Principles of Physics I
Test 1

Show all work!

\[ \Delta x = v_{xi} \Delta t + \frac{1}{2} a_x \Delta t^2 \quad v_{xf} = v_{xi} + a_x \Delta t \quad v_{xf}^2 = v_{xi}^2 + 2 a_x (\Delta x) \]

\[ a_c = \frac{v^2}{r} \]

1) (4 points) For each of the following measurements, what would be the correct SI unit?

- Mass: \( \text{kg} \)
- Length: \( \text{m} \)
- Time: \( \text{s} \)
- Acceleration: \( \text{m/s}^2 \)

2) (6 points) Is each of the following a scalar or a vector?

- S A) area
- V B) displacement
- S C) time
- V D) force
- S E) speed
- S F) radius

3) (5 points) Vector A has a magnitude of 37 N, in the \(-y\) direction. Vector B has a magnitude of 50 N, in a direction 30 degrees above the x-axis. Draw the vectors, and graphically determine the vectors A + B, and B - A.
4) The graph shown above represents the motion of two balls, A and B, rolling on parallel tracks.
A) (2 points) Estimate the time or times at which one ball is passing the other.
\[ t = 1 \text{s} + 4.7 \text{s} \]

B) (2 points) Which ball is moving faster at \( t = 4 \text{ s} \). Explain your reasoning.

A, because the slope is steeper.

C) (2 points) Estimate the time or times at which the two balls have the same velocity.
2.3s - slopes are similar.

5) A coin is tossed directly upward into the air, with an initial velocity of 10 m/s.
A) (4 points) What is the maximum height of the coin?
\[ v_y^2 = v_{iy}^2 + 2\Delta y \]
\[ 0 = (10)^2 + 2(-9.8)(\Delta y) \]
\[ \Delta y = 5.1 \text{ m} \]

B) (3 points) What is the velocity and acceleration of the coin at its highest height? Explain.
\[ v_y = 0 \]
\[ a_y = -9.8 \text{ m/s}^2 \]
C) (4 points) If the coin is caught at the same height it was originally thrown, how long is it in the air?

\[ \Delta y = v_{iy} \Delta t + \frac{1}{2}(-9.8)\Delta t^2 \]
\[ 0 = 10 \Delta t - 4.9\Delta t^2 \]
\[ \Delta t = 0 \text{ or } \Delta t = 2.04s \]

6) The diagram above shows the motion of three fleas.
A) (2 points) Which flea has the largest initial speed? Explain your reasoning.

C — goes the farthest horizontal

B) (2 points) Rank the time each flea is in the air, from greatest to least. Explain.

They are the same; they all go to the same height

C) (2 points) Rank the horizontal component of each flea’s velocity, from greatest to least. Explain your reasoning.

C > B > A, because of their horizontal displacement

D) (2 points) Rank the vertical component of each flea’s velocity, from greatest to least. Explain your reasoning.

they are the same; they reach the same height

7) (6 points) A cliff diver attempts to dive into the ocean by getting a running start off the cliff. What must the diver’s initial speed be in order to miss a 1.75 m wide ledge that juts out of the cliff 9.00 meters below the top of the cliff?

\[ \Delta y = v_{iy} \Delta t + \frac{1}{2}(-9.8)\Delta t^2 \]
\[ -9 = 0 + 4.9\Delta t^2 \]
\[ \Delta t = 1.36s \]

\[ \Delta x = v_{ix} \Delta t \]
\[ 1.75 = v_{ix} (1.36) \]
\[ v_{ix} = 1.29 \text{ m/s} \]
8) (4 points) A soap-box derby vehicle goes around a circular turn with a radius of 25 meters with a speed of 15 m/s. What is the centripetal acceleration of the vehicle?

\[ a_c = \frac{v^2}{R} = \frac{15^2}{25} = 9 \text{ m/s}^2 \]