Physics 4A
Spring 2025

Name _____

Lab: 8:00 am 11:10 am 2:30 pm (circle one)

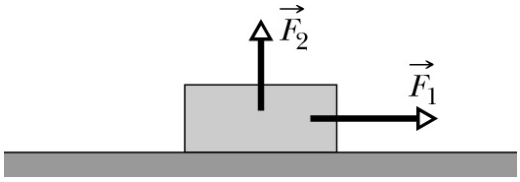
Celebration #1: Kinematics, Vectors, and Newton's Laws

Short Answer Questions (4 or 5 points each)

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

You've slammed on the brakes and your car is skidding to a stop while going down a 20° hill. Air resistance *is not* negligible.

2) In the figure below, a horizontal force $\vec{F}_1$ of magnitude 25 N is applied to a box on a floor, but the box does not slide. Then, as the magnitude of a vertically applied force $\vec{F}_2$ is increased from zero but before the box begins to slide, do the following quantities increase, decrease, or stay the same: **(a)** the magnitude of the frictional force on the box; **(b)** the magnitude of the normal force on the box; **(c)** the maximum value $f_{s,max}$ of the static frictional force on the box?



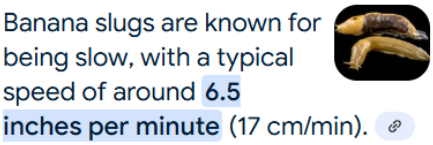
a)

b)

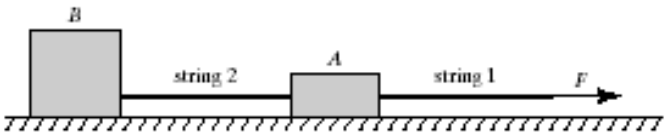
c)

3) A leopard jumps upward with an initial speed 37.4 m/s at an angle θ with respect to the horizontal. The minimum speed of the leopard while it is in the air is 10.6 m/s. What is θ?

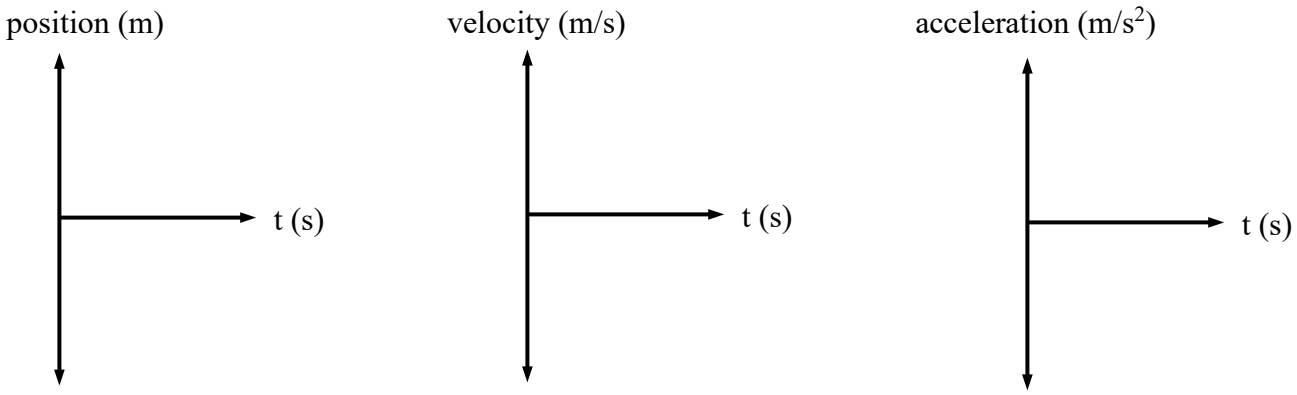
4) According to Wikipedia, **t**he average speed of a banana slug is about approximately 17 cm/min. How fast is this in miles per hour?



5) In the situation below, a person pulls a string attached to a block A, which is in turn attached to another heavier block B via a second string. The mass of block B is twice the mass of block A. Is the force of string 1 on block A greater than, less than, or equal to the force of string 2 on block B? *Explain your answer.*



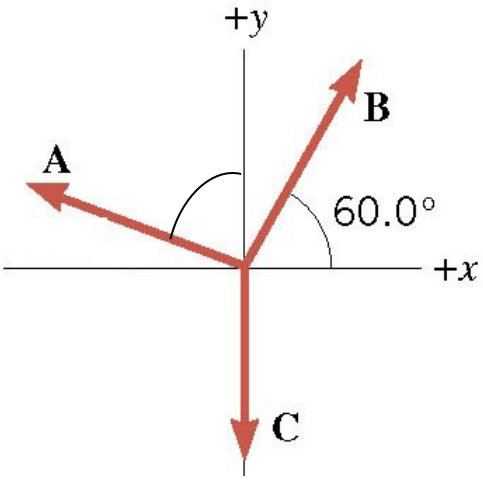
6) A ball is thrown vertically upward, rises to its maximum height, and returns to the thrower's hand. Sketch three different graphs showing the position, velocity, and acceleration of the ball as a function of time. Take upward to be the positive direction and the release point of the ball to be the zero position.



Problems (12 points each)

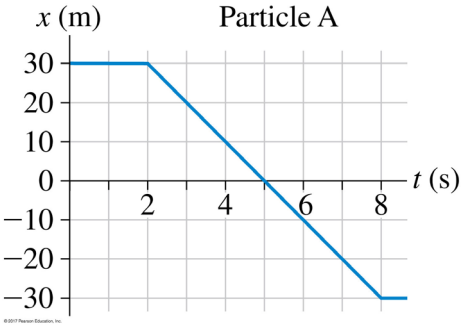
Problem 1

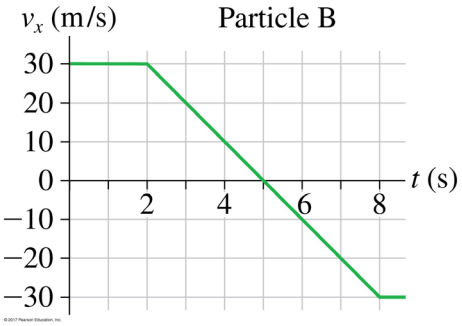
The magnitudes of the three displacement vectors shown in the figure below are A = 15.5 m, B = 17.0 m, and C = 13.0 m. Find the magnitude and direction of vector $\vec{D}$ such that $\vec{D} = 3\vec{A} + 2\vec{B} - \vec{C}$.

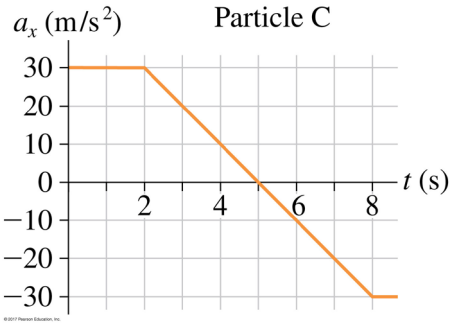


Problem 2

Particles A, B, and C move along an x-axis. In the figure below, the graph for A is a position-versus-time graph; the graph for B is a velocity-versus-time graph; the graph for C is an acceleration-versus-time graph. Particle C has an initial velocity of 10.0 m/s. Find each particle's velocity at t = 7.0 s.







Problem 3

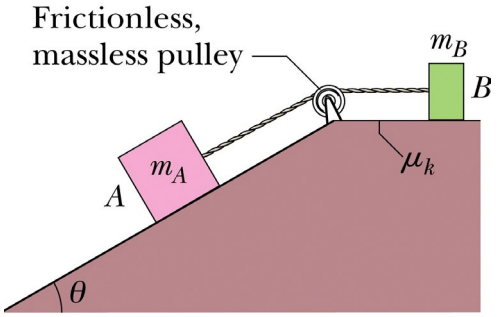
A runner of mass 48.1 kg starts from rest and accelerates with a constant acceleration of 0.35 m/s^2 until she reaches a speed of 4.20 m/s. She then continues running at this constant speed of 4.20 m/s for 15.0 s. Finally, she accelerates at -0.68 m/s^2 until coming to rest. What is the total distance covered by the runner **and** the total time she is in motion?

Problem 4

A soccer ball is kicked from the ground into the air in the absence of air resistance. 2.00 s after it is kicked, the velocity of the soccer ball is $\vec{v} = (7.60\,m/s)\hat{i} + (12.50\,m/s)\hat{j}$. **(a)** What was the initial velocity (magnitude and direction) of the soccer ball? **(b)** What horizontal distance will be traveled by the soccer ball?

Problem 5

Block A in the figure below has mass $m_A = 5.0$ kg, and block B has mass $m_b = 2.5$ kg. The coefficient of kinetic friction between block B and the horizontal plane is $\mu_k = 0.40$. The inclined plane is frictionless and at an angle $\theta = 34.0°$. The rope is massless and stretchless and the pulley is massless and frictionless. Find the magnitude of the acceleration of each block.



Problem 6

A 4.25 kg block is launched up a 3.75 m high frictionless inclined plane ($\theta = 35.0°$) with an initial speed of $v_0 = 17.5$ m/s as shown in the figure below. How far from the base of the ramp does the block land? (Air resistance is negligible)