Exam #1: Basic kinematics and dynamics

Name: /30

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1. In lab you did experiments in which you accelerated a cart down a track by hanging a mass over a pulley, as shown in the figure below. If you hold the cart and start collecting before you let go, you can observe a drop in the force measured by the force probe at the instant that the cart starts accelerating. Why? Consider the forces on the hanging mass to help you answer this question. [6 pts]
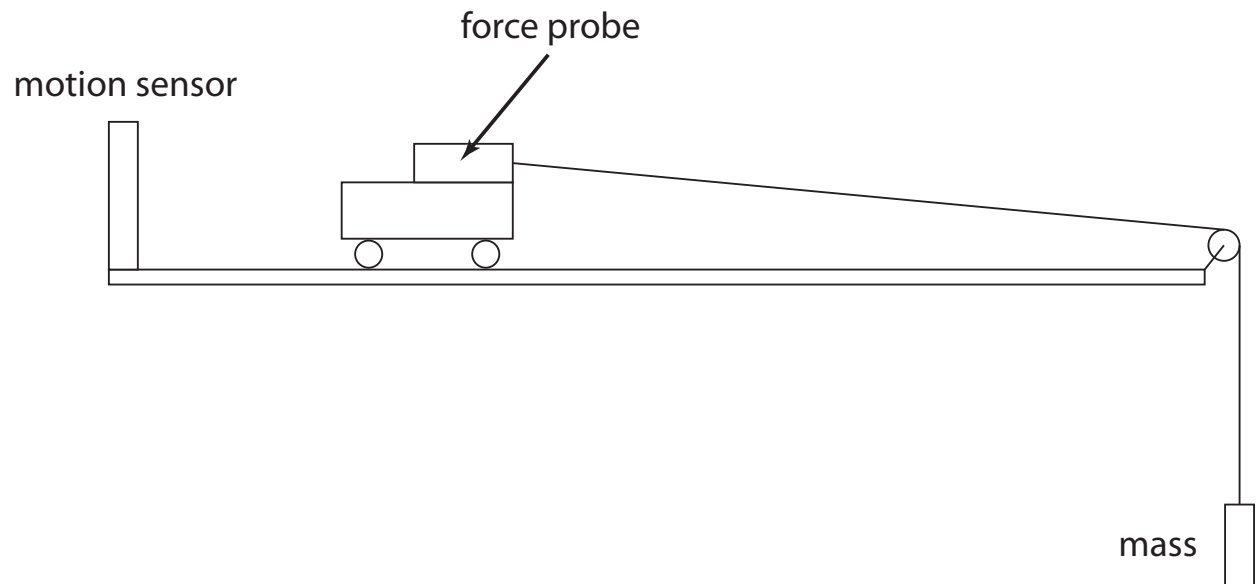
2. In the figure below, the particles are traveling counterclockwise in circles of radius 5 m with speeds that may be varying. The acceleration vectors are indicated at certain times. Find the speed and tangential acceleration for both (a) and (b). [6 pts]

(a)   (b)
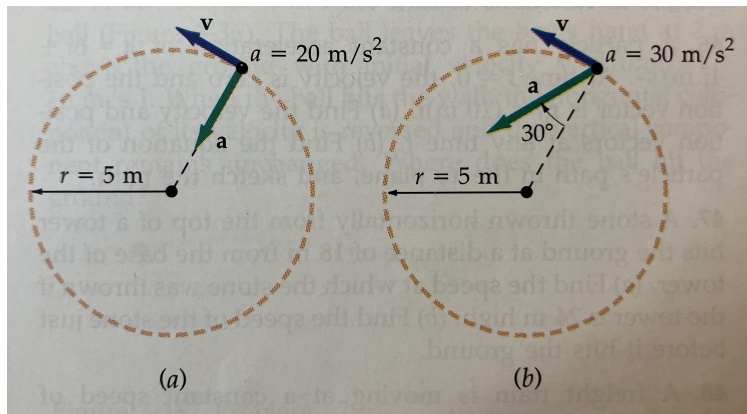
3. A 2-kg block rests on a smooth wedge that has an inclination of $\theta = 60°$ and an acceleration of a to the right such that the block remains stationary relative to the wedge.
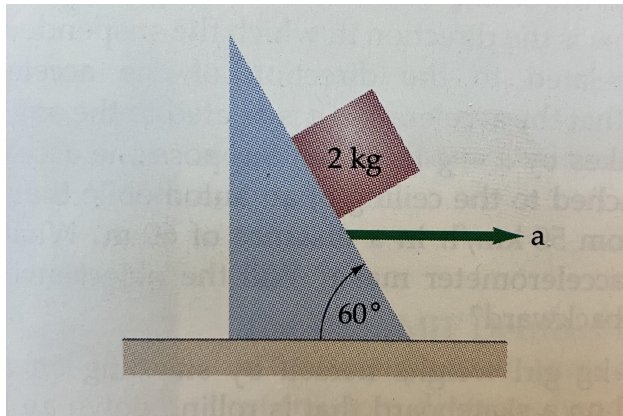
(a) Determine the acceleration a so that the block remains stationary relative to the wedge. (I recommend orienting the coordinate system so that x is horizontal and y is vertical, in which case there is no acceleration in the y-direction.) [4 pts]

(b) What happens to the block if the acceleration is larger or smaller than the value you calculated in (a)? [2 pts]

4. A sprinter running at 9 m/s toward a motorcycle. At the instant that the sprinter is 40 m from the motorcycle, the motorcycle starts to accelerate at 0.9 m/s^2 in the same direction that the sprinter is running. How long does it take for the sprinter to catch the motorcycle, and for how long is the sprinter ahead of the motorcycle? [6 pts]

5. A pitcher throws a fastball at 140 km/h toward home plate, which is 18.4 m away. Assume that the ball is traveling horizontally at the instant that it is released. How far does the ball drop by the time it reaches home plate? [6 pts]