

**PHY2020 - Introduction to Principles of Physics:
Exam 3 Practice Problems**

Problem 1

Rotational Motion

- (a) A wheel rotates around its axle for 2.5 times. How many radians is that?
- (b) A bicycle with wheels of radius 30 cm is travelling at 2 m/s. How many revolutions per second does each wheel turn through?
- (c) A merry-go-round rotates about its center. A person on the outside rim travels with a speed of $v = 5 \frac{\text{m}}{\text{s}}$.
- How fast does someone sitting halfway between the center and the edge travel?
 - If the person on the outside of the merry-go-round has an angular velocity of $\omega = 3 \frac{\text{rad}}{\text{s}}$, what the angular velocity of the person sitting halfway out have?
 - What is the radius of the merry-go-round?
- (d) A pulley, of mass m , is spinning in a horizontal plane with an angular velocity of ω . You drop a lump of clay of mass m on it, halfway between the axle and the edge of the pulley. What is its angular velocity now?
- (e) A meter stick is **balanced** at its midpoint. A 1 kg mass is hanging from the 35 cm mark. At what mark must another 0.5 kg mass be hanging from (so that the meter stick is balanced)?
- (f) A 30 cm long wrench is being used to try to turn a nut. There are three forces acting on the handle of the wrench. A 5 N force is applied at right angles to the end of the wrench handle (farthest from the nut). Another 5 N force is applied at right angles to the center of the wrench handle. A 10 N force is applied parallel to the end of the wrench handle. What is the torque on the nut due to each force? (answer for each of the three forces)
- (g) A hoop, a solid disk, and a sphere, each with a radius R , begin rolling down the same slope at the same time from the same starting location. In what order will they arrive at the bottom?
- (h) A disk and a ball, each with mass M and radius R , have the same angular velocity ω . Calculate the rotational kinetic energy of each.

Problem 2

Structure of Matter

- (a) Of the three particles that are found in almost all atoms, which ones, if any, are believed to be elementary?
- (b) The nucleus of an atom contains positively charged protons, that electrically repel each other, and electrically neutral neutrons that do not. Since the protons repel each other, what keeps the atomic nucleus together?
- (c) Not long after the formation of our visible universe, there was mostly hydrogen and helium. Where did the other elements that, for example, make up the Earth and our bodies come from?
- (d) Which of the common states of matter is typically the least dense? The most dense?
- (e) Fill in the blanks: The density of substance is _____ proportional to the mass and _____ proportional to the volume.

- (f) Two dogs are identical shapes but different sizes. One is 1 m long and the other is 0.5 m long. The shorter dog has a mass of 4 kg. What is the mass of the longer dog?

Problem 3

Fluids

- (a) A cube of ice floats in water with 10% of the cube above the surface. It is removed from the water and placed in an unknown liquid where it floats with 5% of the cube above the surface. What is the density of the unknown liquid?
- (b) A rock of mass 250 kg and volume 0.1 m^3 is submerged at the bottom of a deep lake. How much upward force is required to lift it off of the bottom of the lake?
- (c) A swimming pool of dimension 5 m(wide) \times 50 m(long) \times 6 m(deep) has a leak 4 m below the surface. With what pressure does the water squirt out of the leak?
- (d) An airplane passenger compartment window has an area of 0.1 m^2 . The plane flies to where the air pressure outside is half that at ground level (take the pressure at ground level as 10^5 Pa). If regular atmospheric pressure is maintained in the plane, what is the net force due to air pressure on the window?