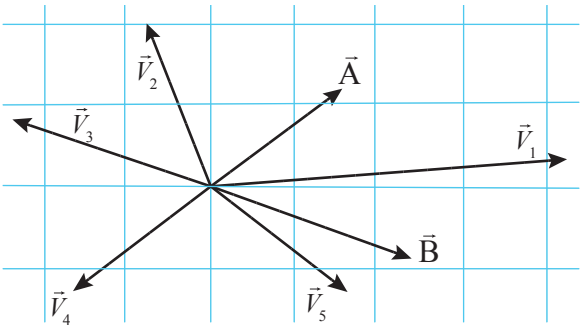
Name _____ **UW Net ID** _____
last *first* *(part before @uw.edu)*

I. [45 pts] Multiple Choice (5 pts each): Mark your answer on BOTH the bubble sheet and this page.

1. [5 pts] The vector in the figure that could represent the vector $\vec{A} - \vec{B}$ is:



   A. $\vec{V}_5$

   B. $\vec{V}_4$

   C. $\vec{V}_3$

   D. $\vec{V}_2$

   E. $\vec{V}_1$

2. [5 pts] A sandbag is dropped from a rising air balloon and hits the ground 7.00 seconds later. From what height was the sandbag released if at the moment it was released, the balloon was traveling upward at 3.00 m/s?

   A. 54.0 m

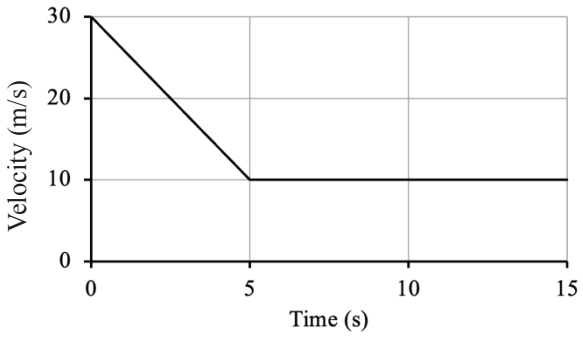
   B. 219 m

   C. 240 m

   D. 439 m

   E. 480 m

3. [5 pts] The graph shows the instantaneous velocity of a car during 15 s of its motion. The distance traveled by this car during this 15-s interval is:



   A. 50 m

   B. 100 m

   C. 150 m

   D. 200 m

   E. 250 m

Name _____ **UW Net ID** _____
last *first* *(part before @uw.edu)*

4. [5 pts] A student swims across a 25-m wide river at an angle of 35° with respect to the riverbank. She swims at a speed of 1.5 m/s ($|\vec{v}_{sw}|$) with respect to the water. The water is flowing at 0.50 m/s with respect to the bank ($\vec{v}_{wb}$) as shown. How far downstream of her starting point is the student when she reaches the other side of the river?

A. 28 m

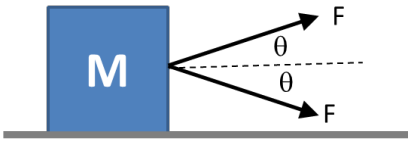
B. 31 m

C. 33 m

D. 42 m

E. 50 m

5. [5 pts] A block of mass M = 4.00 kg is at rest on a surface. The coefficient of static friction between the floor and block is 0.450. A pair of symmetrically oriented cables, as shown, each applies a 12.0 N force on the block. What is the largest angle θ that will just begin to make the block move? (That is, for larger angles, the block remains at rest.)



A. 42.7°

B. 24.3°

C. 18.7 °

D. 47.3°

E. Cannot determine from provided information

6. [5 pts] A golf ball is struck at an angle of 40.0° with respect to the horizontal. Its initial speed is 35.0 m/s. The ball hits a house 80.0 m away and breaks a window. How high off the ground is the ball when it strikes the window?

   A. 5.20 m

   B. 13.8 m

   C. 23.5 m

   D. 33.6 m

   E. 54.5 m

7. [5 pts] A merry-go-round completes one revolution in 30 s. What is the speed of a rider located at a distance 3.0 m from the center of the merry go-round?

   A. 0.1 m/s

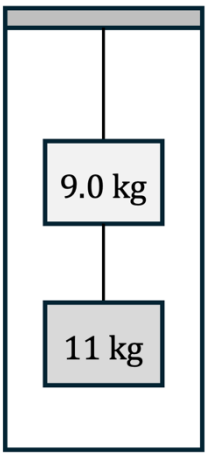
   B. 0.2π m/s

   C. 2π m/s

   D. 6π m/s

   E. 30 m/s

8. [5 pts] A 9.00 kg and an 11.0 kg block are fastened to the ceiling of an elevator, as shown. The elevator accelerates upward at 2.20 m/s^2. Find the tension in the bottom rope.



   A. 24.2 N

   B. 44.0 N

   C. 106 N

   D. 132 N

   E. 196 N

9. [5 pts] A medium-sized jet has a 3.80-m-diameter fuselage and a loaded mass of 85,000 kg. The drag on an airplane is primarily due to the cylindrical fuselage, and aerodynamic shaping gives it a drag coefficient of 0.0370. How much thrust must the jet's engines provide to cruise at 230 m/s at an altitude where the air density is 1.10 kg/m^3?

   A. 0.61 kN

   B. 9.06 kN

   C. 12.2 kN

   D. 15.5 kN

   E. 24.4 kN

II. [15 points total] Lab multiple-choice questions

The situation below applies to the following two questions.

10. [5 pts] Two groups of students want to find the average speed of a cart moving in a straight line. They use a clock and a ruler as described below:

    Group 1: Records the position of the cart at equally-spaced time intervals.

    Group 2: Records the time at which the cart passes specific, equally-spaced positions.

    Which are the dependent and independent variables in each experiment? **(You can choose more than one answer.)**

    A. For Group 1, position is the dependent quantity, and time is the independent quantity.

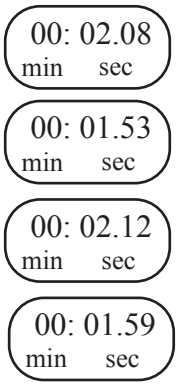
    B. For Group 1, time is the dependent quantity, and position is the independent quantity.

    C. For Group 2, position is the dependent quantity, and time is the independent quantity.

    D. For Group 2, time is the dependent quantity, and position is the independent quantity.

    E. None of the above

11. [5 pts] Group 2 conducts 4 trials. For x = 10.0 cm they find the four times shown at right on their clock.



    Based on the ideas developed in labs A1 and A2, what are the corresponding *instrumental* and *random* uncertainties? (Use one significant digit.)

    A. Instrumental uncertainty is 0.005 s Random uncertainty is 0.3 s

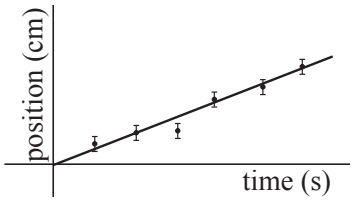
    B. Instrumental uncertainty is 0.05 s Random uncertainty is 0.3 s

    C. Instrumental uncertainty is 0.005 s Random uncertainty is 0.05 s

    D. Instrumental uncertainty is 0.3 s Random uncertainty is 0.005 s

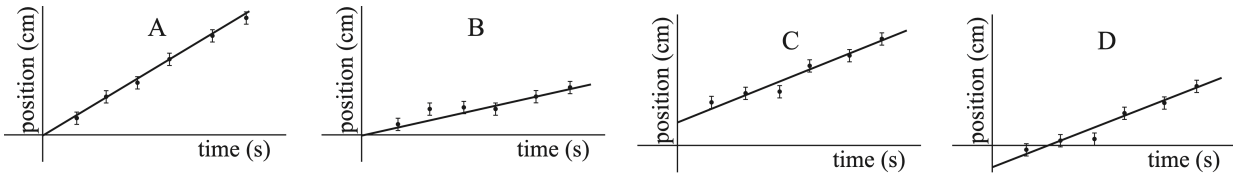
    E. Instrumental uncertainty is 0.3 s Random uncertainty is 0.05 s

12. [5 pts] In Lab A1, recall that students placed pennies on a piece of paper at 1s intervals to mark a cart's location. Group 1's graph is at right.



Group 2 used the same cart. In their case, the student who put down the pennies waited until they heard the metronome click, then took a penny from their hand, and finally reached across the table to the cart and placed the penny next to it. After graphing, Group 2 realized this procedure introduced a systematic error.

Which graph below **best** shows the data collected by Group 2? Assume the systematic error is the same for each instant.



E. Graph same as intial group

Name _____ **UW Net ID** _____
last *first* *(part before @uw.edu)*

III. Lecture long-answer questions (25 points total)

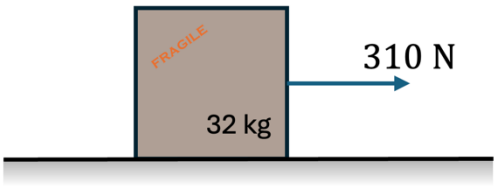
A student pushes on a large crate with a force 300.0 N at an angle of 21.0° from the horizontal, as shown. The crate is on a rough floor and has a mass of 32.0 kg.

13. [4 pts] In the space below, draw a free-body diagram for the crate, *assuming it is at rest*. Label the forces to indicate the object exerting the force and the object on which the force is exerted.

14. [5 pts] What is the magnitude of the normal force exerted on the crate by the floor? Show your work.

15. [6 pts] The coefficient of static friction between the crate and the floor is μ_s. What is the minimum value of μ_s such that the crate remains at rest? Show your work.

Since the student cannot move the crate, they try a different method. The student ties a rope to the crate and pulls directly to the right with a force of 310 N. This force is large enough to get the crate to move, and the coefficient of kinetic friction between the crate and the floor is $\mu_k = 0.63$.



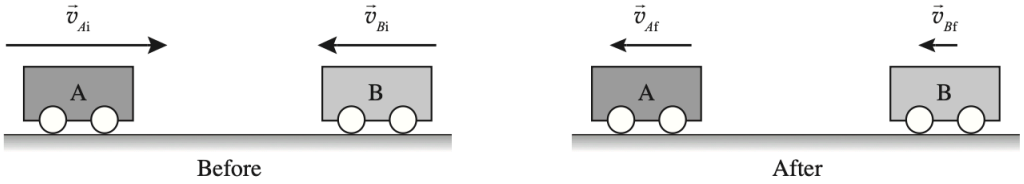
16. [5 pts] Determine the magnitude of the acceleration of the crate. Show your work.

17. [5 pts] If the crate starts from rest, what is the speed of the crate after it has traveled 2.0 m? Assume the student applies a constant 310-N force as shown in the diagram above. Show your work

Name _____ **UW Net ID** _____
last *first* *(part before @uw.edu)*

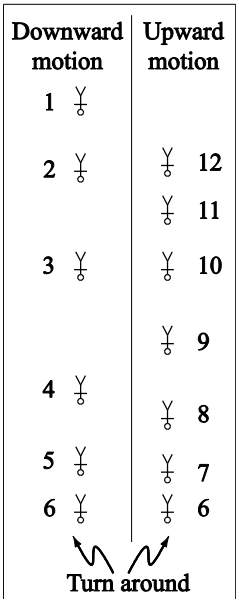
IV. Tutorial and lab long answer questions (15 points total)

18. [6 pts] Two carts, A and B, roll toward each other on a level table. The vectors represent the velocities of the cars just before and just after they collide.



Draw and label a vector **for each cart** to represent the *change in velocity* ($\Delta\vec{v}$) of each cart. The magnitude and direction of your vectors should be consistent with those shown. Show your work.

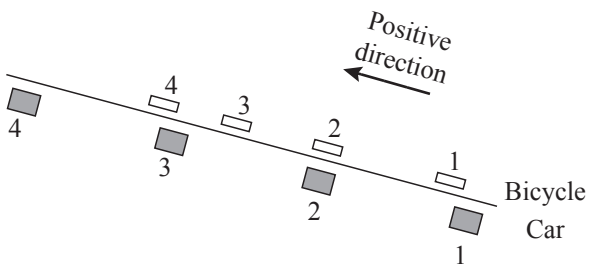
19. [4 pts] The diagram at right shows a bungee jumper's location at **equal time intervals**. At t_1 she steps off a bridge and falls straight down. At t_6, she is at the bottom with the cord fully stretched. She then begins moving upward.



For the interval between t_4 and t_8, draw arrows below to show (a) the *direction* of the change in velocity $\Delta\vec{v}_{4,8}$ and (b) the *direction* of the average velocity $\vec{v}_{\text{avg }4,8}$. Explain/show your work for each.

Direction of the *change in velocity* ($\Delta\vec{v}_{4,8}$)	Direction of the *average velocity* ($\vec{v}_{\text{avg }4,8}$)

20. [5 pts] A bicycle slows down as it coasts up a hill while a car drives up the hill at constant speed. The diagram at right shows their positions in the ground reference frame at equally spaced time instants 1–4.



In the reference frame of the car, is the bicycle *speeding up, slowing down, or moving at constant speed* at instant 2? Explain.