Physics 9A Section A Discussion Questions: Week 8

Question 1: Projectile Explosion

A 16.0 kg projectile is launched at an angle of $60.0°$ with a speed of 150 m/s. At its highest point, the projectile explodes into two separate pieces, one three times heavier than the other. Both fragments land at the same time.

i: The heavier fragment lands back at the launch site. How far away does the smaller fragment land?

ii: How much energy is released in the explosion?

iii: Suppose a third fragment was created (equal in mass to the smaller fragment, such that ratio would be 1:1:2), which fell straight down after the explosion, and the heavier fragment still landed at the launch site. Would that change the amount of energy released in the explosion? If so, what is the new amount of energy released?

Question 2: A Rotating Meter Stick

A student is running a simple experiment where they drill a small hole through one end of a meter stick (assume approximately at exactly the end), and hang it from a frictionless rod. The meter stick has a mass of 0.200 kg. They then hold the meter stick parallel to the ground, and allow it to fall.

i: As the meter stick falls through the vertical, what is the change in gravitational potential energy?

ii: What is the angular speed of the meter stick?

iii: The linear speed of the non-fixed end?

iv: Now imagine the meter stick had no end fixed, but was simply held parallel to the ground and then dropped. How does the speed of the meter stick (after it has fallen 1 m) compare to the answer to (*iii*)?

Question 3: Square Bicycle Wheel

Imagine a square bicycle wheel represented as a thin, uniform rod bent into a sidelength a.

i: What is the moment of inertia of the bicycle wheel, if it is spun about an axis at its center (and perpendicular to the plane of rotation)? Hint: use the parallel axis theorem.

ii: What would be the moment of inertia of the equivalent circular bicycle wheel, with the same length and mass?

iii: What is the difference in energy required to spin each wheel at the same angular velocity ω?

Note: typical numbers, if desired, would be a = .25 m, M = 2 kg, and ω = 40 rad/s.