CALCULUS-BASED PHYSICS-1: MECHANICS (PHYS150-01): WEEK 2

Jordan Hanson

September 11th - September 15th, 2017

Whittier College Department of Physics and Astronomy

1. Methods of approximation
    - Estimating the correct order of magnitude
    - Function approximation
    - Unit analysis
2. Coordinates and vectors
    - Scalars and vectors
    - Cartesian (rectangular) coordinates, displacement
    - Vector addition, subtraction, and multiplication
3. Review of Calculus Techniques
    - Limits
    - Differentiation
    - Integration

Given the displacement vector $\vec{D} = (3\hat{i} - 4\hat{j})$ m, find the displacement vector $\vec{R}$ so that $\vec{D} + \vec{R} = -4D\hat{j}$.

- A: $\vec{R} = (-3\hat{i} - 16\hat{j})$ m
- B: $\vec{R} = (3\hat{i} + 16\hat{j})$ m
- C: $\vec{R} = (-3\hat{i} + 12\hat{j})$ m
- D: $\vec{R} = (-6\hat{i} + 6\hat{j})$ m

Estimate the surface area of a person.

- A: 0.2 m^2
- B: 2 m^2
- C: 5 m^2
- D: 10 m^2

1. Displacement, and instantaneous velocity and acceleration
   - *Mathematics review*: taking derivatives
   - Average velocity and average acceleration
2. The case of constant acceleration
   - Deriving an *an equation of motion* for constant acceleration
   - **Measuring acceleration of gravity: *g***
3. Derivation and use of common equations of motion

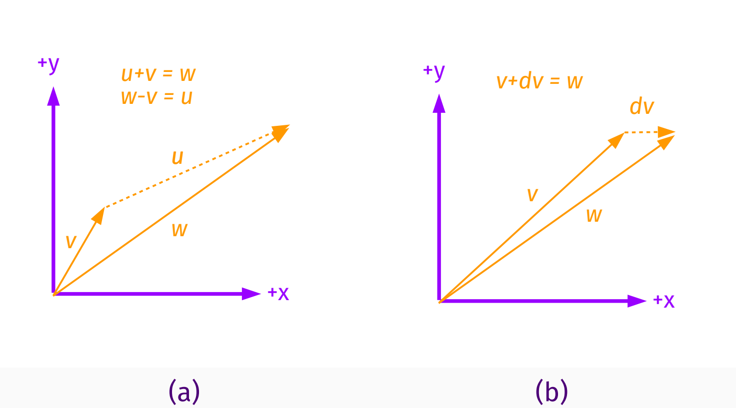

Figure 1: (Left): The displacement vector is $\vec{u}$. (Right) Treat displacement for a small change in time, *dt*, and call it *dv*.

Let $f(t) = A\sin(Bt) + Ct^2$.
Compute f'.

- A: $f'(t) = AB\sin(Bt) + 2Ct$
- B: $f'(t) = AB\cos(Bt) + 2C$
- C: $f'(t) = AB\sin(Bt) + 2Ct$
- D: $f'(t) = AB\cos(Bt) + 2Ct$

Let $f(t) = (4t - 1)/(3t + 2)$.
Compute f'.

- A: $f'(t) = \frac{4}{3t+2}$
- B: $f'(t) = \frac{4}{(3t+2)^2} + \frac{12t-3}{(3t+2)^2}$
- C: $f'(t) = \frac{4}{3t+2} + \frac{12t-3}{(3t+2)^2}$
- D: $f'(t) = \frac{12t-3}{(3t+2)^2}$

Definition of instantaneous velocity vector:

$$\boxed{v(t) = \frac{d\vec{v}}{dt}} \tag{1}$$

Simple example: Let the vector position of an object be

$$\vec{x}(t) = (2t\hat{i} - 3t^2\hat{j}) \quad m \tag{2}$$

Then

$$\vec{v}(t) = (2\hat{i} - 6t\hat{j}) \quad m/s \tag{3}$$

ANSWERS

- $\vec{R} = (-3\hat{i} - 16\hat{j})$ m
- 2 m^2
- $f'(t) = AB\cos(Bt) + 2Ct$
- $f'(t) = \frac{4}{3t+2} + \frac{12t-3}{(3t+2)^2}$
-