Quiz 4, Physics 2a, Oct 22 2010

Double check that you bubble in your code number correctly.

If there's a mistake, your score will be lowered –as a penalty.

VERSION A

⋆ **Fun with cell phones!** The cell-phone referred to in the following questions has a built in accelerometer, with an app which displays its acceleration over time. The mass of the cell phone is negligible.

1. You want to find the coefficient of kinetic friction between an eraser and a table-top, so you tape your cell-phone to the eraser and give it a push. The readout on the phone tells you that it had an acceleration $\vec{a} = a_x \widehat{i}$ with

$$a_x = \begin{cases} 3m/s^2 & \text{for } 0 \leq t \leq 0.5s \\ -1m/s^2 & \text{for } 0.5 \leq t \leq 3s \end{cases}$$

   You deduce that the first time interval, from $t = 0$ to $t = 0.5$ was when you were pushing the eraser, and that the second time interval was when it was slowing down.

   Approximately what is the coefficient of kinetic friction between the table and the eraser?

   (a) $\mu_k \approx 1/3$.

   (b) $\mu_k \approx 3$.

   (c) $\mu_k \approx 1/10$.

   (d) $\mu_k \approx 1/100$.

2. Using only the information given above, can you find the mass M of the eraser and cell phone?

   (a) No, not enough information is given.

   (b) Yes, $M = \frac{1}{3}kg$.

   (c) Yes, $M = 1kg$.

   (d) Yes, $M = 3kg$.

3. A rope loops over a pulley, which is attached to the ceiling. The rope and pulley have negligible mass. On one end of the rope is a $m = 10kg$ mass, and on the other and of the rope is a $M = 20kg$ mass, which has a cell-phone (of negligible mass) taped to it. The masses are initially held in place, and then let go. The heavier mass M goes down and the lighter mass goes up. Before being dropped, the cell-phone's accelerometer indicates zero acceleration.

   What acceleration does the cell phone record while the heavier mass is falling to the ground?

   (a) $a_y = -g$.

(b) $a_y = -\frac{2}{3}g$.
(c) $a_y = -\frac{1}{3}g$.
(d) $a_y = -\frac{1}{2}g$.

4. Same setup. What is the approximate tension in the rope during the time that the heavier mass is falling to the floor?
   (a) $F_T \approx 130N$.
   (b) $F_T \approx 100N$.
   (c) $F_T \approx 200N$.
   (d) $F_T \approx 70N$.

5. Same setup. What is the approximate downward force exerted by the pulley on the ceiling during the time that the heavier mass is falling to the floor.
   (a) $F_{ceiling} = 100N$.
   (b) $F_{ceiling} = 200N$.
   (c) $F_{ceiling} = 130N$.
   (d) $F_{ceiling} = 260N$.

6. The *Giant swing* at a county fair consists of a vertical central shaft with a number of horizontal arms attached to its upper end. Each arm supports a seat suspended from a cable $5.0m$ long. The upper end of the cable is fastened to the arm at a point $3.0m$ from the central shaft. The central shaft rotates at a constant angular velocity, such that the cable supporting the seat makes an angle θ_0, with $\sin\theta_0 = \frac{3}{5}$. Which of the following is correct?
   (a) The rider has an inward radial acceleration equal to $\frac{3}{4}g$.
   (b) The rider has an outward radial acceleration equal to $\frac{3}{4}g$.
   (c) The rider has an inward acceleration equal to $\frac{3}{5}g$.
   (d) The rider has an outward acceleration equal to $\frac{3}{5}g$.

7. Same setup. Suppose that the rider has weight 800N. What is the tension in the supporting cable?
   (a) 800N
   (b) 600N
   (c) 1000N
   (d) 1200N.

8. Same setup. What is the approximate speed of the rider?

(a) $2\sqrt{2}m/s$.

(b) $3\sqrt{5}m/s$.

(c) $10m/s$.

(d) $10\sqrt{2}m/s$.

9. A block weighing $50N$ is on a ramp. The ramp is $5m$ long, and the higher end is $3m$ above the lower end. A rope is tied to the block and runs parallel to the ramp. You are holding on the rope.

Approximately much minimum force would you have to exert to keep the block static, if there were no friction?

(a) 50N

(b) 30N

(c) 10N

(d) 40N

10. Now suppose that the coefficient of friction is $\mu = \frac{1}{2}$. What is the minimum force needed to keep the block static?

(a) 10N

(b) 20N

(c) 30N

(d) 50N.