wall at right angle. Assuming the water to be brought to rest by the wall and does not rebound, calculate the force on the wall.
- (1999) Distinguish between static and dynamic friction.
- (2007) A ball is thrown towards a vertical wall from a point 2 m above the ground and 3 m from the wall. The initial velocity of the ball is 20 m/s at an angle of 30 deg above the horizontal. If the collision of the ball with the wall is perfectly elastic, how far behind the thrower does the ball hit the ground?
- (2007) Explain why when catching a fast moving ball, the hands are drawn back will the ball is being brought to rest.

- (2007) Rockets are propelled by the ejection of the products of the combustion of fuel. Consider a rocket of total mass M travelling at a speed v in a region of space where the gravitational forces are negligible.
- (2007) Supposing the combustion products are ejected at a constant speed v, relative to the rocket, show that a fuel "burn" which reduces the total mass M of the rocket to m results in an increase in the speed of the rocket to v such that $v - V = V_f \ln(M/m)$.
- (2007) Supposing that 2.1×10^6 kg of fuel are consumed during a "burn" lasting 1.5×10^2 seconds and given that there is a constant force on the rocket of 3.4×10^7 N during this burn, calculate v, and increase in speed resulting from the burn if $M = 2.8 \times 10^6$ kg.
- (2007) What is the initial vertical acceleration that can be imparted to this rocket when it is launched from the Earth if the initital mass is 2.8×10^6 kg?
- (2007) State and define Newtons 2nd law of motion with respect to angular motion.
- (2013) A man stands in a lift which is being accelerated upwards at 3.2 m/s^2 . If the man has a mass of 65 kg, what is the net force exerted on the man by the floor of the lift?
- (2013) A rubber cord of a $Y-$ shaped object has a cross sectional area of 4×10^{-6} m^2 ? And relaxation length of 100 mm. If the arms of the catapult are 70 mm apart, calculate the:
  - tension in the rubber.
  - force required to stretch it when the rubber cord is pulled back until its length doubles.
- (2014) State the principle of conservation of linear momentum.
  - Give two examples of the principle of conservation of linear momentum.
- (2014) An insect is released from rest at the top of the smooth bowling ball such that it slides over the ball. Prove that it will loose its footing with the ball at an angle of about 48° with the vertical.
- (2014) A vertical spring fixed at one end has a mass of 0.2 kg and is attached at the other end.
  - Determine the:
  - Extension of the spring.
  - Energy stored in the spring.
- (2014) Define torque and give its S.I. unit.
- (2014) Give two ways in which the internal energy of the system can be changed.
- (2016) State the principles on which the rocket propulsion is based.
- (2016) A jet engine on a test bed takes in 40 kg of air per second at a velocity of 100 m/s and burns 0.80 kg of fuel per second. After compression and heating the exhaust gases are ejected at 600 m/s relative to the air craft. Calculate the thrust of the engine.
- (2016) An object of mass 2 kg is attached to the hook of a spring balance which is suspended vertically to the roof of a lift. What is the reading on the spring balance when the lift is:

  - going up with the rate of 0.2 m/s^2
  - going down with an acceleration of 0.1 m/s^2
  - ascending with uniform velocity of 0.15 m/s

- (2016) Define the term inertia.
- (2017) A 75 kg hunter fires a bullet of mass 10 g with a velocity of 400 m/s from a gun of mass 5 kg. Calculate the:
  - Recoil velocity of the gun.
  - Velocity acquired by the hunter during firing.
- (2017) A traffic light is suspended with two steel wires of equal lengths and radii of 0.5 cm. If the wires make an angle of 15° with the horizontal, what is the fractional increase in their length due to the weight of the light?
- (2018) Under what condition a passenger in a lift feels weightless?
- (2018) Calculate the tension in the supporting cable of an elevator of mass 500 kg which was originally moving downwards at 4 m/s and brought to rest with constant acceleration at a distance of 20 m.
- (2018) The rotating blades of a hovering helicopter swept out an area of radius 2 m imparting a downward velocity of 8 m/s of the air displaced. Find the mass of a helicopter.
- (2019) A rocket of mass 20 kg has 180 kg of fuel. If the exhaust velocity of the fuel is 1.6 km/sec, calculate;
  - The minimum rate of fuel consumption that enable the rocket to rise from the ground.
  - The ultimate vertical speed gained by the rocket when the rate of fuel consumption ts 2 kg/sec.
- (2019) Determine the least number of pieces required to stop the bullet if a rifle bullet loses 1/20 of its velocity when passing through them.
- (2019) A man of 100 kg jumps into a swimming pool from a height of 5 m. If it takes 0.4 seconds for the water in a pool to reduce its velocity to zero, what average force did the water exert on the man?

2.2 Projectile Motion

- (2000) Mention two motions that add up to make projectile motion.
- (2000) In long jumps does it matter how high you jump? State the factors which determine the span of the jump.
- (2000) Derive an expression that relates the span of the jump and the factors you have mentioned.
- (2000) A bullet is fired from a gun on the top of a cliff 140 m high with a velocity of 150 m/s at an elevation of 30° to the horizontal. Find the horizontal distance from the foot of a cliff to the point where the bullet lands on the ground.

- (2007) What is meant by the term "projectile" as applied to projectile motion?
- (2007) Give two (2) practical applications of projectile motion at your locality.
- (2007) The ceiling of a long hall is 25 m high. Determine the maximum horizontal distance that a ball thrown with a speed of 40 m/s can go without hitting the ceiling of the wall.
- (2010) Mention two examples of projectile motion.
- (2010) Define the trajectory.
- (2010) Mention two uses of projectile motion.
- (2010) Find the velocity and angle of projection of a particle which passes in a horizontal direction Just over the top of a wall which is 12 m high and 32 m away.
- (2013) List down two main assumptions in deriving the equation of projectile motion.
- (2013) Why the horizontal motion of a projectile constant?
- (2013) A ball is thrown horizontally with a speed of 14.0 m/s from a point 6.4 m above the ground, calculate:
  - The horizontal distance traveled in that time.
  - Its velocity when it reaches the ground.
- (2014) Outline the motions that add up to make projectile motion.
- (2014) In the first second of its flight, a rocket ejects 1/60 of its mass with a relative velocity of 2400 m/s.
  - Find its acceleration.
  - What is the final velocity if the ratio of initial to final mass of the rocket is 4 at a time of 60 seconds?
- (2014) A ball is thrown upwards with an initial velocity of 33 m/s from a point 65° on the side of a hill which slopes upward uniformly at an angle of 28° .
  - At what distance up the slope does the ball strike?
  - Calculate the time of flight of the ball.
- (2014) A cannon of mass 1300 kg fires a 72 kg ball in a horizontal direction with a nuzzle speed of 55 m/s, If the cannon is mounted so that it can recoil freely calculate the:
  - recoil velocity of the cannon relative to the earth.
  - horizontal velocity of the ball relative to the earth.
- (2015) Define the term trajectory.
- (2015) Briefly explain why the horizontal component of the initial] velocity of a projectile always remains constant.
- (2015) List down two limitations of projectile motion.

- (2015) A body projected from the ground at the angle of 60° is required to pass just above the two vertical walls each of height 7 m. If the velocity of projection is 100 m/s, calculate the distance between the two walls.
- (2015) A fireman standing at a horizontal distance of 34 m from the edge of the burning story building aimed to raise streams of water at an angle of 60° into the first floor through an open window which is at 20 m high from the ground level. If water strikes on this floor 2 m away from the outer edge,
  - Sketch a diagram of the trajectory.
  - What speed will the water leave the nozzle of the fire hose?
- (2016) Mention two characteristics of projectile motion.
- (2016) If the range of the projectile is 120 m and its time of flight is 4 sec , determine the angle of projection and its initial velocity of projection assuming that the acceleration due to gravity $g = 10$ m/s.
- (2017) A jumbo jet traveling horizontally at 50 m/s at a height of 500 m from sea level drops a luggage of food to a disaster area.
  - At what horizontal distance from the target should the luggage be dropped?
  - Find the velocity of the luggage as it hit the ground.
- (2018) How does projectile motion differ from uniform circular motion?
- (2018) A rifle shoots a bullet with a muzzle velocity of 1000 m/s at a small target 200 m away. How high above the target must the rifle be aimed so that the bullet will hit the target?
  - Where does the object strike the ground when thrown horizontally with a velocity of 15 m/s from the top of a 40 m high building?
  - Find the speed of travel when a man jumps a maximum horizontal distance of 1 m spending a minimum time on the ground.
- (2019) Justify the statement that projectile motion is two dimensional motion.
- (2019) A rocket was launched with a velocity of 50 m/s from the surface of the moon at an angle of 40° to the horizontal, Calculate the horizontal distance covered after half time of flight.
- (2019) Show that the angle of projection θ° for a projectile launched from the origin is given by $\theta^\circ = tan^{-1}(4h_m/R)$, where R stand for horizontal range and h_m is the maximum vertical height.
- (2019) Determine the angle of projection for which the horizontal range of a projectile is $4\sqrt{3}$ times its maximum height.

2.3 Uniform Circular Motion

- (2000) Show that the period of a body of mass m revolving in a horizontal circle with constant velocity v at the end of a string of length l is independent of the mass of the object.
- (2000) A ball of mass 100 g is attached to the end of a string and is swung in a circle of radius 100 cm at a constant velocity of 200 cm/s. While in motion the string is shortened to 50 cm. Calculate:
  - The new velocity of the motion.
  - The new period of the motion.
- (2000) A car travels over a humpback bridge of radius of curvature 45 m. Calculate the maximum speed of the car if the wheels are to remain in contact with the bridge.
- (2007) What is meant by centripetal force?
- (2007) Derive the expression $a = (v^2/r)$ where a, v, and r stands for the centripetal acceleration, linear velocity and radius of a circular path respectively.
- (2007) A ball of mass 0.5 kg attached to a light inextensible string rotates in a vertical circle of radius 0.75 m such that it has a speed of 5 m/s when the string is horizontal. Calculate:
  - The speed of the ball and the tension in the string at the lowest point of its circular path.
- (2010) What is the origin of centripetal force for:
  - A satellite orbiting around the Earth.
  - An electron in the hydrogen atom?
- (2010) A small mass of 0.15 kg is suspended from a fixed point by a thread of a fixed length. The mass is given a push so that it moves along a circular path of radius 1.82 m in a horizontal plane at a Steady speed, taking 18.0 s to make 10 complete revolutions. Calculate:
  - The speed of the small mass.
  - The centripetal acceleration.
  - The tension in the thread.
- (2013) Why is it technically advised to bank a road at corners?
- (2013) A wheel rotates at a constant rate of 10 revolutions per second. Calculate the centripetal acceleration at a distance of 0.80 m from the centre of the wheel.
- (2014) Define the term radial acceleration.
- (2015) Mention three effects of looping the loop.
  - Why there must be a force acting on a particle moving with uniform speed in a circular path? Write down an expression for its magnitude.
- (2015) A driver negotiating a sharp bend usually tend to reduce the speed of the car.
  - What provides the centripetal force on the car?

  - Why is it necessary to reduce its speed?

- (2015) A ball of mass 0.5 kg is attached to the end of a cord whose length is 1.5 m then whirled in horizontal circle. If the cord can withstand a maximum tension of 50 N calculate the:
  - Maximum speed the ball can have before the cord breaks.
  - Tension in the cord if the ball speed is 5 m/s
- (2015) Define the term tangential velocity.
- (2016) A boy ties a string around a stone of mass 0.15 kg and then whirls it in a horizontal circle at constant speed. If the period of rotation of the stone is 0.4 sec and the length between the stone and boys hand is 0.50 m ;
  - Calculate the tension in the string.
  - State one assumption taken to reach the answer above.
- (2017) A car is moving with a speed of 30 m/s on a circular track of radius 500 m. If its speed is increasing at the rate of 2 m/s, find its resultant linear acceleration.
- (2017) An object of mass 1 kg is attached to the lower end of a string 1 m long whose upper end is fixed and made to rotate in a horizontal circle of radius 0.6 m. If the circular speed of the mass is constant, find the:
  - Tension in the string.
  - Period of motion.
- (2019) In which aspect does circular motion differ from linear motion?
- (2019) Why there must be a force acting on a particle moving with uniform speed in a circular path?
- (2019) A stone tied to the end of string 80 cm long, is whirled in a horizontal circle with a constant speed making 25 revolutions in 14 seconds. Determine the magnitude of its acceleration.

2.4 Simple Harmonic Motion

- (1998) Define simple harmonic motion.
- (1998) Prove that, the velocity v of a particle moving in simple harmonic motion is given by: $v = w(A^2 - y^2)^{0.5}$, where A is the amplitude of oscillation, w the angular frequency and y the displacement from the mean position.
- (1998) A simple pendulum has a period of 2.8 seconds. When its length is shortened by 1.0 metre, the period becomes 2.0 seconds. From this information, determine the acceleration g , of gravity and the original length of the pendulum.
- (1998) A particle rests on a horizontal platform which is moving vertically in simple harmonic motion with an amplitude of 50 mm. Above a certain frequency the particle ceases to remain in contact with the platform throughout the motion. With a help of a diagram and illustrative equations, find;

  - the lowest frequency at which this situation occurs.
  - the position at which contact ceases.

- (1999) Give two similarities between simple harmonic motion and circular motion.
- (1999) On the same set of axes, sketch how energy exchange (kinetic to potential) takes place in an oscillator placed in a damping medium.
- (2000) Define simple harmonic motion.
- (2000) Two simple pendulums of length 0.4 m and 0.6 m respectively are set oscillating in step.
  - After what further time will the two pendulums be in step again?
  - Find the number of oscillations made by each pendulum during the time found above.
- (2000) Cite two examples of SHM which are of importance to everyday life experience.
- (2000) Explain, giving reasons, whether either transverse or longitudinal waves could exist, if the vibratory motion causing them were not simple harmonic motion.
- (2014) State where the magnitude of acceleration is greatest in simple harmonic motion.
- (2014) Sketch a graph of acceleration against displacement for a simple harmonic motion.
- (2014) The displacement of a particle from the equilibrium position moving with simple harmonic motion is given by $x = 0.05\sin(6t)$, where t is the time in seconds measured at an instant when $x = 0$. Calculate the:
  - Amplitude of oscillations.
  - Period of oscillations.
  - Maximum acceleration of the particle.
- (2015) Briefly explain why the motion of a simple pendulum is not strictly simple harmonic?
  - Why is the velocity and acceleration of a body executing simple harmonic motion (S.H.M.) out of phase?
- (2015) A body of mass 0.30 kg executes simple harmonic motion with a period of 2.5 s and amplitude of 4.0×10^{-2} m. Determine the:
  - Maximum velocity of the body.
  - Maximum acceleration of the body.
  - Energy associated with the motion.
- (2015) A particle of mass 0.25 kg vibrates with a period of 2.0 s. If its greatest displacement is 0.4 m what is its maximum kinetic energy?
- (2016) Show that the total energy of a body executing S.H.M. is independent of time.
- (2016) A mass of 05 kg connected to a light spring of force constant 20 N/m oscillates on a horizontal frictionless surface. If the amplitude of the motion 1 s 3.0 cm , calculate the;

  - Maximum speed of the mass.
  - Kinetic energy of the system when the displacement is 2.0 cm.

- (2017) The equation of simple harmonic motion is given as $x = 6\sin(10\pi t) + 8\sin(10\pi t)$, where x is in centimeters and t in seconds. Determine the:
  - Amplitude
  - Initial phase of motion.
- (2017) Show that the total energy of a body executing simple harmonic motion is independent of time.
- (2017) Find the periodic time of a cubical body of side 0.2 m and mass 0.004 kg floating in water then pressed and released such that it oscillates vertically.
- (2018) What is meant by the following terms as used in simple harmonic motion (S.H.M)?
  - Periodic motion.
  - Oscillatory motion.
- (2018) List four important properties of a particle executing simple harmonic motion (S.H.M).
- (2018) Sketch a labeled graph that represents the total energy of a particle executing simple harmonic motion (S.H.M).
- (2018) The periodic time of a body executing S.H.M is 4 seconds. How much time interval from time, $t = 0$ will its displacement be half its amplitude?
- (2018) Giving reasons, explain whether either transverse or longitudinal waves could exist, if the vibratory motion causing them were not simple harmonic motion.
- (2019) Provide two typical examples of simple harmonic motion (S.H.M).
- (2019) Why the velocity and acceleration of a body executing simple harmonic motion are out of phase?
- (2019) The period of a particle executing simple harmonic motion (S.H.M) is 3 seconds. If its amplitude is 25 cm, calculate the time taken by the particle to move a distance of 12.5 cm on either side from the mean position.
- (2019) A person weighing 50 kg stands on a platform which oscillates with a frequency of 2 Hz and of amplitude 0.05 m. Find his/her minimum weight as recorded by a machine of the platform.

2.5 Gravitation

- (1999) What do you understand by the term escape velocity?
- (1999) Calculate the escape velocity from the moons surface given that a man on the moon has 1/6 his weight on earth. The mean radius of the moon is 1.75×10^6 m.
- (1999) Explain the meaning of the following terms:

  - Gravitational Potential of the Earth.
  - Gravitational Field Strength of the Earth.
  - How are the above quantities in and related?

- (1999) Show that the total energy of a satellite in a circular orbit equals half its potential energy.
- (1999) Calculate the height above the Earth's surface for a satellite in a parking orbit.
- (1999) What would be the length of a day if the rate of rotation of the Earth were such that the acceleration of gravity $g = 0$ at the equator?
- (2007) Evaluate the work done by the Earth's gravitational force and by the tension in the string as the ball moves from its highest to its lowest point.
- (2007) Two small spheres each of mass $10g$ are attached to a light rod 50 cm long. The system Is set into oscillation and the period of torsional oscillation is found to be 770 seconds. To produce maximum torsion to the system two large spheres each of mass 10 kg are placed near each suspended sphere, if the angular deflection of the suspended rod Is 3.96×10^{-3} rad. and the distance between the centres of the large spheres and small spheres is 10 cm, determine the value of the universal constant of gravitation, G , from the given information.
- (2007) On the basis of Newtons universal law of gravitation, derive Keplers third law of planetary motion.
- (2007) A planet has half the density of earth but twice its radius. What will be the speed of a satellite moving fast past the surface of the planet which has on no atmosphere?
  - (Radius of earth $R_E = 6.4 \times 10^3$ km and gravitational potential energy $g_E = 9.81$ N/kg)
- (2009) State Kepler's laws of planetary motion.
- (2009) Explain the variation of acceleration due to gravity, g . inside and outside the earth.
- (2009) Derive the formula for mass and density of the earth.
- (2009) What do you understand by the term satellite?
- (2009) A satellite of mass 100 kg moves in a circular orbit of radius 7000 km around the earth, assumed to be a sphere of radius 6400 km. Calculate the total energy needed to place the satellite in orbit from the earth assuming $g = 10$ N/kg at the earths surface.
- (2013) With the aid of a labeled diagram, sketch the possible orbits for a satellite launched from the earth.
  - From the diagram above, write down an expression for the velocity of a satellite corresponding to each orbit.
- (2014) Define the universal gravitational constant.
- (2014) How is the gravitational potential related to gravitational field strength?

- (2014) Write down an expression for the acceleration due to gravity (g) of a body of mass (m) which is at a distance (r) from the centre of the earth.
  - If the Earth were made of lead of relative density of 11.3 kg/m^3 , what would he the value of acceleration due to gravity on the surface of the earth?
- (2014) Why the value of acceleration due to gravity (g) changes due to the change in latitude? Give two reasons.
- (2014) A rocket is fired from the earth towards the sun. At what point on its path is the gravitational force on the rocket zero?
- (2015) Explain why the astronaut appears to be weightless when traveling in the space vehicle.
- (2015) State Newton's law of gravitation.
  - Use Newtons law of gravitation to derive Keplers third law.
- (2015) Briefly explain why Newtons equation of universal gravitation does not hold for bodies falling near the surface of the earth?
- (2015) Show that the total energy of a satellite in a circular orbit equals half its potential energy.
- (2015) Calculate the height above the Earths surface for a satellite in a parking orbit.
- (2015) A 10 kg satellite circles the Earth once every 2 hours in an orbit having a radius of 8000 km. Assuming Bohrs angular momentum postulate applies to the satellite just as it does to an electron in the hydrogen atom, find the quantum number of the orbit of the satellite.
- (2016) Mention one application of parking orbit.
- (2016) Briefly explain how parking orbit of a satellite is achieved.
- (2016) The earth satellite revolves in a circular orbit at a height of 300 km above the earths surface. Find the;
  - Velocity of the satellite
  - Period of the satellite.
- (2016) A spaceship is launched into a circular orbit close to the earths surface. What additional velocity has to be imparted on the spaceship if order to overcome the gravitational pull?
- (2017) Why does the kinetic energy of an earth satellite change in the elliptical orbit?
- (2017) A space craft is launched from the earth to the moon, If the mass of the earth is 81 times that of the moon and the distance from the centre of the earth to that of the moon is about 4.0×10^5 km;
  - Draw a sketch showing how the gravitational force on the spacecraft varies during its journey.
  - Calculate the distance from the centre of the earth where the resultant gravitational force becomes zero.

- (2018) A satellite of mass 600 kg is in a circular orbit at a height 2×10^6 km above the earths surface. Determine the:
  - Orbital speed.
  - Gravitational potential energy.
- (2018) What would happen if gravity suddenly disappears?
- (2018) Two base of a mountain are at sea level where the gravitational field strength is 9.81 N/kg . If the value of gravitational field at the top of the mountain is 9.7 N/kg, calculate the height of the mountain above the sea level.
- (2019) Why the weight of a body becomes zero at the centre of the earth?
- (2019) How far above the earth surface does the value of acceleration due to gravity becomes 36% of its value on the surface?
- (2019) Compute the period of revolution of a satellite revolving in a circular orbit at a height of 3400 km above the Earths surface.
- (2019) Prove that the angular momentum fora satellite of mass M_s revolving round the
  - earth of mass M_e in an orbit of radius r is equal to $(GM_e\ M_s^2 r)^{1/2}$.

2.6 Rotation of Rigid Bodies

- (1999) State the parallel axis theorem.
- (1999) Show that the Kinetic energy (K.E.) of rotation of a rigid body about an axis with a constant angular velocity w is given by $KE = 1/2Iw^2$ where i is the moment of inertia of the rigid body about the given axis.
- (1999) What do you understand by the term "moments of inertia" of a rigid body?
- (1999) State the perpendicular axes theorem of moments of inertia for a body in the form of a lamina
- (1999) Calculate the moments of inertia of a thin circular disc of radius 50 cm and mass 2 kg about an axis along a diameter of the disc.
- (1999) A wheel mounted on an axle that is not frictionless is initially at rest. A constant external torque of 50 Nm is applied to the wheel for 20 s. At the end of the 20 s, the wheel has an angular velocity of
  - 600 rev/min. The external torque is the removed, and the wheel comes to rest after 120 s more.
  - Determine the moments of inertia of the wheel.
  - Calculate the frictional torque which is assumed to be constant.
- (2007) The T is then suspended from the free end of rod Y and the pendulum swings in the plane of T about the axis Of rotation.
  - Calculate the moment of inertia i of the T about the axis of rotation.

  - Obtain the expression for the k.e. and p.e. in terms of the angle θ of inclination to the vertical oscillation of the pendulum.
  - Show that the period of oscillation is $2\pi\sqrt{17L/18g}$.
  - (Moment of inertia of a thin rod about its centre $I_C = mL^2/12$.)

- (2009) Define angular momentum and give its dimensions.
- (2009) A grinding wheel in a form of solid cylinder of 0.2 m diameter and 3 kg mass is rotated at 3600 rev/minute.
  - What is its kinetic energy?
  - Find how far it would have to fall to acquire the same kinetic energy as in the question above.
- (2014) A disc of moment of inertia 2.5×10^{-4} kg/m^2 is rotating freely about an axis through its centre at 20 rev/min. If some wax of mass 0.04 kg is dropped gently on to the disc 0.05 m from its axis, what will be the new revolution per minute of the disc?
- (2014) Explain briefly why a:
  - high diver can turn more somersaults before striking the water?
  - dancer on skates can spin faster by folding her arms?
- (2014) A heavy flywheel of moment of inertia 0.4 kg/m^2 is mounted on a horizontal axle of radius 0.01 m. If a force of 60 N is applied tangentially to the axle:
  - Calculate the angular velocity of the flywheel after 5 seconds from rest.
  - List down two assumptions taken to arrive at your answer in above.
- (2015) Define moment of inertia of a body.
  - Briefly explain why there is no unique value for the moment of inertia of a given body?
- (2015) State the principle of conservation of angular momentum.
  - A horizontal disc rotating freely about a vertical axis makes 45 revolutions per minute. A small piece of putty of mass 2.0×10^{-2} kg falls vertically onto the disc and sticks to it at a distance of 5.0×10^{-2} m from the axis. If the number of revolutions per minute is thereby reduced to 36 , calculate the moment of inertia of the disc.
- (2015) What would be the length of a day if the rate of rotation of the Earth were such that the acceleration due to gravity $g = 0$ at the equator?
- (2016) Why is Newtons first law of motion called the law of inertia?
- (2016) What is meant by moment of inertia of a body?
- (2016) List two factors on which the moment of inertia of a body depends.
- (2016) A thin sheet of aluminum of mass 0.032 kg has the length of 0.25 m and width of 0.1 m. Find its moment of inertia on the plane about an axis parallel to the:
  - Length and passing through its centre of mass, m .

  - Width and passing through the centre of mass, m , in its own plane.

- (2016) Define the term angular momentum.
- (2016) A thin circular ring of mass, M , and radius, r , is rotating about its axis with constant angular velocity, w_1 . If two objects each of mass, m , are attached gently at the ring, what will be the angular velocity of the rotating wheel?
- (2016) Why are space rockets usually launched from west to east?
- (2017) Justify the statement that If no external torque acts on a body, its angular velocity will not conserved.
- (2018) Why is flywheel designed such that most of its mass is concentrated at the rim? Briefly explain.
- (2018) Estimate the couple that will bring the wheel to rest in 10 seconds when a grinding wheel of radius 40 cm and mass 3 kg is rotating at 3600 revolutions per minute.
- (2018) Why an ice skater rotates at relatively low speed when stretches her arms and a leg outward?
- (2018) Calculate the moment of inertia of a sphere about an axis which is a tangent to its surface given that the mass and radius of the sphere are 10 kg and 0.2 m respectively.