Physics 2A
Fall 2024

Name _____

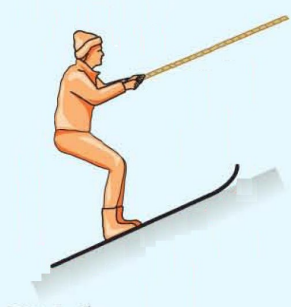
Lab: early late (circle one)

Midterm Celebration

Short Answer Questions (4 or 5 points each)

1) For the situation described below, draw a motion diagram **and** a free-body diagram.

A tow rope pulls a skier up a snow-covered hill. The speed of the skier is increasing. There is friction and air resistance.



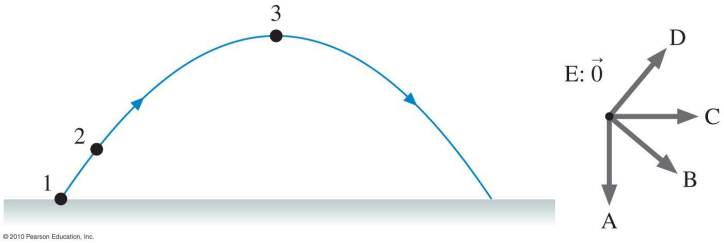
2) A ball is fired at point 1 and follows the trajectory shown in the figure below. Air resistance is negligible. Five possible vectors are shown in the figure; the letter E represents the zero vector. Which vector best represents

a) The ball's velocity at position 2?

b) The ball's acceleration at point 2?

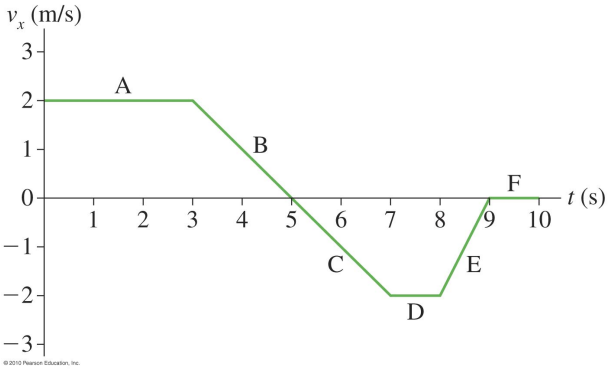
c) The ball's velocity at position 3?

d) The ball's acceleration at point 3?



3) An object's average density ρ is defined as the ratio of its mass to its volume ($\rho = m/V$). The earth's mass is 5.94×10^{24} kg and its volume is 1.08×10^{12} km^3. What is the earth's average density in g/cm^3?

4) The figure below is the velocity-versus-time graph for an object moving along the x-axis.



Circle the correct answer(s)

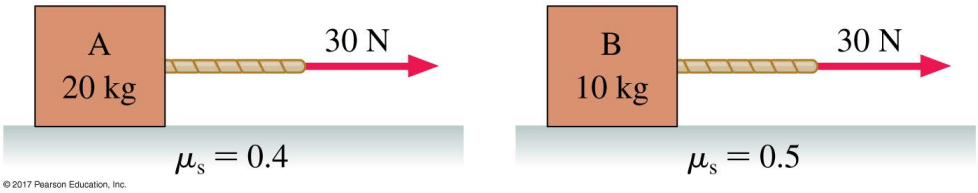
a) During which segment(s) is the velocity constant? A B C D E F

b) During which segment(s) is the object speeding up? A B C D E F

c) During which segment(s) is the object slowing down? A B C D E F

d) During which segment(s) is the object standing still? A B C D E F

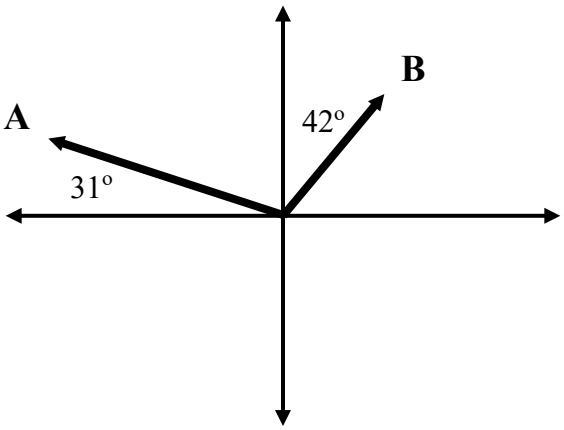
5) Boxes A and B in the figure below both remain at rest as a 30 N force is applied to each. Is the force of friction on box A greater than, less than, or equal to the force of friction on box B? *Explain your answer.*



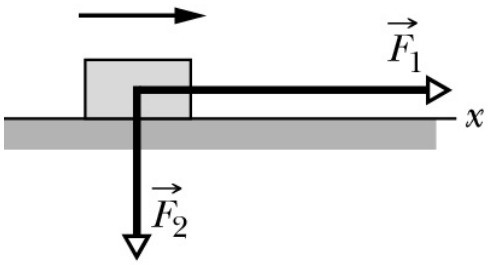
6) It used to be common wisdom to build cars to be as rigid as possible to withstand collisions. Today, though, cars are designed to have "crumple zones" that collapse upon impact. What advantage does this have? Explain your answer using the impulse-momentum theorem.

Problems (12 points each)

1) Two force vectors, $\vec{A}$ and $\vec{B}$, are shown below. Force $\vec{A}$ has a magnitude of 26.0 N and force $\vec{B}$ has a magnitude of 12.0 N. Find the magnitude and direction of $\vec{A}+\vec{B}$.



2) Two forces of magnitudes $F_1 = 105.0$ N and $F_2 = 62.0$ N act on a 25.0 kg box that is moving to the right as shown in the figure below. The coefficient of kinetic friction between the floor and the box is $\mu_k = 0.65$.



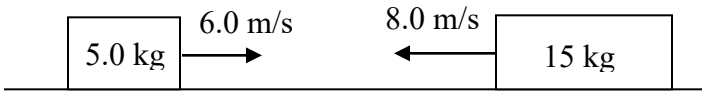
a) Draw a free body diagram showing of all the forces acting on the box. (2 points)

b) What is the normal force acting on the box? (5 points)

c) What is the magnitude and direction of the acceleration of the box? (5 points)

3) Starting from rest, a car accelerates at a constant 4.50 m/s^2 for a distance of 405 m. The car is then shifted into neutral and slows down at a rate of 2.50 m/s^2 until coming to rest. How much time elapses between when the car starts and when it stops?

4) Two crates are sliding on a frictionless surface as shown in the figure below. The 5.0 kg crate is sliding to the right at 6.0 m/s and the 15 kg crate is sliding to the left at 8.0 m/s. The two crates collide and stick together. Use conservation of momentum to find the velocity of the two crates after the collision.



5) A projectile is launched with an initial speed of 45.0 m/s at an angle of 40.0°. Air resistance is negligible.

a) What is the minimum speed of the projectile while it is in the air?

b) What is the highest point reached by the projectile?

c) What is the height of the projectile when it has traveled 37.5 m horizontally?

6) A 23.5 kg child goes down a long, straight slide inclined at an angle of 38° above the horizontal. The coefficient of kinetic friction between the child and the slide is $\mu_k = 0.40$. If the child starts from rest, how far down the slide does the child slide in 2.50 s?