Physics 114 A
Winter 2025

114A - DEPIES

Midterm 1
February 4th, 2025

Please use the boxes below to clearly print your name and UW NetID.
Please write within the boxes.

Printed Name	

first *last*

UW Net ID	

(part before @uw.edu)

I certify that the work I shall submit is my own creation, not copied from any source.

Signature _____ **Seat Number** _____

Clearly fill out this cover page and the top portion of the provided bubble sheet with the necessary information.

Do not open the exam until told to do so.
When prompted, clearly print the information required at the top of each page of this exam booklet.
You can remove the equation sheet(s). Otherwise, keep the exam booklet intact.
You will have 60 minutes to complete the examination.

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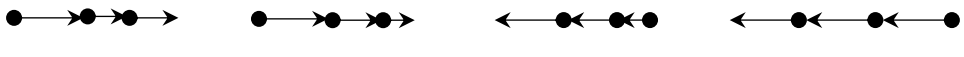
I. **Multiple Choice** [5 pts each] Bubble in the most correct answer on your bubble sheet and circle the correct answer here.

1. A building contractor is tasked with placing glass windows on two new rectangular buildings. The buildings are designed such that the entire outer surface is made of glass. Building A requires 150 windows. Building B is three times the width, three times the length and three times the height of building A. How many windows will the contractor need to complete building B? The windows used on both buildings are the same.

   A) 150
   B) 450
   C) 900
   D) 1350
   E) 4050

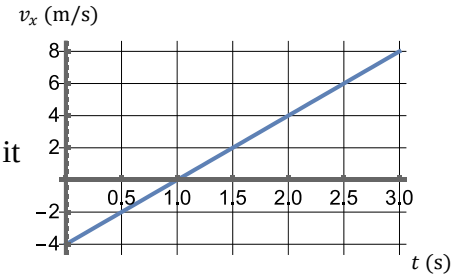
2. Consider the following four motion diagrams. In which of them is the object experiencing a constant acceleration to the left?



I. II. III. IV.

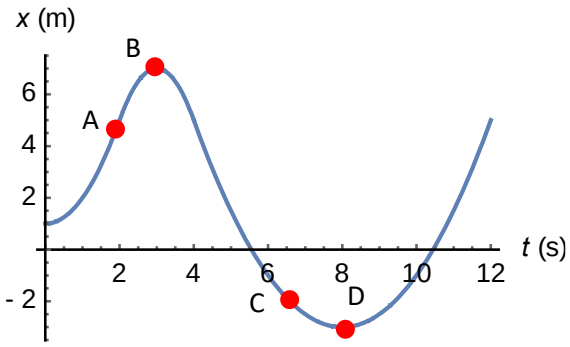
   A. (I) and (III).
   B. (III) only.
   C. (II) and (III).
   D. (III) and (IV).
   E. (II), (III) and (IV).

3. An object is moving along the x-direction. Its velocity is recorded as a function of time in the graph at right. At $t = 0.5$ s the object is located at $x = -3.0$ m. Where is it located at $t = 2.0$ s?



   A) $x = -0.5$ m
   B) $x = -1.5$ m
   C) $x = 3.0$ m
   D) $x = 4.5$ m
   E) $x = 9.0$ m

Use the next situation to answer the next two questions:
The graph at right shows the position vs. time graph for an object moving along the x-axis.



4. Choose the correct ranking of **magnitudes** of velocity (no signs) at the points show.

   A. $v_B = v_D < v_C < v_A$
   B. $v_D < v_C < v_A < v_B$
   C. $v_A < v_C < v_B = v_D$
   D. $v_C < v_A < v_B = v_D$
   E. $v_C < v_D < v_A < v_B$

5. In which one of the following time intervals is the object moving in the $+x$-direction and slowing down?

   A. From $t = 0$ s to $t = 2.0$ s.
   B. From $t = 2$ s to $t = 3.0$ s.
   C. From $t = 3.0$ s to $t = 8.0$ s.
   D. From $t = 8.0$ s to $t = 12$ s.
   E. None of the above.

Use the next situation to answer the next three questions, 6-8:

6. You throw a ball straight up and then catch it 2.5 seconds later at the same location you threw it up. At what speed did you throw the ball?

   A. 3.0 m/s
   B. 6.0 m/s
   C. 12 m/s
   D. 18 m/s
   E. 24 m/s

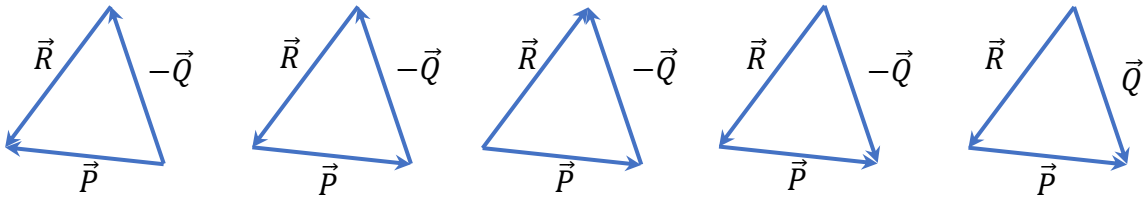
7. What was the maximum height reached by the ball?

   A. 1.8 m
   B. 29 m
   C. 13 m
   D. 7.6 m
   E. 4.1 m

8. If we double the initial speed of the ball, what does that do to the ball's maximum height?

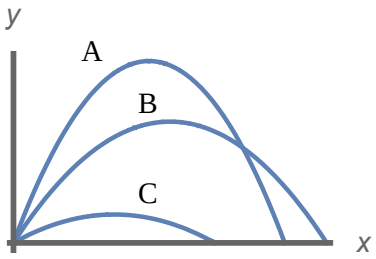
   A. It increases by a factor between 1 and 2
   B. It increases by a factor of 2.
   C. It increases by a factor between 2 and 4.
   D. It increases by a factor of 4.
   E. The answer would depend on the magnitude of the speed.

9. Consider the vector equation $\vec{P} - \vec{Q} = \vec{R}$. Which of the following diagrams correctly represents that equation?



A. B. C. D. E.

10. The curves shown at right are the trajectories of three projectiles, labeled A, B and C, all launched with the same initial speed but at different angles. Which one of the following statements must be true?
Neglect air resistance.



   A. At maximum height A is faster than B or C.
   B. When C lands it is faster than A or B.
   C. They all have the same speed at landing.
   D. They all have the same speed at their highest points.
   E. None of the above must be true.

11. In deep space far from anything else, an asteroid moves at a constant speed and without changing direction. What allows it to do so?
   A. A combination of forces acting on the asteroid allows it to keep moving.
   B. The sum of all velocities acting on the body is zero, so it moves with constant velocity.
   C. Something must be pushing on the asteroid for it to keep moving at a constant velocity.
   D. The inertia of the asteroid keeps it moving.
   E. None of these are correct.

12. If we apply the same constant force to two objects, where object 1 has twice the mass of object 2, what can we say about the motion of the two objects? You measure this while the forces are being applied, and the objects start at rest. No other forces are acting.
    A. Object 2 will move twice as far as object 1 during the same time interval.
    B. Object 1 will have half the speed of object 2 during the same time interval.
    C. Object 1 will have the same speed and move the same distance as object 2 since the net force is the same.
    D. One needs to know the direction the force is applied to answer any questions about speed or distance.
    E. None of these are correct.

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II. **Lecture Free Response** [20 pts total]: Show work and/or explain reasoning where indicated. For problems 13-16 the following situation applies:

13. [3 pts] A car drives off a cliff that is 18.5 m high above the ocean. The driver bails out, but the car continues on. What is the acceleration of the car the instant after it leaves the cliff? Magnitude and direction.

14. [3 pts] Assuming the cliff is horizontal as seen at right, what is the direction of the velocity the <u>instant</u> after it leaves the cliff? Explain.

15. [7 pts] How long is the car in the air before it crashes into the water? Show work for full credit.

$t =$

16. [7 pts] What distance from the cliff face does it impact the water if its initial speed is 22.0 m/s? Assume the cliff face is vertical. Show work for full credit.

$d =$

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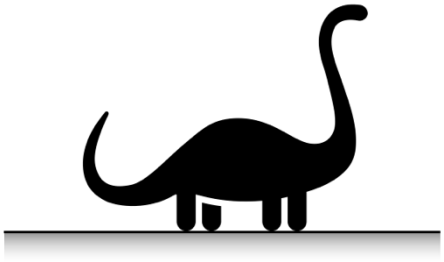
III. **Tutorial Free Response** [20 pts total]: Problems 17-20. Show work and/or explain reasoning where indicated.

17. [5 pts] A sculptor forms a 3D statue of a brachiosaurus dinosaur from a solid block of wood. The statue has a mass m_0. The sculptor uses 1 can of paint to paint the entire statue.



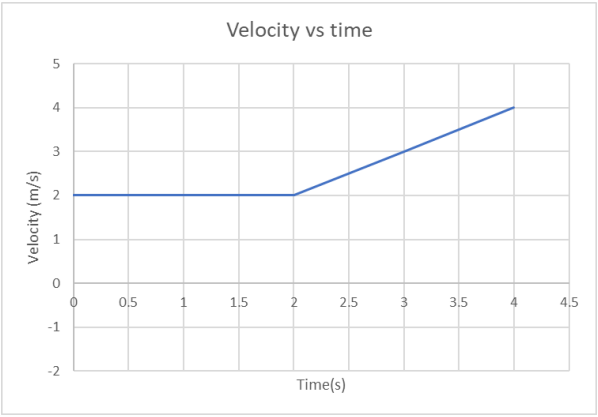
The sculptor forms a second 3D statue from the same type of wood. The second statue is an isometrically scaled version of the statue described above and it is twice as large in each dimension. The sculptor also paints the entire statue. The thickness of paint is the same on both statues.

What is the mass of the second statue in terms of m_0 and how many cans of paint did they use? Explain. If not enough information is given to answer, state so explicitly.

m=

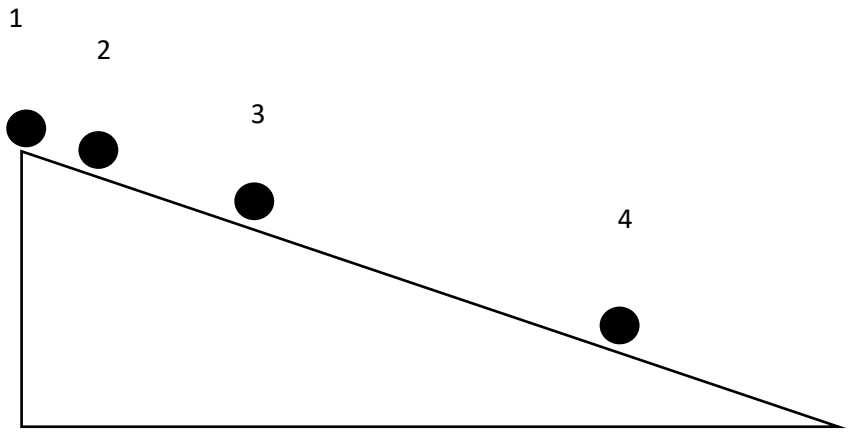
N_{cans}=

18. [5 pts] Given the velocity vs time graph, draw a position vs time graph that corresponds to this motion from 0 to 4 s. Be sure to label the time on the axis. The position does not need to be exact.



For 19. and 20. use the diagram below. Ignore air resistance and friction. The ramp below shows a ball moving along a ramp, and the time interval is the same between each point.

19. [4 pts] Assuming the ball starts at point 1 at rest, draw the direction and relative size of the velocity vector at each point on the diagram. If velocity is zero write that explicitly.



20. [6 pts] Rank from greatest to smallest, the magnitude of the change in velocity between subsequent points. (For example, between 1 and 2 it would be Δv_{12}) So you will need Δv_{12}, Δv_{23}, and Δv_{34}. Explain your results.

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Physics 114 Midterm 1 Equation Sheet

Constants and Conversions

Free-fall acceleration	$g = 9.80\ \mathrm{m/s^2}$
Newton	$1\ \mathrm{N} = 1\ \mathrm{kg\,m/s^2}$

Mathematics, Scaling and Vectors

Logarithm	$b = a^x \leftrightarrow \log_a(b) = x$
	$\log(ab) = \log(a) + log(b)$
	$\log Ax^n = n\log x + \log A$
Volume of a sphere	$V = \frac{4}{3}\pi r^3$
Surface area of a sphere	$A = 4\pi r^2$
Volume of a cylinder	$V = \pi r^2 l$
Surface area of a cylinder	$A = 2\pi r^2 + 2\pi rl$
Mass density	$\rho = m/V$
Area of trapezoid	$A = \frac{1}{2}(b_1 + b_2)h$
x -component of a vector $\vec{A}$	$A_x = A\cos\theta$ (rel. to $x-$ axis)
y -component of a vector $\vec{A}$	$A_y = A\sin\theta$ (rel. to $x-$ axis)
Magnitude of vector $\vec{A}$	$A = \sqrt{A_x^2 + A_y^2}$
Direction of $\vec{A}$ relative to x-axis	$\theta = \tan^{-1}(A_y/A_x)$
Addition of two vectors	If $\vec{C} = \vec{A} + \vec{B}$, then
	$C_x = A_x + B_x$
	$C_y = A_y + B_y$

Kinematics

Displacement	$\Delta x = x_f - x_i$
Average Velocity	$v_{avg} = \frac{\Delta x}{\Delta t}$
Instantaneous Velocity	$v_{inst.} = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t}$
Average Acceleration	$a_{avg} = \frac{\Delta v}{\Delta t}$

Kinematics Continued

Instantaneous Acceleration	$a_{inst.} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t}$
Uniform motion	$(v_x)_\mathrm{f} = (v_x)_\mathrm{i} = \mathrm{constant}$
Position in uniform motion	$x_f = x_i + (v_x)_i \Delta t$
Constant acceleration:	$(v_x)_f = (v_x)_i + a_x \Delta t$
	$x_f = x_i + (v_x)_i \Delta t + \frac{1}{2} a_x (\Delta t)^2$
	$(v_x)_f^2 = (v_x)_i^2 + 2a_x \Delta x$

Forces

Newton's second law	$\vec{F}_\mathrm{net} = \sum \vec{F} = m\vec{a}$