

**PHYS 121: Second Hour Exam****June 19, 2008**

Do not begin this exam until instructed to do so. Please complete this form and read the rules on this cover sheet now.

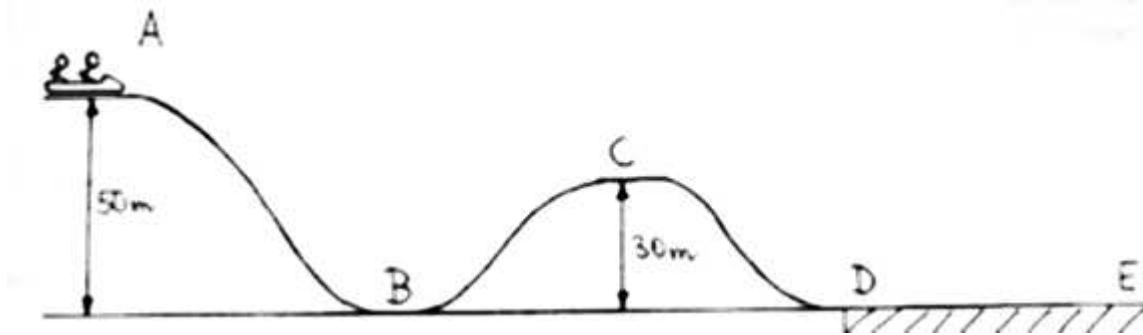
Your Name: \_\_\_\_\_

**Rules for Exam:**

This exam is worth either 10 percent of your grade. You have 80 minutes to complete the exam. You are allowed one textbook. You are also allowed one  $8\frac{1}{2} \times 11$  sheet of hand-written notes (both sides). Answer all questions. Show your work. Partial credit will be awarded for cases where you have progressed toward the correct answer. If you have a question on the wording of a problem or the interpretation of a problem, raise your hand and a proctor will come to you. Write your answers on the pages provided. Calculators are okay, but no PDA's or laptops.

1. Relax. Don't panic.
2. Put a box around your final answer. Use English words.
3. Be as clear as possible when you are working the problems. It helps to draw a picture or say in a few words what you are doing. You will be awarded partial credit for knowing how to solve the problem even if you cannot successfully implement that solution. State clearly the central physics concept associated with each problem. Explain your work. The correct answer alone is worth nothing.
4. You will receive most of the points if you set up the problem clearly and correctly. If you make a math blunder or plug in the wrong numbers at the end, this will cost you a relatively small number of points.
5. Take your time. Do not rush your work. Presentation counts. Neatness counts. Illegible or very untidy answers will be graded as simply wrong. Irrelevant or hostile comments are grounds for lost points. Do not annoy the graders. Show that you care about your work. Go slow, take care, and pace yourself so that you can keep your work organized.

Problem 1	Problem 2	Problem 3	Problem 4	–Total– Score

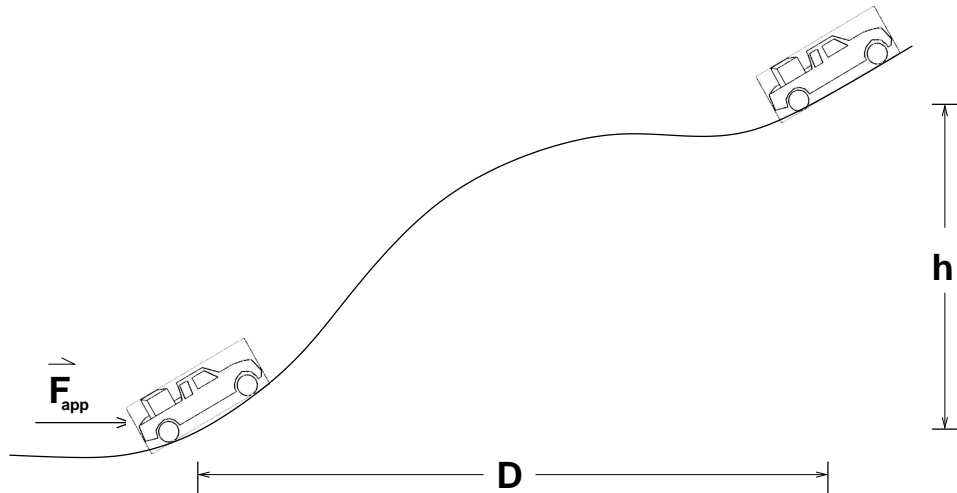
**Problem 1: Energy** (25 points):

A bobsled run leads down a hill as sketched in the figure above. Between points A and D, friction is negligible. Between points D and E at the end of the run, the coefficient of kinetic friction is  $\mu_k = 0.4$ . The height of the hill at point A is given as  $h_A = 50$  meters. The height of the hill at point C is given as  $h_C = 30$  meters. The mass of the bobsled with drivers is given as  $m = 200$  kg and the sled starts from rest at point A.

- What is the *speed* of the bobsled at Point B? Explain.
- What is the *speed* of the bobsled at Point C? Explain.
- Find the *distance*  $x$  beyond point D at which the bobsled will come to a halt. Explain. Hint: there are two ways to do this correctly. One way is rather faster than the other.
- Harder: What is the *minimum* radius of curvature  $R$  for the track at point C that ensures that the bobsled will *not* become airborne (leave the track) at this point? Explain how you worked this out.

**(Extra space for Problem 1 if needed):**

**(More Extra space for Problem 1 if needed):**

**Problem 2: A Toy Truck: (25 points)**

A toy truck of mass  $m$  placed at rest on a small hill and then is pushed up the hill as a result of a *horizontal* applied force  $\vec{F}_{app}$ . The magnitude of the horizontal force changes as a function of horizontal position according to this expression:

$$F_{app} \equiv A(D^2 - x^2)$$

where  $A$  is a known constant.

The wheels on the truck are quite sticky so that there is considerable friction (sometimes sliding, sometimes rolling) between the wheels and the hill as the truck is pushed up the hill. The final horizontal displacement of the truck is  $D$  and the final vertical displacement is  $h$ . Assume that  $m$ ,  $A$ ,  $D$ , and  $h$  are given. Assume that the length of the path and any coefficients of friction cannot be determined. Assume that the truck starts at rest and that it ends at rest.

**a)** Calculate the Work done by the force of Weight on the truck as it moves from the bottom of the hill to the top as shown. Explain.

**b)** Calculate the Work done by the force Normal on the truck as it moves from the bottom of the hill to the top as shown. Explain.

**c)** Calculate the Work done by the applied force  $\vec{F}_{app}$  on the truck as it moves from the bottom of the hill to the top as shown. Explain.

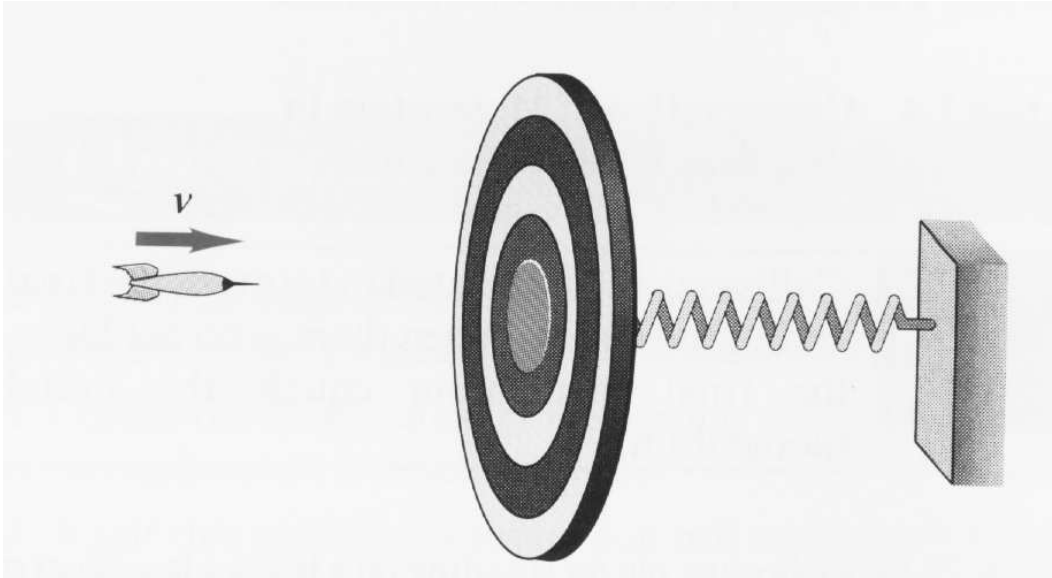
**d)** Harder: calculate the work done by the force of friction on the truck as it moves from the bottom of the hill to the top as shown. Explain.

**(Extra space for Problem 2:)**

**(More Extra space for Problem 2 if needed:)**

**Problem 3: Dart on a Board with Spring (25 points)**

Suppose you conduct the following experiment: You throw a heavy dart with a mass of 0.1 kg so that it moves with a horizontal speed of  $v = 40$  meters per second. The dart embeds itself into a target with a mass of 3.9 kg that is attached to the end of a spring as shown below. The spring is compressed 0.1 meters as a result of the impact.



Now repeat the experiment: Remove the dart and throw it once more against the target, but this time with a horizontal velocity of  $v = 80$  meters per second.

- What is the spring constant  $k$  for this spring?
- How far will the spring compress when the dart is thrown at 80 meters per second?
- Describe the different forms of energy in this problem? Where does the energy go?

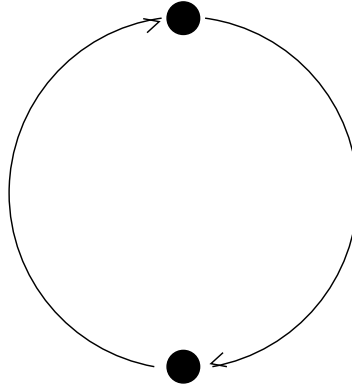
Neglect gravity and air resistance here. Consider horizontal motion only.

**(Extra space for Problem 3:)**

**(More Extra space for Problem 3 if needed:)**

**Problem 4: Two Stars (25 points)**

Two stars orbit each other in deep space. Each star has a given mass  $m$ . The orbit is circular and the distance between the two stars is given as  $d$ .



- Draw an accurate Free Body Diagram for each star. Include a coordinate system.
- In terms  $m$  and  $d$ , what is the magnitude of the *net force* on each star? Explain.
- In terms  $m$  and  $d$ , what is the magnitude of the *total acceleration* on each star? Explain.
- Somewhat harder: In term of  $m$  and  $d$  what is the *orbital period* of each star? Explain.