Grade 12 Physics

SPH4U

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Contents

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

$$n = \text{the amount of displacement you want to add}$$

$$\Delta\vec{d_{tot}} = \sum_{i=1}^{n} \Delta\vec{d_i}$$

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 questionss

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 compoents)
4. Set direction conventions
5. Solve for each compoents (ex. $\Delta \vec{d_{1y}}, \Delta \vec{d_{2x}}$)
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

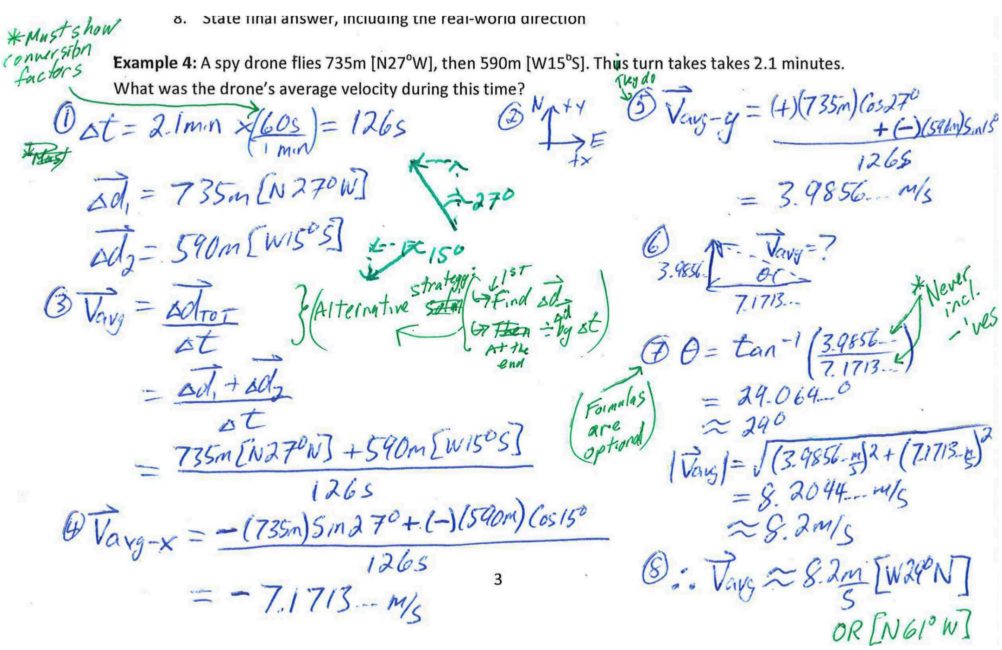
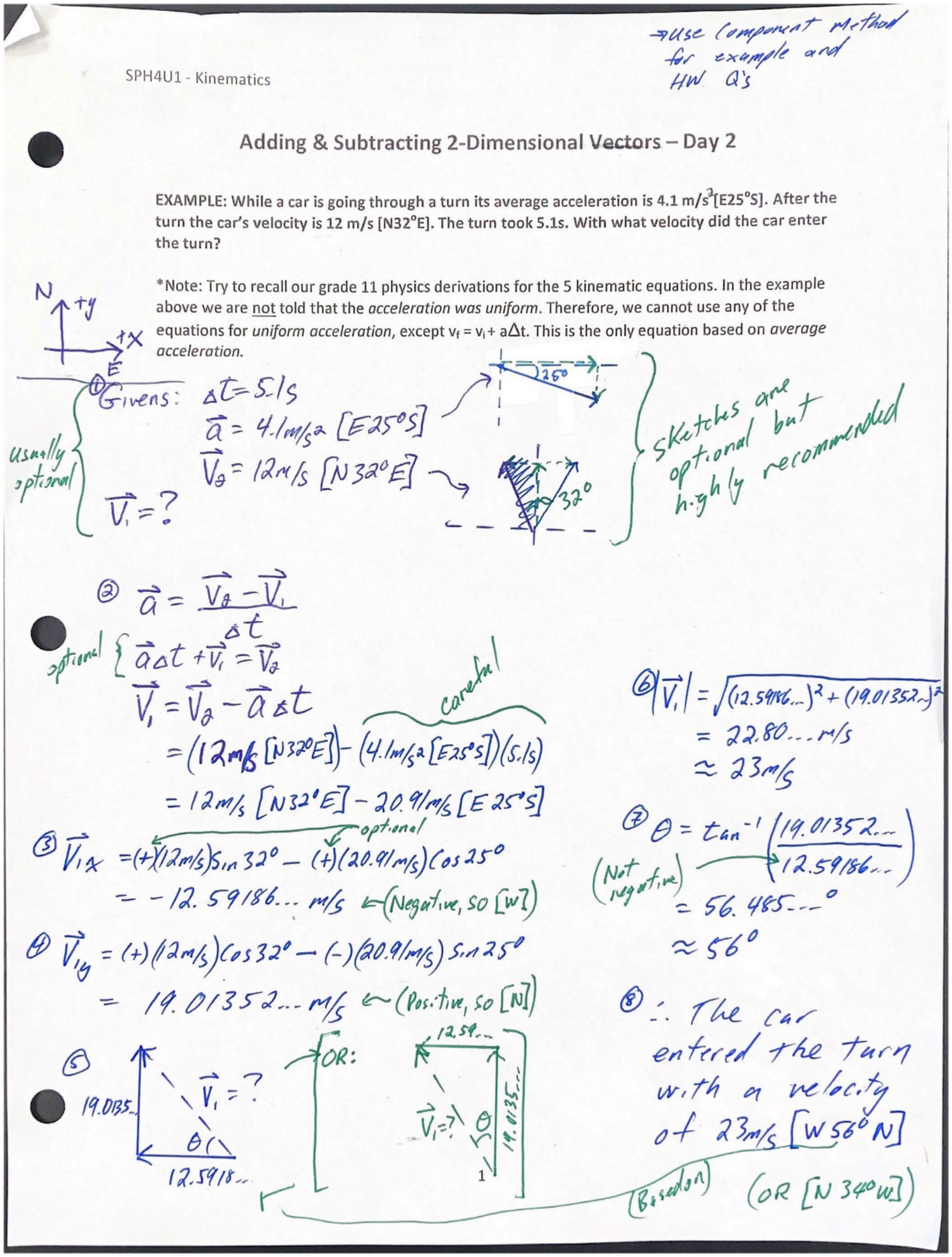


Figure 1.1: A sample answer for vector question

1.3.3 Another question type



→use component method for example and HW Q's

SPH4U1 - Kinematics

Adding & Subtracting 2-Dimensional Vectors – Day 2

EXAMPLE: While a car is going through a turn its average acceleration is 4.1 m/s²[E25°S]. After the turn the car's velocity is 12 m/s [N32°E]. The turn took 5.1s. With what velocity did the car enter the turn?

*Note: Try to recall our grade 11 physics derivations for the 5 kinematic equations. In the example above we are not told that the *acceleration was uniform*. Therefore, we cannot use any of the equations for *uniform acceleration*, except $v_f = v_i + a\Delta t$. This is the only equation based on *average acceleration.*

N +y, +x E

usually optional

① Givens: $\Delta t = 5.1s$

$\vec{a} = 4.1 m/s^2 [E25°S]$

$\vec{V}_2 = 12 m/s [N32°E]$

$\vec{V}_1 = ?$

25°, 32°

Sketches are optional but highly recommended

② $\vec{a} = \frac{\vec{V}_2 - \vec{V}_1}{\Delta t}$

optional { $\vec{a}\Delta t + \vec{V}_1 = \vec{V}_2$

$\vec{V}_1 = \vec{V}_2 - \vec{a}\Delta t$

$= (12 m/s [N32°E]) - \underbrace{(4.1 m/s^2 [E25°S])(5.1s)}_{\text{careful}}$

$= 12 m/s [N32°E] - 20.91 m/s [E25°S]$

③ $\vec{V}_{1x} = (+)(12 m/s)\sin 32° - (+)(20.91 m/s)\cos 25°$ optional

$= -12.59186... m/s$ ← (Negative, so [W])

④ $\vec{V}_{1y} = (+)(12 m/s)\cos 32° - (-)(20.91 m/s)\sin 25°$

$= 19.01352... m/s$ ← (Positive, so [N])

⑤ 19.0135..., $\vec{V}_1 = ?$, θ, 12.5918...

OR: 12.59..., $\vec{V}_1 = ?$, θ, 19.0135...

⑥ $|\vec{V}_1| = \sqrt{(12.59186...)^2 + (19.01352...)^2}$

$= 22.80... m/s$

$\approx 23 m/s$

⑦ $\theta = \tan^{-1}\left(\frac{19.01352...}{12.59186...}\right)$ (Not negative)

$= 56.485...°$

$\approx 56°$

⑧ ∴ The car entered the turn with a velocity of 23 m/s [W56°N]

(Based on) (OR [N34°W])

Figure 1.2: Remainder, multiply first

1.4 Frame of Reference

For certain Chase and Collision questions, you can use frame of reference to solve them

Example. How to write givens

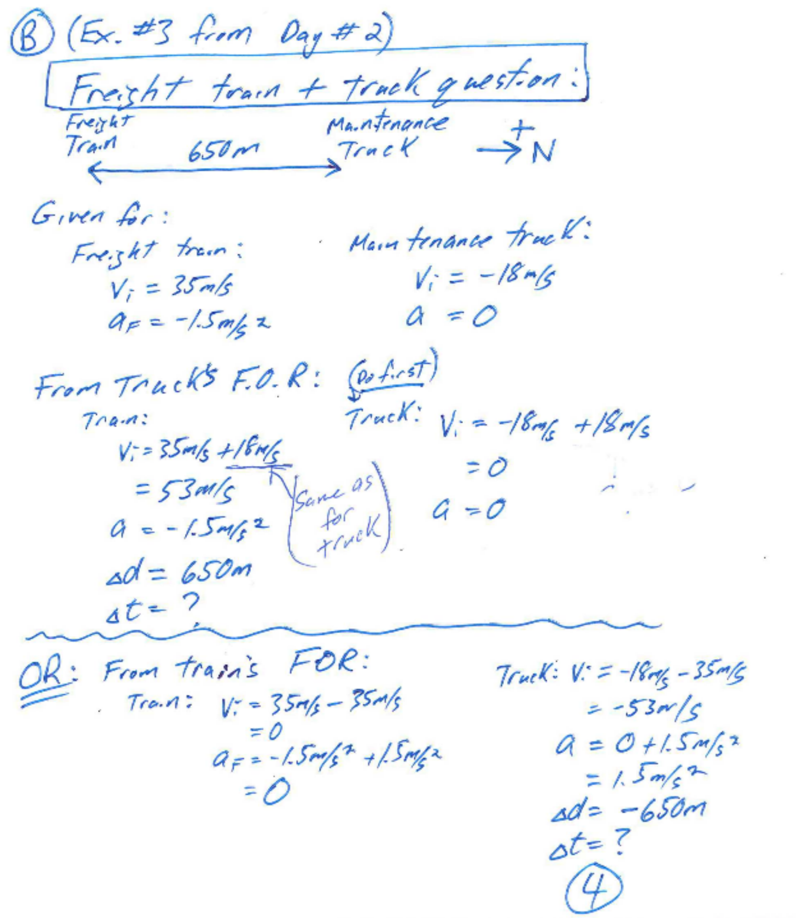


Figure 1.3: You should always write it