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Physics 4A FINAL EXAM - "Take Me Out to the Ball Game" Spring 1992

Solve the following problems in the space provided. Use the back of the page if needed. Each problem is worth 10 points. You must show your work in a logical fashion starting with the correctly applied physical principles which are on the last page. Your score will be maximized if your work is easy to follow because partial credit will be awarded.

1. The pitcher throws a pitch from the mound toward home plate 18.4m away. The ball is released horizontally from a height of 2.00m with a velocity of 40.0m/s. Find (a)the time it takes for the ball to reach home plate and (b)the height above the ground when it gets there.

2. An 85.0kg baserunner tries to steal second base. When he is 3.00m from the base he begins his slide at a speed of 9.00m/s. He comes to rest just as he touches the base. Find the coefficient of friction between the sliding baserunner and the ground.

3. A 150g baseball starts at rest and rolls down the 50.0cm high pitcher's mound. Find its speed at the bottom.

4. An 85.0kg shortstop jumps upward to catch the 150g baseball traveling horizontally at 60.0m/s. At the instant before the catch the shortstop is traveling upward at 0.250m/s. Find the velocity (magnitude and direction) of the shortstop and ball just after the catch.

5. A 1.00kg baseball bat 85.0cm long has a center of mass that is 55.0cm below the knob. It leans against a wall smooth wall making a 60˚ angle with the ground. Find the magnitude of each force that acts on the bat and show its direction in the sketch below.

6. Estimate the rotational inertia about the end of a 1.00kg baseball bat that is 85.0cm long by treating it like a uniform stick. (Using the right formula is worth 5pts. Clearly deriving the formula is worth 15pts.)

7. A physics of a batter striking a pitched ball can be modeled as shown below. The bat is rotating about the knob as the ball approaches. After the collision, the ball heads off as the rotation rate of the bat drops. We assume that the collision time is so short that effectively no torque is exerted on the bat by the batter during the collision. Given the mass of the bat is 1.00kg, the rotational inertia of the bat about the knob end is $0.350\text{kg}\cdot\text{m}^2$, the mass of the ball is 150g, the initial rotation rate of the bat is 600rpm, the speed of the incoming pitch is 40.0m/s, the final rotation rate of the bat is 300rpm, find the resulting velocity of the batted ball if it strikes the bat 60.0cm from the knob.

8. A 1.000±.001kg baseball bat is 85.0±.2cm long and its center of mass is 55.0 ±.2cm from the knob end. When held at the knob end and allowed to oscillate, it is found to have a period of 1.60±.05s. Find the rotational inertia of the bat about the knob end and find the uncertainty in this value.

9. A baseball announcer describing a long home run states that the batter "put that one in orbit." (a)Find the speed that the ball would have to leave the bat in order to go into orbit just above the surface of the earth. (b)Find the kinetic energy that the ball would have to have.

10. The Metrodome is a domed stadium in Minneapolis where the World Champion Twins play. Its roof is supported almost entirely by the air density $1.29 kg/m^3$ inside the stadium. The mass of the roof is $7.50 \times 10^5 kg$ and is it $2.50 \times 10^4 m^2$ in area. Find (a)the required pressure difference across the roof, (b)the speed that air would travel out of an open door to the stadium, (c)Would the air move in or out ?