PHYS 131 MIDTERM October 31st, 2008

The exam comprises two parts: 8 short-answer questions, and 4 problems. Calculators are allowed, as well as a formula sheet (one-side of an 8½" x 11" sheet) of your own making.

Answer **all the short-answer questions** with a few words or a phrase, but be concise, please! For the problems, your grade will be calculated with the **best three problems**. Show your work.

The short answer problems are worth two points each, and the problems are worth 10 points each. Put all answers in the **red and white answer booklets** provided; you may keep this exam.

Good luck !

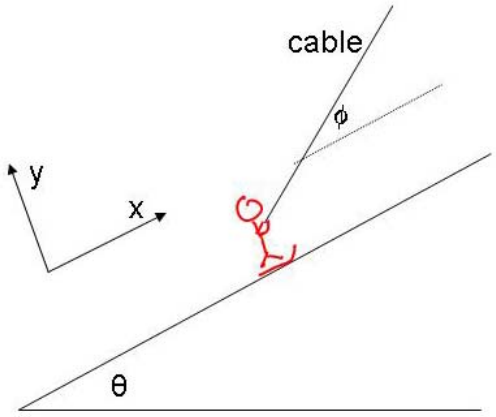
Short answer questions (answer all): you should not need to do any calculations for these questions. Answer in **a few words, a short phrase, or a simple sketch.**

1) [2 pts] a) a system of particles is known to have zero kinetic energy. What can you say about the momentum of the system? b) A system of particles is known to have zero momentum. What can you say about the kinetic energy of the system?

2) [2 pts] You drop a ball from a high balcony and it falls freely (and there's no air resistance). Does the ball's kinetic energy increase by equal amounts in equal times, or by equal amounts in equal distances? Explain.

3) [2 pts] Two drivers are on a highway at the same speed, side by side. At the same instant, they each see an obstacle on the highway and start to brake (ignore reaction times). Driver 1 hits the brakes, locks the wheels, and skids to a stop. Driver 2 hits the brakes and applies the brakes to the verge of locking, but so that the wheels never lock up. Which driver stops in the shorter distance?

4) [2 pts] A skier is being pulled up a slope (angle θ) at constant speed by a cable angled at ϕ from the slope, as shown in the diagram. Draw the free-body diagram on the skier (don't ignore friction). Write down the sum of forces in the x and y directions (two equations), using the coordinate system indicated.

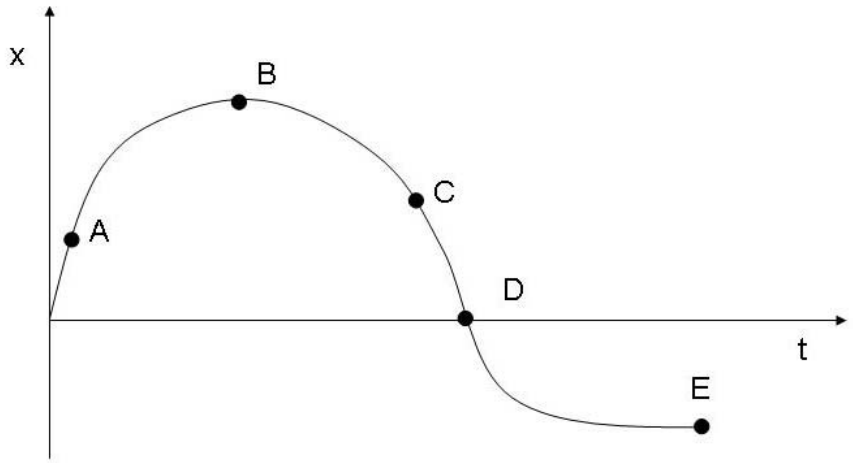


5) [2 pts] Two balls of clay of equal mass are suspended from the ceiling on massless strings of equal length. One of them is pulled to an angle of 45° and released, and it swings down to hit the other. The two of them stick together. To determine the angle to which the balls rise on the other side, would you invoke a) conservation of mechanical energy, b) conservation of momentum, c) both, d) either but not both, or e) none of the above? DON'T solve the problem – just explain which approach [a) through e)] is the correct one.

6) [2 pts] Tarzan swings through the jungle on a vine. At the bottom of his swing, is the tension in the vine greater to, equal to, or less than his weight mg?

7) [2 pts] A projectile is launched over horizontal ground at an angle between (but excluding) 0° and 90°. a) Is there any point on the trajectory where velocity and acceleration are parallel? If so, where? b) is there any point on the trajectory where velocity and acceleration are perpendicular to each other? If so, where?

8) [2 pts] The figure below shows the position-vs-time graph for a moving object. Positive coordinates are to the right. At which point (or points) a) is the object moving the fastest? b) is the object moving to the left? c) is the object at rest? d) is the object turning around?



Problems (you will be graded on the best THREE out of four):

1) [10 pts] A cowboy wishes to display his shooting skills to his friends. He asks a gentleman, standing 8.0 m from him, to toss a coin, and tells his friends that he can shoot the coin in the air. Having done his homework, he knows that the muzzle velocity of his Colt revolver is 73 m/s, and that the man will toss the coin upwards with a speed of 3.2 m/s.

   The cowboy shoots at the same moment as the man tosses the coin, and the height above the ground of his revolver is the same as the man's hand, 1.0 m.

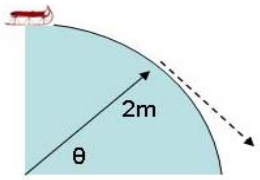
   a) At what angle from the horizontal does the cowboy aim?

   b) At what height above the ground does the bullet strike the coin?

2) [10 pts] A child is sledding on a semi-circular hill as shown, starting from rest at the top of the hill. Assume a frictionless surface. At some point down the hill the sled leaves the surface.

a) Draw a free-body diagram for the sled at an arbitrary angle θ.

b) When the sled leaves the surface, the normal force is zero. Calculate where this happens (ie, at what value of the angle θ). (Hint: at that instant consider the motion to be uniform circular motion).



3) [10 pts] In the "Supernova model" demonstrated in class, a small rubber ball is dropped on top of a larger, more massive, ball, from a height h above the floor. Assume the more massive ball (of mass M) reaches the floor first and bounces elastically, and then the two balls collide (essentially at floor height) elastically. Find the height h' to which the lighter ball (mass m) rises after the collision, in terms of h.

Find the rebound height h' in the case where M=100g, m=50g, and h=1.0 m.

Hint: in a 1-D elastic collision between m_1 moving at v_1 and m_2 moving at v_2, the final velocities v_1', v_2' are given by:

$$v_1' = ((m_1-m_2)/(m_1+m_2)\ v_1 + 2m_2/(m_1+m_2)\ v_2$$

$$v_2' = 2m_1/(m_1+m_2)\ v_1 + ((m_2-m_1)/(m_1+m_2))\ v_1$$

4) [10 pts] A water park has a stunt where a water-skier, pulled by a towboat, skies up a frictionless ramp and over a tank filled with piranha. The ramp is 2.0 m high, and the tank is 5.0 m wide. What minimum speed must the skier have at the base of the ramp (where she drops her tow rope) to clear the tank and thus survive the stunt?