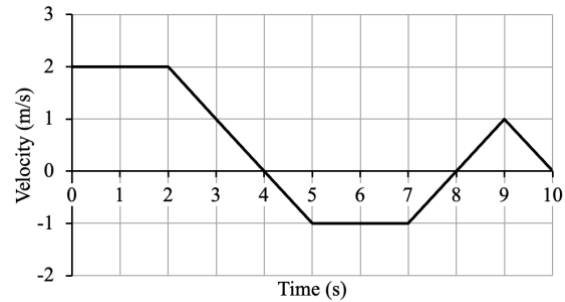


Name _____ Student ID: _____
 Last First

1. [5 pts] The figure shows the velocity-time graph of an object that is at $x = -3.0$ m at $t = 2.0$ s. What is the object's position at $t = 9.0$ s?

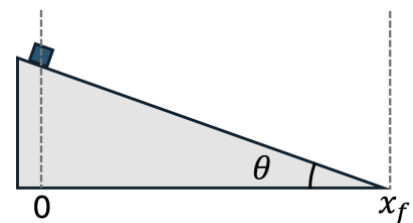


- A) 10 m
- B) 4.0 m
- C) 1.0 m
- D) -0.50 m
- E) -3.5 m

2. [5 pts] A ball is tossed straight up from the ground with a speed of 16.0 m/s. When it returns, it falls into a hole 2.0 m deep. What is the ball's speed just before it hits the bottom of the hole?

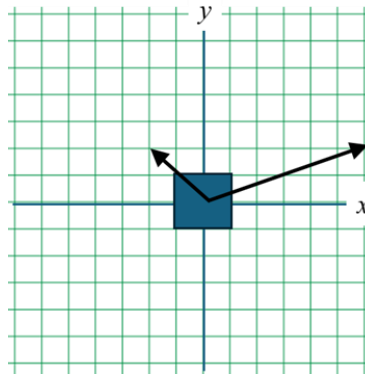
- A) 15 m/s
- B) 17 m/s
- C) 36 m/s
- D) 48 m/s
- E) 217 m/s

3. [5 pts] A block slides down a frictionless incline starting from rest as shown in the diagram. In terms of the horizontal location at the bottom of the ramp, x_f , and the angle of the incline, θ , what is the velocity of the block at the bottom of the slide?

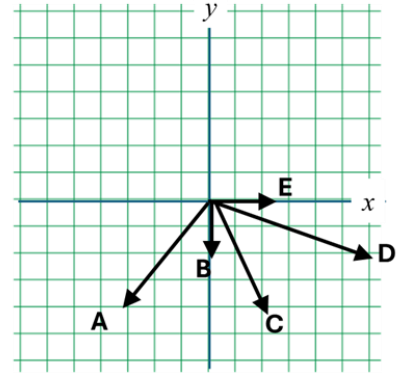


- A) $v_f = \sqrt{2gx_f \sin \theta}$
- B) $v_f = \sqrt{2gx_f \cos \theta}$
- C) $v_f = \sqrt{gx_f}$
- D) $v_f = \sqrt{2gx_f \tan \theta}$
- E) $v_f = \sqrt{gx_f \sin \theta}$

4. [5 pts] The diagram on the left shows a top-view diagram of a block sitting at the origin of an ice sheet (no friction). The two vectors represent two forces acting on the block.



The diagram on the right shows 5 additional vectors representing forces. Which one, when applied to the block, will result in an acceleration directly to the right along the x axis? All forces are in the xy plane.



Top-view diagram

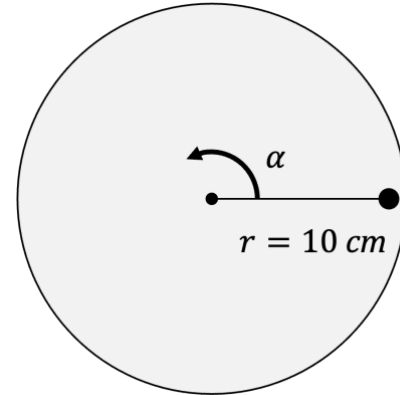
- A) Vector A
 - B) Vector B
 - C) Vector C
 - D) Vector D
 - E) Vector E
5. [5 pts] A car of mass m is traveling on a flat circular track with diameter d . At what speed v_t would the car need to go for the magnitude of the force causing its centripetal acceleration to be equal to the magnitude of the gravitational force acting on it?

- A) mgd
- B) \sqrt{gd}
- C) $\sqrt{\frac{mgd}{2}}$
- D) $\sqrt{\frac{2g}{d}}$
- E) $\sqrt{\frac{gd}{2}}$

Name _____ Student ID: _____
Last First

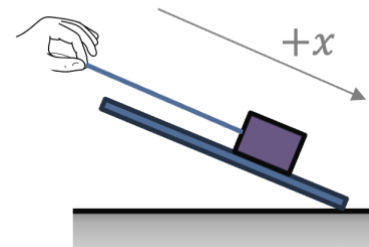
6. [5 pts] A dot is drawn on a disc 10 cm from its center. The disc starts at rest at $t = 0$ s, then undergoes a constant angular acceleration of $\alpha = 3.0$ radians/s². What is the magnitude of the dot's total linear acceleration at $t = 0.71$ s?

- A) 0.30 m/s²
- B) 0.45 m/s²
- C) 0.54 m/s²
- D) 0.75 m/s²
- E) 45 m/s²

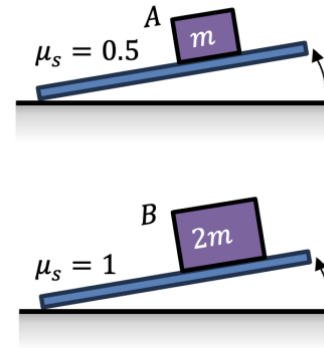


7. [5 pts] A block is moving down a ramp in the $+x$ direction. There is friction between the block and the surface, and a rope exerts a tension force pulling the block in the $-x$ direction. The block is slowing down. Which of the following is true about the forces on the block?

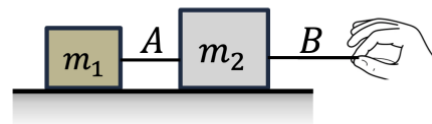
- A) The net force on the block points in the $+x$ direction.
- B) Static friction is exerting a force in the $+x$ direction.
- C) Static friction is exerting a force in the $-x$ direction.
- D) The force of kinetic friction is in the same direction as the tension force from the rope.
- E) The component of gravity pointing in the $+x$ direction must be smaller in magnitude than the tension from the rope.



8. [5 pts] Block A of mass m is stationary on a ramp. The coefficient of static friction between block A and the ramp is 0.5. The angle of the ramp is increased until block A slips at angle θ_A . Block B, which has mass $2m$ and is made of a different material, is initially stationary on a different ramp. The coefficient of static friction between block B and its ramp is 1. The angle of the ramp is increased until block B slips at angle θ_B . How do θ_A and θ_B compare?



- A) $\theta_B > 2\theta_A$
 B) $2\theta_A > \theta_B > \theta_A$
 C) $\theta_B = \theta_A$
 D) $\theta_A > \theta_B$
 E) Cannot be determined from the information given
9. [5 pts] Two blocks are connected by rope A and pulled to the right on a horizontal frictionless table by rope B. If the tension in rope B is 3.0 N, $m_1 = 2$ kg and $m_2 = 7$ kg, what is the tension in the rope A?



- A) 0.66 N
 B) 0.85 N
 C) 2.3 N
 D) 3.0 N
 E) 10.5 N

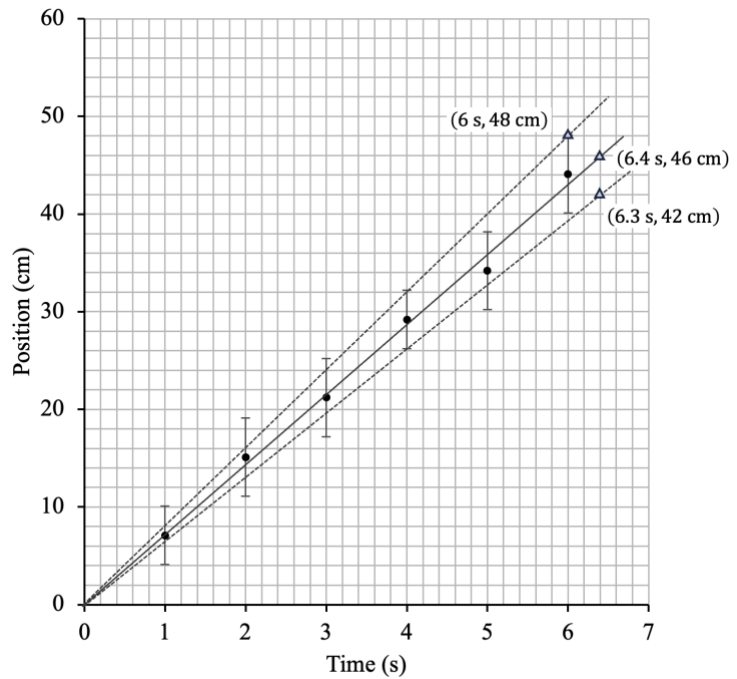
Lab Multiple Choice Questions

10. [5 pts] A group of students is using a digital stopwatch to make time measurements as part of a lab experiment. They perform three trials, and their data is shown at right. The students use the maximum deviation method to determine the random uncertainty in their measurements. For this case, how much larger is the random uncertainty compared to the instrumental uncertainty of the stopwatch?

| Trial | Time |
|-------|--------|
| 1 | 3.15 s |
| 2 | 3.58 s |
| 3 | 2.96 s |

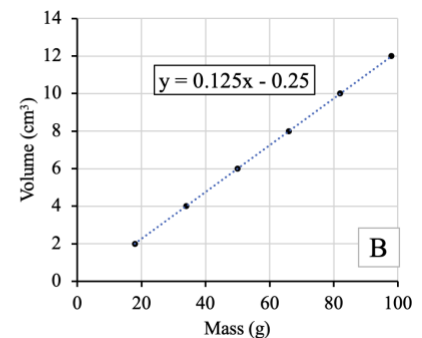
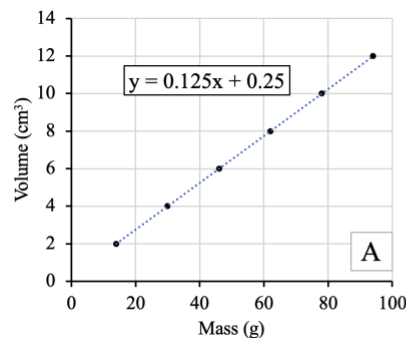
- A) Random uncertainty is 16 times larger than the instrumental uncertainty.
 B) Random uncertainty is 30 times larger than the instrumental uncertainty.
 C) Random uncertainty is 50 times larger than the instrumental uncertainty.
 D) Random uncertainty is 70 times larger than the instrumental uncertainty.
 E) Random uncertainty is 270 times larger than the instrumental uncertainty.

11. [5 pts] A group of students (group A) have studied the motion of a toy car and formed the position-time graph at right. They have also plotted a best-fit line and lines of maximum and minimum slope. Coordinates on these lines (indicated by triangular data markers) are shown, and all three lines pass through the origin. Based on these values and the guidelines introduced in Labs A1/A2, which of the choices below represents a correct reporting of the velocity of the car?

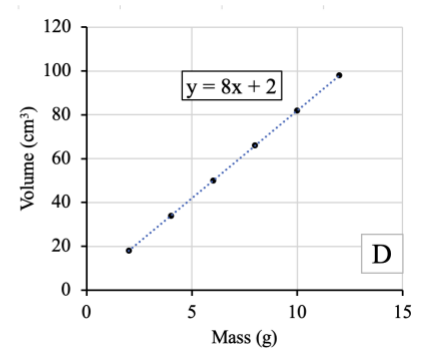
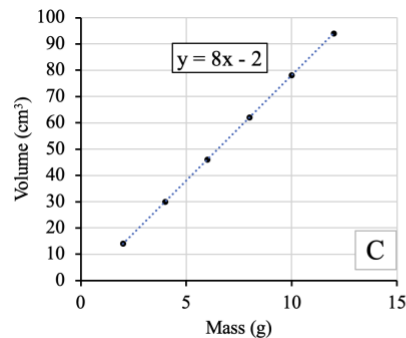


- A) (6.3 ± 1.47) cm/s
- B) (6.3 ± 1.5) cm/s
- C) (7.19 ± 0.81) cm/s
- D) (7.2 ± 0.6) cm/s
- E) (7.2 ± 1.1) cm/s

12. [5 pts] Students are given 6 different steel blocks. The density of steel is 8.00 g/cm^3 ($\rho = m/V$). The students use a mass scale to measure the mass of each block, and they use a graduated cylinder to measure the volume. They form a plot of volume versus mass.



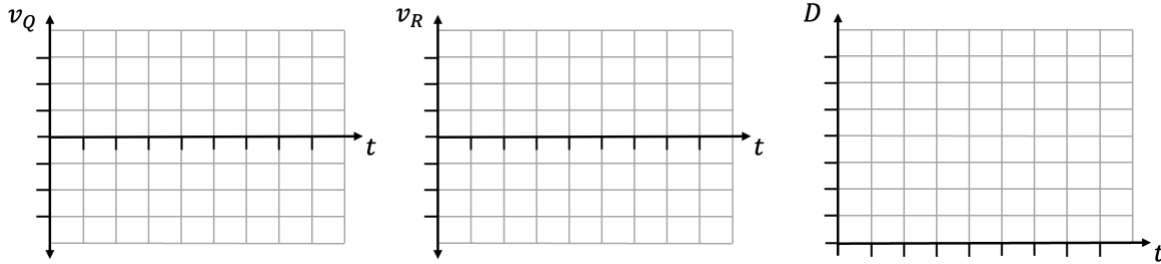
After they make their plot, they notice that the mass scale reads -2.00 g when no object is on the scale. Which of the graphs at right would be closest to the student's volume versus mass plot?



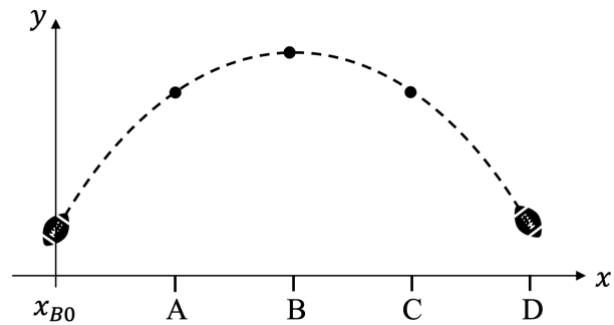
- A) Graph A
- B) Graph B
- C) Graph C
- D) Graph D

Lecture Free Response

13. [5 pts] A Quarterback (Q) and a Receiver (R) stand side by side at position $x = 0$. At $t = 0$, Q begins to run backwards with velocity $v_Q = -2 \text{ m/s}$ for 3 seconds, then Q stops. At the same time, R runs forward with velocity $v_R = +4 \text{ m/s}$ for 3 seconds and then instantaneously begins to run with $v_R = +6 \text{ m/s}$ for the next 5 seconds. On the axes below, draw a graph of v_Q and v_R vs time, and the total distance D between Q and R vs time. You can assume the time axis ticks are 1 second apart, but you must indicate the scale of your vertical axes (values and units).



14. [6 pts] When the quarterback stops, he launches the ball from location x_{B0} with velocity v_{B0} at an angle θ from the horizontal. The trajectory of the ball is shown in the figure. Draw acceleration vectors (labeled a) and velocity vector components (labeled v_x and v_y) on the ball's trajectory at positions A, B, and C.



15. [5pts] For this question, $t = 0$ is when the ball is thrown, and the initial vertical position of the ball is zero. Recall that Q launches the ball from location x_{B0} with velocity v_{B0} at an angle θ from the horizontal. At this instant, the receiver (R) is at x_{R0} and is moving with a speed v_R . In terms of the given variables, write equations that represent the x and y locations of the ball (B) and the x position of the receiver (R) as a function of time. Your final expressions should not include any terms which are zero.

Eqn. 1: $x_B(t) =$

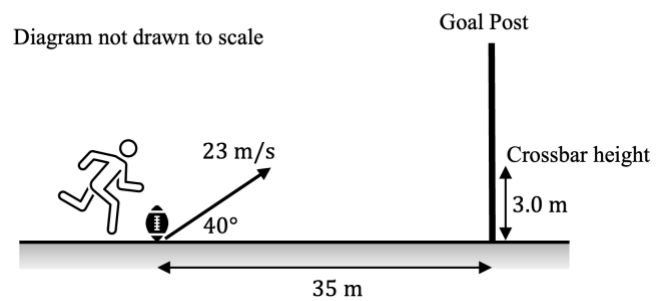
Eqn. 2: $y_B(t) =$

Eqn. 3: $x_R(t) =$

Name _____ Student ID: _____
Last First

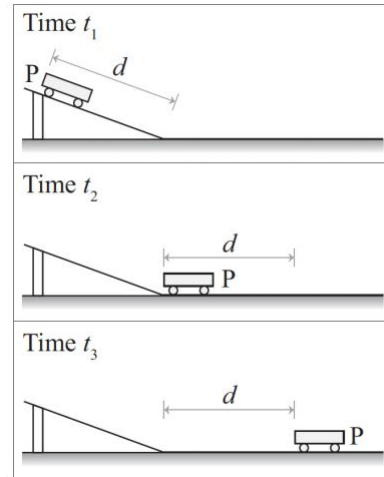
16. [3 pts] The information above is insufficient to determine if the ball reaches the receiver or not. What conditions must be met for this to be a catch? You should not solve this, just state what is the relationship between the above expressions that represents a catch and explain your reasoning.

17. [6 pts] Later in the game, a field-goal kicker kicks a ball with a speed of 23 m/s at an angle of 40° from the horizontal. The goal post is 35 meters away and the goal post crossbar is 3.0 m above the ground. Assuming the aim is correct, how high is the ball above the ground when it passes the goal post? Show your work.



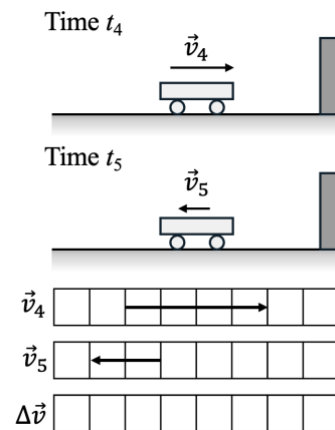
Tutorial Free Response Questions

18. [5 pts] Cart P is released from rest on a frictionless incline at time t_1 as shown. Between times t_1 and t_2 , it travels a distance d , reaching the end of the incline. Between times t_2 and t_3 , it moves a distance d across a frictionless horizontal surface.



Is $t_3 - t_2$ greater than, less than, or equal to $t_2 - t_1$? Explain.

19. [5 pts] At some later time, t_4 , the cart has a velocity, \vec{v}_4 to the right as shown at right. The cart collides with a wall and its velocity, \vec{v}_5 , after the collision is also shown. In the space below right, determine the change in velocity of cart from t_4 to t_5 . Briefly explain.



20. [5 pts] An object moves clockwise around the track shown at right (this is a top-view diagram). At point A, the object is speeding up, and at point B the object is slowing down. At each of these points, draw the acceleration vector of the object. Briefly explain.

