

Grade 12 Physics

SPH4U

Qinghao Hu

September 8, 2025

Contents

1 Unit 1A	2
1.1 Review of Describing and Graphing Motion	3
1.1.1 Position: \vec{d}	3
1.1.2 displacement: $\Delta\vec{d}$	3
1.1.3 Velocity: \vec{v}	3
1.1.4 Acceleration: \vec{a}	3
1.1.5 Graphing motion	3
1.2 Equations of Motion	4
1.2.1 Format requirements for answering Motion questionss	4
1.3 Adding and Subtracting 2-Dimensional Vectors	5
1.3.1 Vector addition and subtraction key words	5
1.3.2 Steps for solving a vector problem	5
1.3.3 Another question type	6

Chapter 1

Unit 1A

1.1 Review of Describing and Graphing Motion

1.1.1 Position: \vec{d}

Position is the **straight-line distance** from a fixed reference point to a location, with a direction to the location from the reference point.

1.1.2 displacement: $\Delta\vec{d}$

Displacement is the **change of position**

Formula:

$$\Delta\vec{d} = \vec{d}_2 - \vec{d}_1$$

or

n = the amount of displacement you want to add

$$\Delta\vec{d}_{tot} = \sum_{i=1}^n \Delta\vec{d}_i$$

1.1.3 Velocity: \vec{v}

Velocity is the **rate of change of position**

$$\vec{v} = \frac{\Delta\vec{d}}{\Delta t}$$

1.1.4 Acceleration: \vec{a}

Acceleration is the *rate of change* of velocity, always in the form of $\frac{m}{s^2}$

$$\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$$

1.1.5 Graphing motion

For a **Position vs Time** graph:

- For a position/displacement vs time graph, the velocity = the **slope**
- A slope of zero = The object is not moving
- Instantaneous velocity (\vec{v}_{inst}) = the slope of **tangent** line to the graph at that point in time
- Average velocity (\vec{v}_{avg}) = the slope of **secant** line for that time interval

For a **Velocity vs Time** graph:

- Can get an object's instantaneous velocity directly from the graph
- slope = **acceleration**
- Displacement = The **area** between the graph and the time-axis for that time interval

1.2 Equations of Motion

To start off, there are five equations that are used in the calculation of motion

$$\vec{v}_f = \vec{v}_i + \vec{a} * \Delta d$$

$$\Delta \vec{d} = \frac{1}{2}(\vec{v}_i + \vec{v}_f) * \Delta t$$

$$\Delta \vec{d} = \vec{v}_i \Delta t + \frac{1}{2} \vec{a} * \Delta t^2$$

$$\Delta \vec{d} = \vec{v}_f \Delta t - \frac{1}{2} \vec{a} * \Delta t^2$$

$${\vec{v}_f}^2 = {\vec{v}_i}^2 + 2\vec{a}\Delta \vec{d}$$

1.2.1 Format requirements for answering Motion questions

1. You should always include a diagram that contains every known information from the question
2. \vec{v} should be presented for at least two decimal places
3. Always list steps in your answer
4. When using quadratic solving function on calculator, always write **Using Quadratic Eq* in your answer
5. When you form an equation system, you should label 1.2.3. on each equation in the system
6. Follow the Sig Digit rules
 - ! For **add** and **subtract**, keep the least **decimal places**
 - ! For **multiply** and **divide**, keep the least amount of **signficiant digit**

1.3 Adding and Subtracting 2-Dimensional Vectors

1.3.1 Vector addition and subtraction key words

- + Addition: Find "the **resultant**", "the total", or "the net".
- Subtraction: Find "the **difference**" or "the change in".

1.3.2 Steps for solving a vector problem

1. Read the question carefully
2. Show unit conventions
3. Write "givens" (It helps to roughly sketch each vector and their components)
4. Set direction conventions
5. Solve for each components (ex. Δd_{1y} , Δd_{2x})
6. Choose one component direction (ex. Just the 'x' direction) and solve the equations for that direction
7. Repeat with the other direction
8. Sketch your resulting x and y vectors, joining them head-to-tail.
9. Calculate the magnitude and direction of the resultant. (Trigonometry)
10. State the final answer, including the real-world direction

**Must show conversion factors*

8. State final answer, including the real-world direction

Example 4: A spy drone flies 735m [N27°W], then 590m [W15°S]. This turn takes 2.1 minutes. What was the drone's average velocity during this time?

① $\Delta t = 2.1 \text{ min} \times \frac{60 \text{ s}}{1 \text{ min}} = 126 \text{ s}$

② $\vec{V}_{avg-y} = \frac{(+) (735 \text{ m}) \cos 27^\circ + (-) (590 \text{ m}) \sin 15^\circ}{126 \text{ s}}$

③ $\vec{V}_{avg-y} = \frac{(+)(735 \text{ m}) \cos 27^\circ + (-)(590 \text{ m}) \sin 15^\circ}{126 \text{ s}}$

④ $\vec{V}_{avg-x} = \frac{(-)(735 \text{ m}) \sin 27^\circ + (-)(590 \text{ m}) \cos 15^\circ}{126 \text{ s}}$

⑤ $\vec{V}_{avg} = \sqrt{(\vec{V}_{avg-x})^2 + (\vec{V}_{avg-y})^2}$

⑥ $\theta = \tan^{-1} \left(\frac{\vec{V}_{avg-y}}{\vec{V}_{avg-x}} \right)$

⑦ $\vec{V}_{avg} = 8.2044 \dots \text{ m/s} \approx 8.2 \text{ m/s}$

⑧ $\therefore \vec{V}_{avg} \approx 8.2 \text{ m/s [W}24^\circ\text{N]}$
OR [N}61^\circ\text{W]

The handwritten notes show the step-by-step solution for finding the average velocity of the spy drone. It includes diagrams of the vectors, trigonometric identities for finding components, and the final result with a note about the angle being included or excluded from the vector.

Figure 1.1: A sample answer for vector question

1.3.3 Another question type

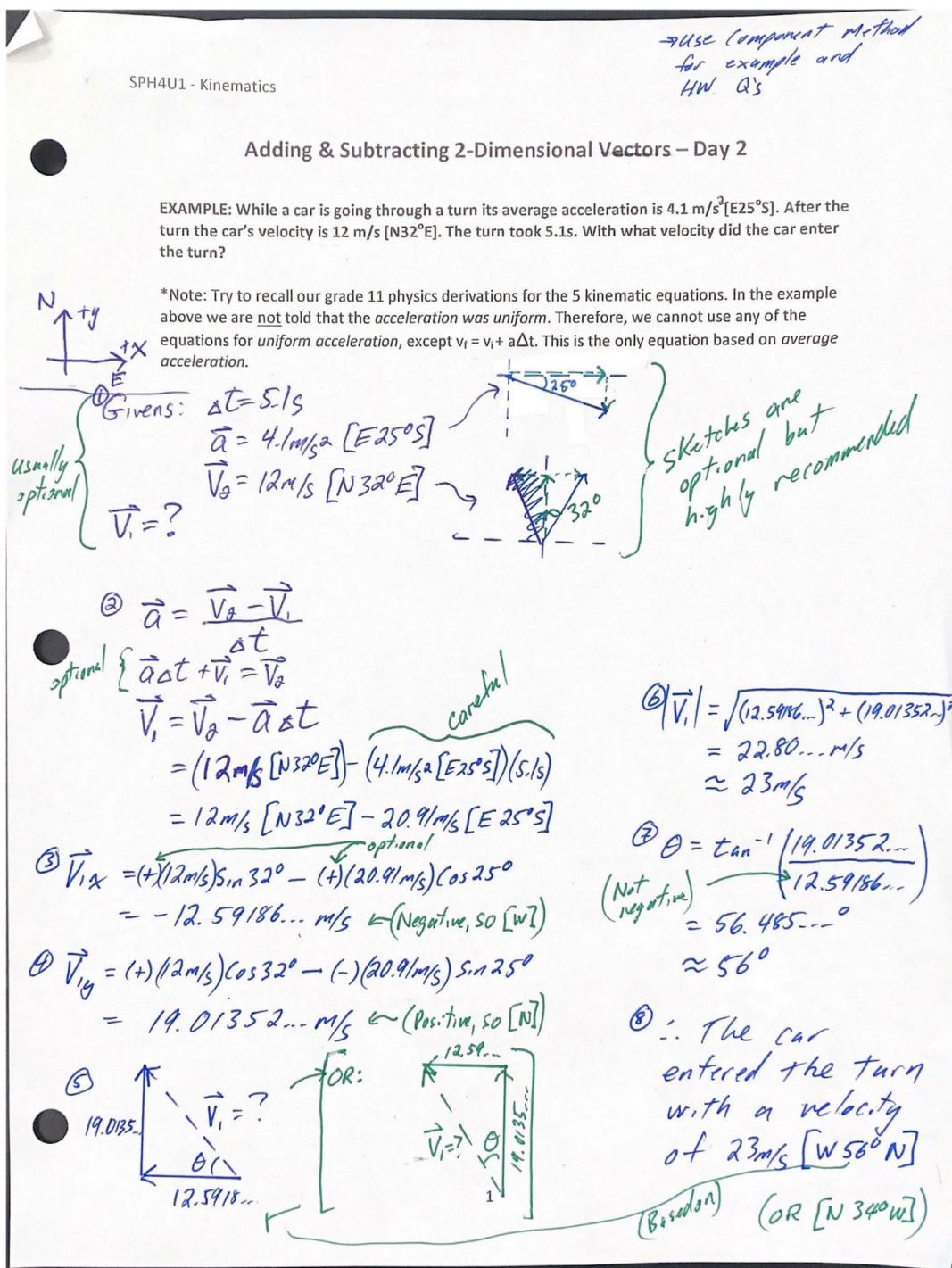


Figure 1.2: Remainder, multiply first