Study Guide for Midterm 3 for Algebra-Based Physics-1: Mechanics (PHYS135A-01)

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1 Rotational Kinematics and Dynamics

1. Express the following angles in radians: (a) 10° (b) 20° (c) 30° (d) 40°

2. A record is spinning at 45 rpm. What is the angular velocity in radians per second?

3. A *sling* was an ancient weapon used to hurl polished stones at high velocity at enemies (like David versus Goliath). Suppose the tangential velocity of the stone is $v = 20$ m/s, and the radius is $r = 1$ m. (a) What is the angular velocity? (b) What is the centripetal acceleration at the location indicated by the arrow? (c) How many g's is this?

4. A car is traveling along a flat curved road with radius r and frictional coefficient μ. (a) Show that if the net force is zero as the car goes through this curve, that $v = \sqrt{\mu r g}$. (b) What is v, if $r = 600$ m, $g \approx 10$ m/s^2, and $\mu = 0.7$?

2 Newton's Law of Gravity

1. Set Newton's Law of Gravity ($F_G = Gm_1m_2/r^2$) equal to the weight force ($w = mg$), and rederive the fact that the acceleration due to gravity near the Earth's surface is $g \approx 9.81$ m/s^2.

2. Rederive Kepler's 3rd Law by setting Newton's Law of Gravity equal to the centripetal force of Earth. Using 1 year for the period of Earth's orbit, and 1.5×10^{11} m for the radius of Earth's orbit, calculate the mass of the Sun.

3 Work and the Work-Energy Theorem

1. If a force $\vec{F} = -3\hat{i} + 9\hat{j}$ N is applied to an object, and the object is displaced by $\vec{d} = 2\hat{j}$ m, what is the work done?

2. (a) If a person drops a 0.6 kg baseball from a building that is 30 m tall, what is the final speed of the basketball? (b) If a person throws the same basketball 30 m into the air, what is the initial speed of the basketball?

3. Recall the loop-the-loop lab activity done in class, in which a marble rolls through a loop of radius R if rolled from a height h. In your own words, what should the ratio h/R be? (See `http://physics.bu.edu/~redner/211-sp06/class-energy/looptheloop.html` for a good discussion that neglects rotational inertia.)