Name:_____ ID: _____

Physics 201

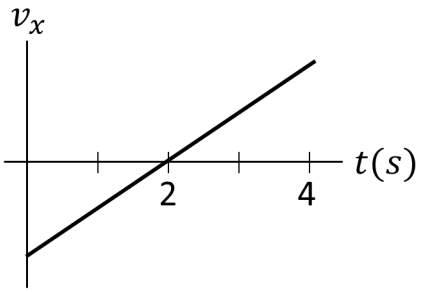
Midterm 1

10/22/2025

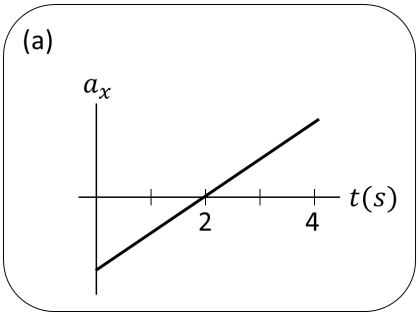
Collaboration is not allowed. Allowed on your desk are: ten 8.5 x 11 inch doubled-sided sheets of notes that are bound together, non-communicating graphing scientific calculator, a page of scratch paper, writing utensils, and the exam. You will have 80 minutes to complete this exam.

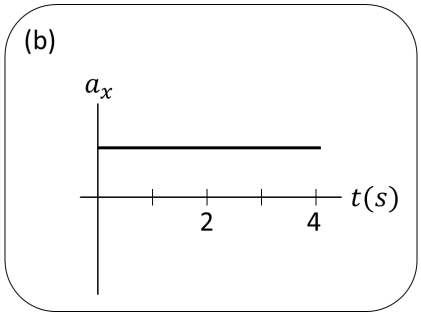
For questions 1 through 4 **fill in the square** next to all correct answers. A given problem may have more than one correct answer. Each correctly bubbled answer will receive two points. There are **6** correct answers in this section and only the first **6** filled in answers will be graded. There is no partial credit.

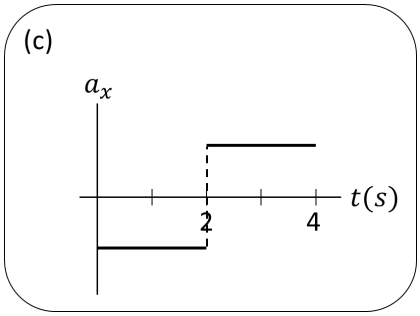
1. Pictured is a graph of the speed of an object along the x-axis during a 4 second period. Which of the graphs is a description of the acceleration of the same object during the same time?



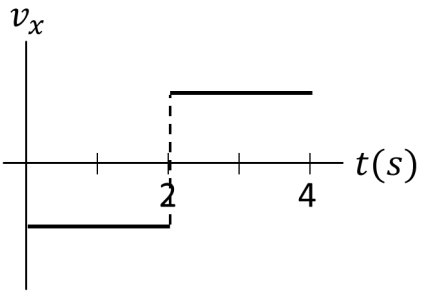
□ (a) □ (b) □ (c)



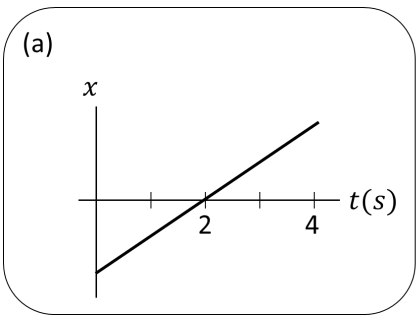


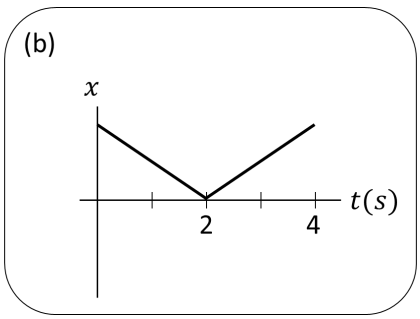


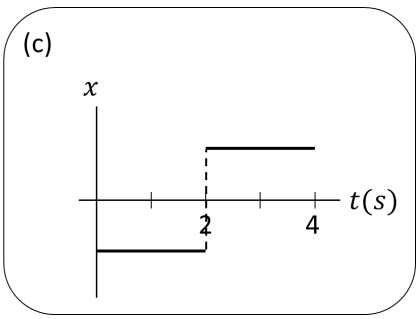
2. Pictured is a graph of the speed of an object along the x-axis during a 4 second period. Which of the graphs is a description of the position of the same object during the same time?



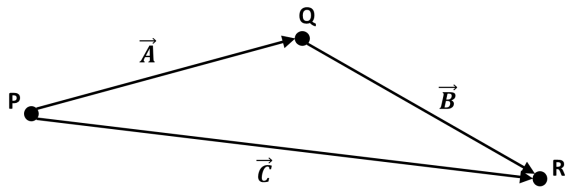
□ (a) □ (b) □ (c)







3. Benny the Beaver walks from location **P** to location **Q**, then to location **R**. Which of the following statements **must** be true? Assume a standard coordinate system.



□ (a) $\vec{C} = \vec{B} - \vec{A}$
□ (b) $\vec{C} = \vec{B} + \vec{A}$
□ (c) $\left|\vec{A}\right|^2 + \left|\vec{B}\right|^2 = \left|\vec{C}\right|^2$
□ (d) The magnitude of the **y-component** of vector $\vec{A}$ is **greater** than the magnitude of the **x-component** of vector $\vec{A}$.
□ (e) The magnitude of the **y-component** of vector $\vec{C}$ is **less** than the magnitude of the **x-component** of vector $\vec{C}$.

4. What are the primary traits of vectors (select all that apply):

□ (a) Vibe
□ (b) Direction
□ (c) Area
□ (d) Magnitude
□ (e) Time
□ (f) Velocity
□ (g) Displacement
□ (h) Scaler
□ (i) Forces

Free response questions

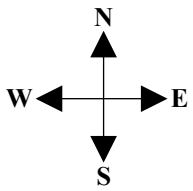
5. (4 points) One of the relationships (equations) we will explore in PH 202 is: $\vec{\boldsymbol{T}} = \boldsymbol{I}\,\vec{\boldsymbol{\alpha}}$, where:

$\vec{\boldsymbol{T}}$ has dimensions of $[\boldsymbol{force}] * [\boldsymbol{distance}]$
$\vec{\boldsymbol{\alpha}}$ has dimensions of $\frac{\mathbf{1}}{[\boldsymbol{time}]^2}$
$[\boldsymbol{force}]$ has dimensions of $[\boldsymbol{mass}] * [\boldsymbol{acceleration}]$

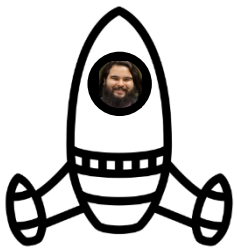
What are the dimensions of $\boldsymbol{I}$? Express your answer **only** in terms of **mass, distance, and/or time**. Make sure to show your work using any combination of words, symbols, diagrams, etc.

6. (9 points) You observe Oregon's State Fish, the Chinook Salmon, swimming in the Willamette River. When you first observe it, it is moving directly **South** at a constant speed of **3 m/s**. It continues at this rate for **9 meters**. After that, it moves **8 meters**, **60 degrees South of East** at a speed of **4 m/s**. Answer the following questions:

(a) In part (b) you will find the total displacement of the salmon. Before you do that, do a quick **sign** sensemaking step. Do you expect the vertical component of the total displacement to be in the north or south direction? Do you expect the horizontal component to be in the east or west direction? Justify your claim using a physical representation and some words.
(b) Using a standard coordinate system ($+\hat{x}$ in East direction, $+\hat{y}$ in North direction) that aligns with the compass rose pictured here, what was the total displacement of the Chinook salmon?
(c) Complete the sign sensemaking by comparing your answer to part (b) with your prediction in part (a). Explain using any combination of words, diagrams, algebra, etc.
(d) What was the salmon's **average velocity** during the entire trip?
(e) What was the salmon's **average acceleration** during the entire trip?
(f) What would you name the salmon?



7. (12 points) One of the closest stars to our sun is Alpha Centauri, **4.12×10^{16} m** away. Astronaut Ben plans to make the long journey starting from rest. The max acceleration he can withstand comfortably is the acceleration of gravity, **g**, which also creates artificial gravity in the ship. The maximum speed of the ship is **1%** the speed of light. The speed of light is **$c = 3 \times 10^8$ m/s**.



   (a) How much time does it take to reach maximum speed?
   (b) How far does he travel while accelerating to maximum speed?
   (c) After reaching maximum speed, he travels at the constant max speed of ship for some amount of time (which you will calculate in part d) until he needs to slow down to a stop. The maximum deceleration he can withstand is also g. This means it will take the same amount of time to slow down to a stop as it took to speed up to maximum speed. This is a symmetry we can exploit in our analysis. Show that the time to slow down is the same as the time to speed up.
   (d) Part (a) and (b) cover the speeding up stage 1. Part (c) covers the slowing down stage 3. Now calculate how much time it takes to travel stage 2, the constant speed stage.
   (e) How much time does it take to make the entire trip in years? Was the majority of that time in the accelerating stages or the constant speed stage?