

## Physics 161 Midterm 1

*There are three (3) problems, worth 33 points each. You must show your work to receive full credit.*

**1.** A small car is traveling on a straight section of freeway at a constant speed of 120 km/hr. It is passed by a large truck traveling at a constant speed of 130 km/hr. 5 s after the truck passes the car, the car starts accelerating at a constant rate to catch up with the car, while the truck keeps going at a constant speed. (Note: 1 km = 1000 m.)

**(a)** (8 points) Draw a motion diagram for the car and the truck. Indicate where the truck passes the car, where the car starts to accelerate, and where the car catches the truck again.

**(b)** (25 points) Find the acceleration of the car such that it catches the truck 15 s after the truck passes the car.

**2.** A block of mass 0.50 kg is held against a wall by a force pushing upward on the block at an angle of  $70^\circ$  above the horizontal, as shown below.

**(a)** (13 points) Assume there is no friction between the wall and the block. Draw a free-body diagram and indicate what physical agent is responsible for each of the forces. Use this to find the value of  $F_{\text{push}}$  required to keep the block from sliding if there is no friction between the wall and the block.

**(b)** (20 points) Now suppose that there is friction between the wall and the block, with coefficients  $\mu_k = 0.20$  and  $\mu_s = 0.40$ . Draw a free-body diagram and indicate what physical agent is responsible for each of the forces. Use this to find the *maximum* value of  $F_{\text{push}}$  such that the block does not slide on the wall.

*Problem 3 is on the back of this page.*

**3.** A 2.0 kg sled is being pulled up a snow-covered slope that is an angle of  $10^\circ$  above the horizontal. The coefficient of kinetic friction between the sled and the snow is  $\mu_k = 0.10$ . The sled is being pulled by a rope that makes an angle of  $30^\circ$  above the surface of the snow. The rope has a tension of 20 N.

**(a)** (13 points) Draw a free-body diagram for the sled and indicate what physical agent is responsible for each of the forces. Also indicate where the angles  $10^\circ$  and  $30^\circ$  appear in the free-body diagram.

**(b)** (20 points) Find the acceleration of the sled.