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**PHY 140Y – FOUNDATIONS OF PHYSICS**  
**1999-2000**  
**Term Test #1, Version 1**  
**Thursday, October 28, 1999**  
**6:30 PM - 8:30 PM**

**INSTRUCTIONS:**

*Please give your name, student number, and TA's name on ALL examination booklets used. Answer ALL questions. Total marks = 100. Marks, shown in brackets, will be given for workings and units as well as for final answers. [Non-]programmable calculators may be used. No aid/crib sheets are allowed.*

*Constants:  $g = 9.81 \text{ m/s}^2$*

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Calvin's approach is not recommended!

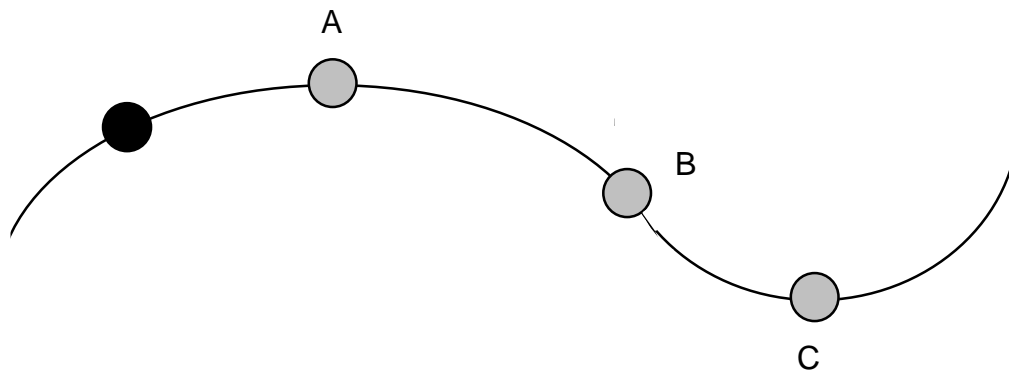
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**QUESTIONS:**

1. Give BRIEF answers to each of the following. *[5 marks each for 20 total]*
  - (a) State Newton's three Laws of Motion. Briefly explain the significance of each one.
  - (b) Define the concept of work. A team of movers wishes to load a truck using a ramp from the ground to the rear of the truck. One of the movers claims that less work would be required to load the truck if the length of the ramp were increased, reducing the angle of the ramp with respect to the horizontal. Is this claim valid? Explain.

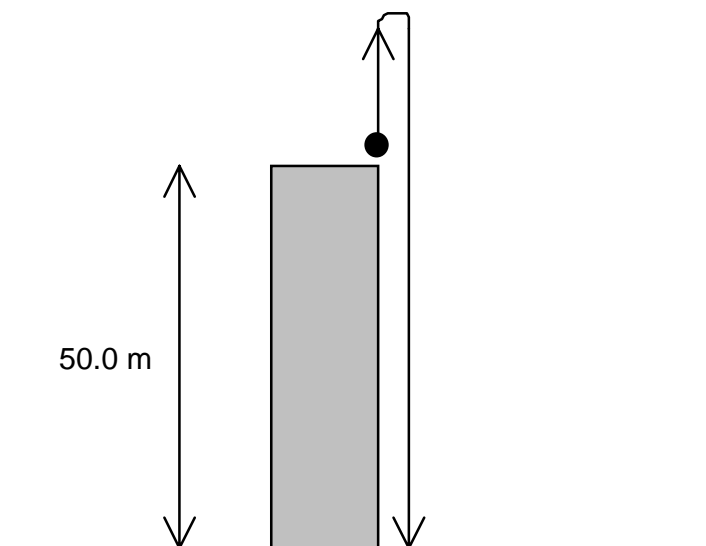
(c) The gas pedal in an automobile is called the accelerator. Are there any other controls in an automobile that can be considered accelerators? When is the gas pedal not an accelerator.

(d) A bead slides freely along a curved wire at constant speed, as shown in the following overhead view. At each of the points A, B, and C, describe the magnitude and direction of the force that the wire exerts on the bead in order to cause it to follow the path of the wire at that point.

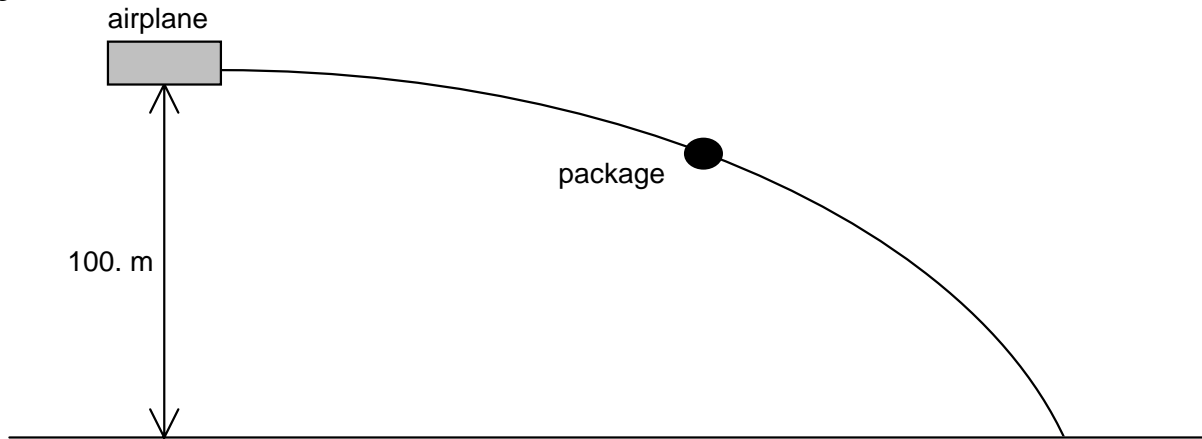


*[Each of the following five questions is worth 16 marks.]*

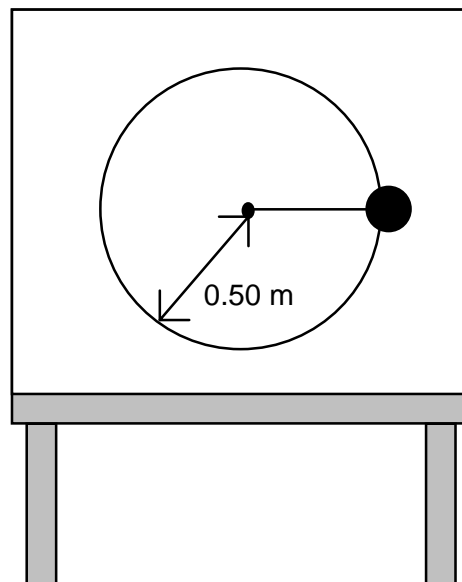
2. A stone is thrown from the top of a building with an initial velocity of 20.0 m/s straight upward. The building is 50.0 m high, and the stone just misses the edge of the roof on its way back down. Determine:
- the time needed for the stone to reach its maximum height,
  - the maximum height,
  - the time needed for the stone to return to the level of the thrower,
  - the velocity of the stone at this instant, and
  - the velocity of the stone just before it hits the ground.



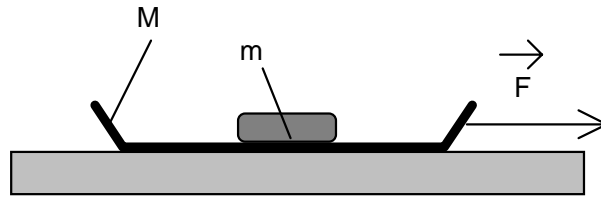
3. A rescue plane drops a package of emergency rations to a stranded party of explorers. The plane is travelling horizontally at 40.0 m/s at a height of 100. m.
- Where does the package strike the ground relative to the point at which it was released?
  - What are the horizontal and vertical components of the velocity of the package just before it hits the ground?
  - What are the magnitude and direction of the velocity of the package just before it hits the ground?



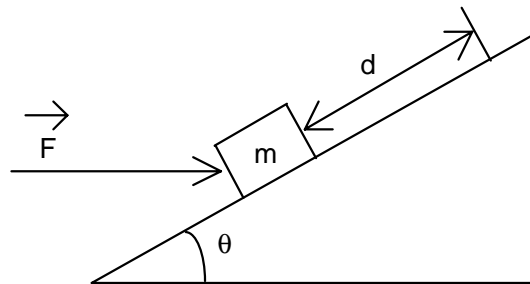
4. A small puck of mass  $m = 0.20$  kg moves in a circle of radius 0.50 m on a table top. The puck is tied with a massless string to a point in the middle of the circle. The coefficient of kinetic friction between the puck and the table is  $\mu_k = 0.34$ . At  $t = 0$ , the puck has a velocity of 12 m/s.
- Draw the free-body diagram for the puck and identify all forces acting on it.
  - What is the tension in the string as a function of time?
  - What is the tension in the string at  $t = 0$ ?
  - What is the time after the puck has completed one revolution and what is the tension in the string at this time?



5. A candy bar of mass  $m$  rests on a tray of mass  $M$  that is on a horizontal frictionless surface. The coefficient of static friction between the candy bar and the upper surface of the tray is  $\mu_s$ . A constant horizontal force  $F$  on the tray accelerates the tray and the candy bar to the right.
- Draw a free-body diagram indicating the forces acting on the tray and the candy bar, considering them as a single system.
  - Determine the magnitude of the acceleration of this system in terms of the applied horizontal force and the appropriate masses.
  - Draw another free-body diagram indicating the forces acting on the candy bar, considering it as a separate system from the tray. What force accelerates the candy bar?
  - What is the maximum magnitude of the acceleration if the candy bar does not slip on the tray?
  - Draw a third free-body diagram indicating the forces acting on the tray, considering it as a separate system from the candy bar. Using this diagram, determine the magnitude and direction of the tray's acceleration. How does this answer compare with that in part (b)?



6. A block of mass  $m$  is placed on an inclined plane that makes an angle  $\theta$  with the horizontal. A horizontal force  $F$  is applied to the block and it moves up the plane with constant velocity. The coefficient of kinetic friction between the block and the plane is  $\mu_k$ .
- Draw the free-body diagram for mass  $m$  and identify all forces acting on it.
  - Derive an expression for the applied force  $F$  in terms of  $m$ ,  $\theta$ , and  $\mu_k$ .
  - What is the work done by the force  $F$  after the block has moved a distance  $d$  up the plane?



**END**