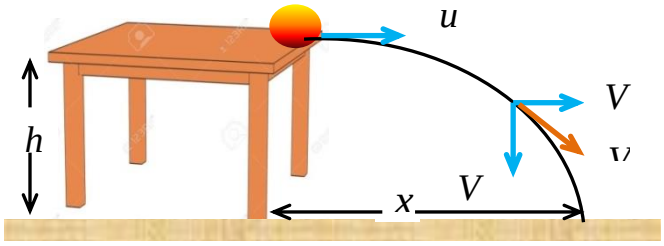
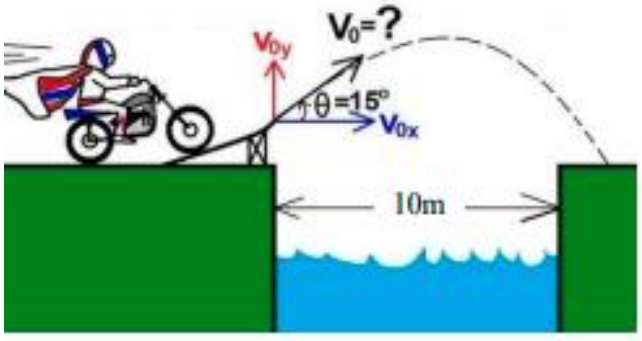
Ambo University Special Non Boarding Secondary School
Grade 12th Physics Work sheet I In 2023 Academic Year

1. A projectile is fired in such a way that twice of its horizontal range is equal to three times its maximum height. What is the angle of projection?
2. A ball is kicked into the air from the ground at an angle θ with the horizontal. When the ball reaches its highest point, which statement is true?
   A. Both the velocity and acceleration of the ball are zero.
   B. Its velocity is not zero, but its acceleration is zero.
   C. Its velocity is perpendicular to its acceleration.
   D. Its acceleration depends on the angle at which the ball was thrown.
3. A marble roll off the edge of a table 1.25m high with an initial speed of 8m/s and strikes the ground as shown below.
   a. How long does it take the marble to hit the ground?
   b. How far away from the foot of the table will land the marble?
   c. What was its speed just when it strikes the ground?
   d. What was its speed 0.4secnd later? Use g =10m/s^2



Horizontal throw

4. One ball is thrown horizontally. At the same time, a second ball is dropped from the same height. Ignoring air resistance and assuming the ground is level, which ball hits the ground first? Explain why?
5. A motor cyclist initially travelling at a constant speed tries to jump a 10m wide valley at an angle 15^0 to the horizontal.



   a. With what minimum speed must he leave the edge of the valley in order to jump the valley?
   b. What maximum height does the cyclist rise to jump exactly the width of the valley?

6. The projection velocity of a projectile is (6, 8) m/s. If the projectile passes through point Q whose x-coordinate is x = 5m, then find
   a. The time taken to reach at point Q
   b. The magnitude and direction of velocity at Q point
   c. Projection angle and maximum height
   d. Range of projectile

7. As a projectile moves in its parabolic path, is there any point along the path where the velocity and acceleration vectors are:-
   a. Perpendicular to each other (at right angles)?
   b. Parallel to each other?

8. Which of the following statements about projectile motion are true? (ignoring air resistance)
   A. The horizontal and vertical motions are independent.
   B. The force on the projectile is constant throughout the flight.
   C. The acceleration of the projectile is constant throughout the flight.
   D. The path depends upon the initial velocity, but not upon the mass of the projectile.
   E. All of the above statements are true.

9. A disk, projected on the Earth's surface attained a maximum height of 8m and range of 12m. What would be the height and the range of the disk if it were projected on the surface of Earth's Moon with the same initial velocity and projection angle? ($g_{moon} = 1.6m/s^2$)

10. An object is projected vertically upwards. 4 seconds later, it is caught at the same height (point of release) on its way downwards. Determine how long it took the ball to pass a height of 8 m in the upward direction. Choose downward as the positive direction.

11. Suppose you are running at constant velocity and you wish to throw a ball such that you will catch it as it comes back down. In what direction should you throw the ball relative to you?
   A. Straight up
   B. At an angle to the ground that depends on your running speed
   C. In the forward direction.

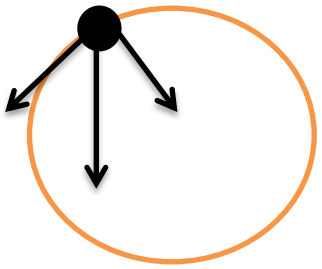
12. A ball is thrown in such a way that its initial vertical and horizontal components of velocity are 40 m/s and 20 m/s, respectively. Estimate the total time of flight and the distance the ball is from its starting point when it lands.

13. At what angle of projection will the range of projectile be:
   a. Twice the maximum height it raises?
   b. Equal to the maximum height it rises?
   c. Quadrupled that of the maximum height it raises?

14. While punting a football, a kicker rotates his leg about the hip joint. The moment of inertia of the leg is 3.75 kgm^2 and its rotational kinetic energy is 175 J.
   a. What is the angular velocity of the leg?
   b. What is the velocity of tip of the punter's shoe if it is 1.05 m from the hip joint?
   c. Explain how the football can be given a velocity greater than the tip of the shoe.

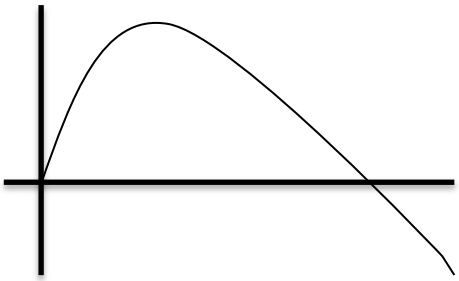
15. Provided any value of the same initial velocity for two projectiles having θ and $90^0-\theta$ for their angles projection, show that they achieve at the same range.

16. Consider a particle rotating with a constant tangential about a horizontal circle of radius 1.4m. The resultant acceleration of the particle at point P is directed vertically down instant point find



a. Magnitude of the net, radial and tangential acceleration.
b. Angular speed of the particle

17. A projectile is thrown at A with speed u at an angle 53^0 above the horizontal. If it flies for 6 seconds to reach at point B, find the projection speed u



18. Initially, a ball has an angular velocity of 5.0 rad/s counterclockwise. Sometime later, after rotating through a total angle of 5.5 radians, the ball has an angular velocity of 1.5 rad/s clockwise.

a. What is the angular acceleration? What is the average angular velocity? How much time did this take?
b. At some point the angular velocity of the ball had to have been zero. At what angle from its initial orientation did this occur and how long did it take?

19. The moment of inertia of a long rod spun around an axis through one end perpendicular to its length is $\frac{ML^2}{3}$. Why is this moment of inertia greater than it would be if you spun a point mass M at the location of the center of mass of the rod (at $\frac{L}{2}$)? (That would be $\frac{ML^2}{4}$.)

20. Why is the moment of inertia of a hoop that has a mass M and a radius R greater than the moment of inertia of a disk that has the same mass and radius? Why is the moment of inertia of a spherical shell that has a mass M and a radius R greater than that of a solid sphere that has the same mass and radius?

21. Give an example in which a small force exerts a large torque. Give another example in which a large force exerts a small torque.

22. While reducing the mass of a racing bike, the greatest benefit is realized from reducing the mass of the tires and wheel rims. Why does this allow a racer to achieve greater accelerations than would an identical reduction in the mass of the bicycle's frame?

23. Describe the energy transformations involved when a yo-yo is thrown downward and then climbs back up its string to be caught in the user's hand.

24. Calculate the moment of inertia of a skater given the following information.
   a. The 60 kg skater is approximated as a cylinder that has a 0.110 m radius.
   b. The skater with arms extended is approximately a cylinder that is 52.5 kg, has a 0.110 m radius, and has two 0.900 m long arms which are 3.75 kg each and extend straight out from the cylinder like rods rotated about their ends. The triceps muscle in the back of the upper arm extends the forearm. This muscle in a professional boxer exerts a force of 2.00×10^3 N with an effective perpendicular lever arm of 3.00 cm, producing an angular acceleration of the forearm of 120 rad/s^2. What is the moment of inertia of the boxer's forearm?

25. A soccer player extends her lower leg in a kicking motion by exerting a force with the muscle above the knee in the front of her leg. She produces an angular acceleration of 30.00 rad/s^2 and her lower leg has a moment of inertia of 0.750 kgm^2. What is the force exerted by the muscle if its effective perpendicular lever arm is 1.90 cm?

26. Suppose you exert a force of 180 N tangential to a 0.280m radius 75 kg grindstone (solid disk).
   a. What torque is exerted?
   b. What is the angular acceleration assuming negligible opposing friction?
   c. What is the angular acceleration if there is an opposing frictional force of 20.0 N exerted 1.50 cm from the axis?

27. What is the final velocity of a hoop that rolls without slipping down a 5.00-m-high hill, starting from rest?

28. Calculate the rotational kinetic energy of Earth on its axis. What is the rotational kinetic energy of Earth in its orbit around the Sun?

29. A baseball pitcher throws the ball in a motion where there is rotation of the forearm about the elbow joint as well as other movements. If the linear velocity of the ball relative to the elbow joint is 20.0 m/s at a distance of 0.480 m from the joint and the moment of inertia of the forearm is 0.500 kg m^2, what is the rotational kinetic energy of the forearm?

30. A rope is wrapped many times around a pulley of radius 50 cm as shown in figure below. How many revolutions of the pulley are required to raise a bucket to a height of 20 m?

31. A hot air balloon ascends with a constant velocity of 5 m·s^{-1}. A ball is dropped from the hot air balloon at a height of 50 m above the ground and falls vertically towards the ground. Determine the following:

i. Find the distance between the hot air balloon and the ball after 2 seconds.

ii. Find the velocity of the ball when it reaches the ground. c) How long does it take the ball to reach at the ground? (When an object is dropped from a moving reference (hot air balloon), the initial velocity will be equal to that of the reference. Neglect the air resistance.)

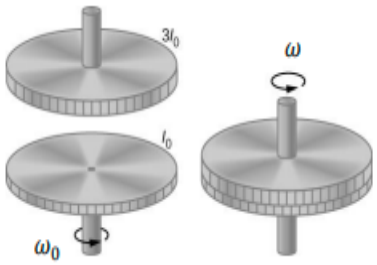


32. What object experiences uniform circular motion? a) A car speeding up as it turns left c) A car traveling around a curve at a constant speed b) A car slowing down as it crests a tall hill d) A car traveling down the road at a constant speed

33. Satellite of mass m and speed v orbits the Earth at a distance r from the center of the Earth. The gravitational field strength due to the Earth at the satellite is equal to.

A. $\frac{V}{r}$ B. $\frac{V^2}{r}$ C. $\frac{mV}{r}$ D. $\frac{mV^2}{r}$

34. A flywheel rotates without friction at an angular velocity =600rev/min on frictionless, vertical shaft of neglecting rotational inertia. A second flywheel, which is at rest and has a moment of inertia three times that of the rotating flywheel is dropped onto it and due to friction existing between the surfaces, the flywheels spin together and quickly reach at the same rotational velocity.



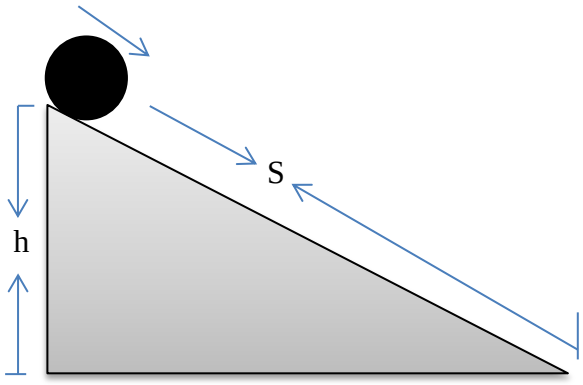
i. Use the law of conservation of angular momentum to determine the angular velocity of the combination.
ii. What fraction of the initial kinetic energy is lost in the coupling of the flywheels?

35. What is the gravitational field strength at a point 5km away from the surface of the Earth?

36. Find the escape velocity for a satellite that leaving the Earth. The radius of the Earth is 6.4x106m and take $g = 9.8\frac{m}{s^2}$

37. Determine the magnitude of the force of attraction between Mercury and the Sun. They are approximately 5.8×10^{10} m apart. The mass of Mercury is about 3.3×10^{23} kg and the mass of the Sun is about 2×10^{30} kg. G is $G = 6.67 \times 10^{-11}\ Nm^2\ kg^{-2}$

38. What is the acceleration of a solid sphere rolling down without slipping a plane inclined at an angle with the horizontal as shown below? Assume that the sphere starts from rest.



39. Find the period of revolution of Venus if its mean distance from the sun is about 0.72times that of the earth. The period for the Earth is 1year.

40. The space shuttle aims for an orbit about 500 km above the surface of the earth. The mass of the space shuttle is about 95,000 kg. The radius of the earth is approximately 6.4 x 10^6 m.
   a. Determine the mass of the Earth.
   b. Calculate the orbital speed of the space shuttle

41. Suppose you are at mission control on the moon, in charge of launching a moon-orbiting communications satellite. The radius of the moon is 1.74x10^6 m. The gravitational field strength on the surface of the moon is 1.6 N/kg.
   i. Determine the mass of the moon.
   ii. The satellite is to have an altitude of 100 km above the moon's surface.
   iii. What is the radius of the orbit of the satellite?
   iv. Determine the orbital velocity for the satellite d. How long will it take the satellite to orbit the moon? (This time is called the orbital period.)

42. . With what speed does the earth orbit the sun? The mass of the sun is 2 x 10^{30} kg, and the radius of the earth's orbit is 1.5 x 10^{11} m. Why don't you "feel" like the earth is moving this fast?

43. Determine the orbital velocity and period for the International Space Station (ISS) if the ISS orbit is 4.0x10^2km above the Earth's surface. The radius of the Earth is about 6400km.

44. Is it possible for two objects with the same mass, radius, and the same rotational speed to have different values of angular momentum? Explain.

45. A bicycle tire of radius 0.40 m and mass 1.5 kg is rotating at 80rad/s. What torque is necessary to stop the tire in 2s?

46. A 400N child and a 300N child sit on either end of a 2m long seesaw that has a mass of 25 kg.
   a. Where along the seesaw should the pivot be placed to ensure rotational equilibrium?
   b. Suppose a 225 N child sits 0.20 m from the 400N child. Where must a 325 N child sit in relation to the 300N child to maintain equilibrium?

47. A hypothetical planet has a mass of four times that of the Earth and radius of twice that of the Earth? What is the acceleration due to gravity on the planet in terms of the acceleration on Earth?