NAME: _____

Vector Handout

Assignment

1. Which one of the following is a vector quantity?
   A. time
   B. speed
   C. energy
   D. displacement *(circled)*

2. Which of the following statements concerning vector and scalar quantities is **incorrect**?
   A. All scalar quantities have direction. *(circled)*
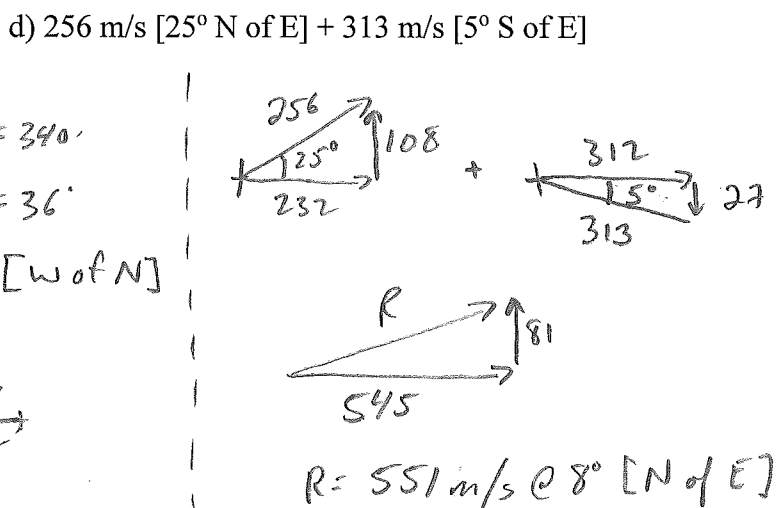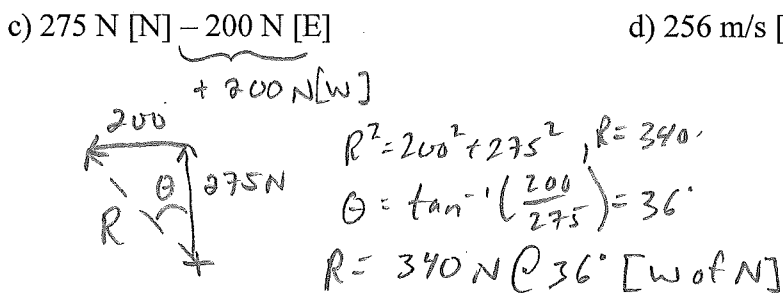   B. All vector quantities have direction.
   C. All scalar quantities have magnitude.
   D. All vector quantities have magnitude.

3. Which of the following is a vector quantity?
   A. work
   B. speed
   C. acceleration *(circled)*
   D. kinetic energy

4. Which set of quantities contains no vectors?
   A. mass, speed, time *(circled)*
   B. force, speed, velocity
   C. acceleration, force, time
   D. acceleration, mass, velocity

5. Convert the following vectors to x and y components

   a) 25 m/s [35° N of E]

   $X = 25 \cos 35° = 20.5 \text{ m/s } [E]$
   $Y = 25 \sin 35° = 14.3 \text{ m/s } [N]$

   b) 373 N [42° W of N]

   $X = 373 \sin 42° = 250 \text{ N } [W]$
   $Y = 373 \cos 42° = 277 \text{ N } [N]$
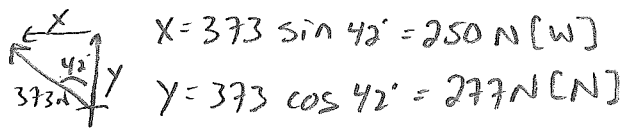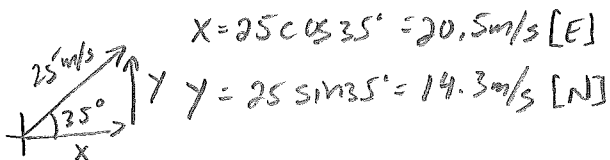
6. Add/subtract the following vectors.

   a) 35 m/s² [N] + 25 m/s² [S]

   $10 \text{ m/s}^2 [N]$

   b) 163 km/h [S] + 37 km/h [W]

   $R^2 = 163^2 + 37^2 \qquad \theta = \tan^{-1}\left(\frac{37}{163}\right)$
   $= 13°$
   $R = 167 \text{ km/H } @ 13° [W \text{ of } S]$

   c) 275 N [N] – 200 N [E]

   $+ 200 \text{ N } [W]$

   $R^2 = 200^2 + 275^2, \quad R = 340$
   $\theta = \tan^{-1}\left(\frac{200}{275}\right) = 36°$
   $R = 340 \text{ N } @ 36° [W \text{ of } N]$

   d) 256 m/s [25° N of E] + 313 m/s [5° S of E]

   $R = 551 \text{ m/s } @ 8° [N \text{ of } E]$

   e) 1.56 m/s [13°N of W] – 3.25 m/s [27°N of E]

   $R = 4.56 \text{ m/s } @ 14° [S \text{ of } W]$
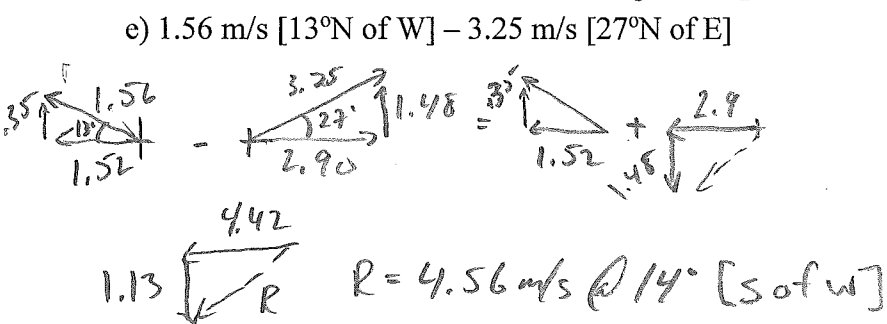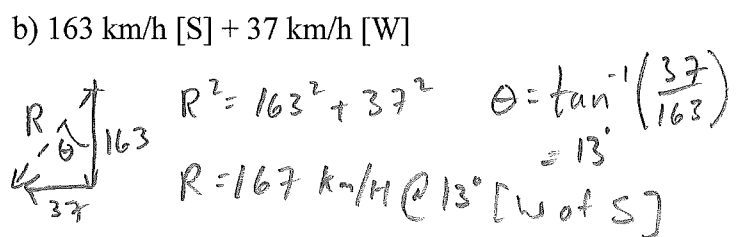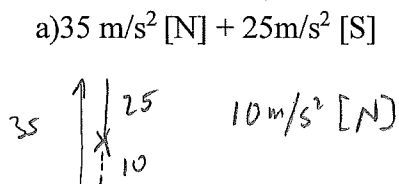
7. Two forces act on an object as shown in the diagram. Which of the following **best** shows the resultant R of these forces?
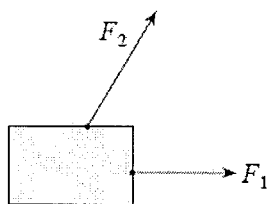
A. B.

C.

D.

8. An airplane which was flying eastward is later flying southward at the same speed. Which vector shows the airplane's **change** in velocity?
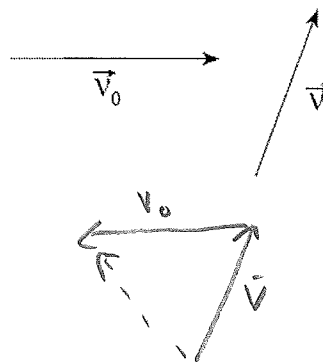
A. B.

C. D.

$$\Delta V = V_f - V_o$$

$$\downarrow \quad \rightarrow \; = \; \downarrow + \leftarrow \; = \; \text{⬋}$$

9. Initial velocity vector v_0 and final velocity vector v are shown below. Which of the following represents the change in velocity Δv?
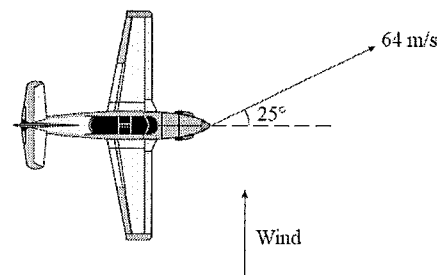
$$\Delta v \; ? \quad = \; V_f - V_o \; = \; V_f + (-V_o)$$
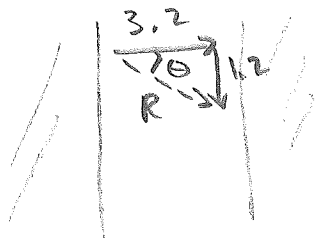
A. B.

C. D.

$\vec{V_0}$ $\vec{V}$

10. A pilot points an aircraft due east, while the wind blows from the south. The resultant velocity of the aircraft over the ground is 64 m/s, 25° N of E . At what speed does the wind blow?
A. 2.6 m/s   B. 27 m/s   C. 30 m/s   D. 58 m/s

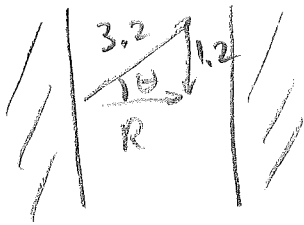$$y = 64 \sin 25° = 27 \text{m/s}$$

11. Pamela swims at 3.2 m/s relative to the water, heading east. The current flows south at 1.2 m/s. Find Pamela's resultant velocity (mag. & dir.).

$$R^2 = 3.2^2 + 1.2^2 \quad, \quad \theta = \tan^{-1}\left(\frac{1.2}{3.2}\right) = 21°$$

$$R = 3.4 \text{ m/s @ } 21° [S \text{ of } E]$$

12. At what angle should Pamela swim if she wants to head straight across the river?

$$\Theta = \sin^{-1}\left(\frac{1.2}{3.2}\right) = 22° \;[N \text{ of } E]$$
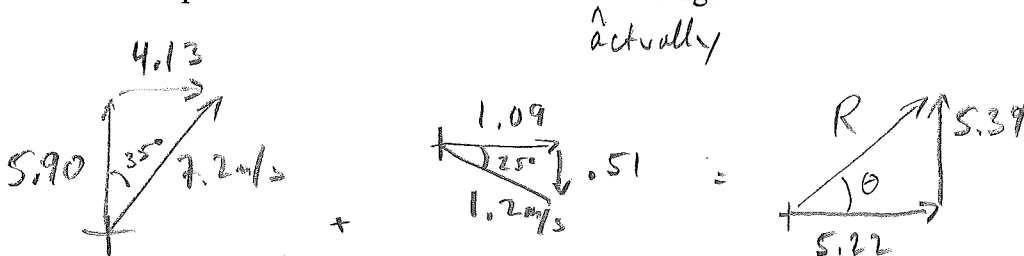
$$R = 2.97 \text{ m/s } [E]$$

13. If the river in the above problems is 200 m wide how long will it take Pamela to cross the river in each case?

#3

#4

$$V = \frac{d}{t}, \quad t = \frac{d}{V} \qquad t = \frac{200 \text{ m}}{3.2 \text{ m/s}} = 62.5 \text{ s} \qquad t = \frac{200 \text{ m}}{2.97 \text{ m/s}} = 67.3 \text{ s}$$
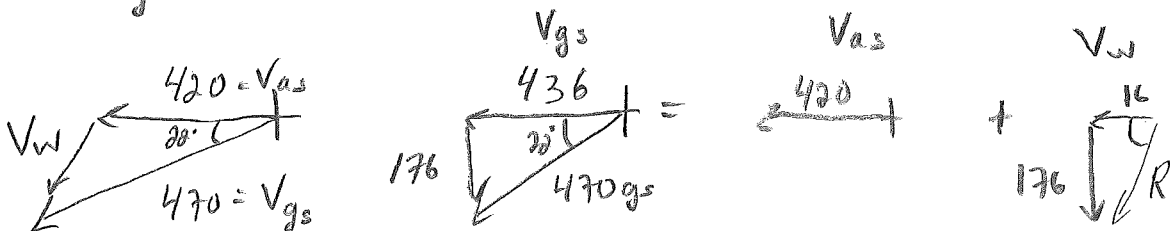
14. A sailboat is heading 35° East of North at 7.2 m/s. The ocean current is 25° South of East at 1.2 m/s. What speed and direction is the sailboat heading?

actually

4.13
5.90 35° 7.2 m/s

1.09
25° .51
1.2 m/s

R 5.39
θ
5.22

$$R = 7.50 \text{ m/s } @ 46° \;[N \text{ of } E]$$

15. A B747 is crossing the Pacific at 420 knots on a heading of W (air velocity). Air Traffic Control radar is tracking the plane at 470 knots [22° S of W] (ground velocity). What is the wind speed and direction?

$$\overline{V_{as}} + \overline{V_w} = \overline{V_{gs}}$$

resultant

Vgs
420 = Vas
Vw 22°
470 = Vgs

436
22°
176 470 gs

Vas
420

Vw
16
176 R

$$R = 177 \text{ knots } @ 85° \;[S \text{ of } W]$$

16. Determine the ground velocity of a plane with air velocity of 150 m/s @ 30 [W of S] and a wind velocity of 25 m/s [W]

150 30° 130
75

25

R
130
100

$$R = 164 \text{ m/s } @ 38° \;[W \text{ of } S]$$

Enrichment

16. A passenger jet needs to reach a speed of 100 m/s on the runway for takeoff. If the runway is 2.5 ×10³m long, what minimum average acceleration from rest is needed?

$V_0 = 0$ $a = ?$ $V_f^2 = V_0^2 + 2ad$

$V_f = 100 \, m/s$ $100^2 = 0^2 + 2a(2.5 \times 10^3 m)$

$d = 2.5 \times 10^3 m$ $a = 2.0 \, m/s^2$

17. At what speed must a ball be thrown upwards to reach a maximum height of 25 m?

$V_0 = ?$ $d = 25$ $V_f^2 = V_0^2 + 2ad$

$V_f = 0$ $0 = V_0^2 + 2(-9.8)(25)$

$a = -9.8 \, m/s^2$ $V_0 = 22 \, m/s$
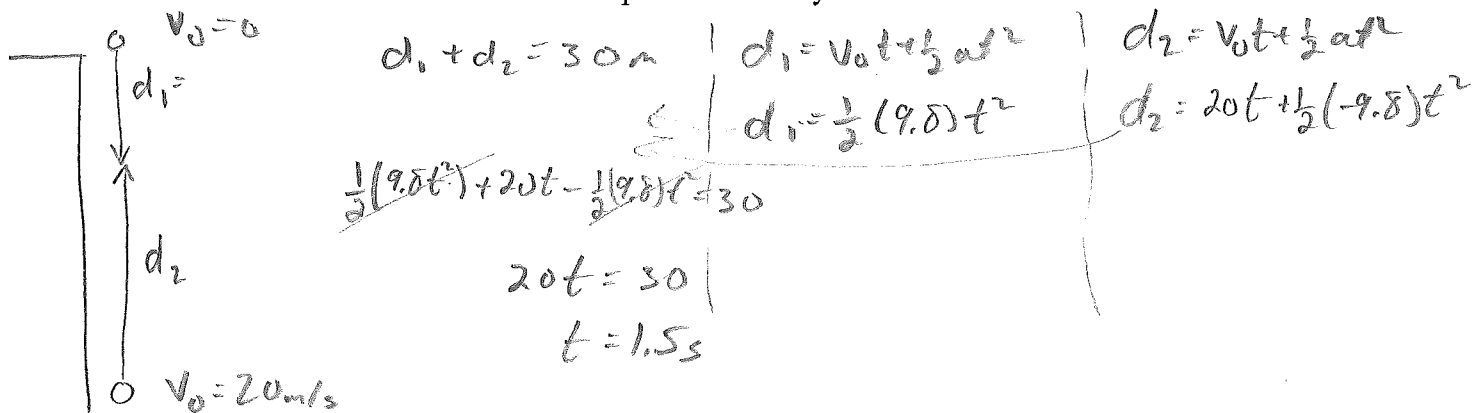
19. A skier accelerates uniformly from 5.2 m/s to 12.8 m/s at 0.85 m/s². Find the distance she travels.

$V_0 = 5.2 \, m/s$ $d = ?$ $V_f^2 = V_0^2 + 2ad$

$V_f = 12.8$ $12.8^2 = 5.2^2 + 2(.85)d$, $d = 80m$

$a = .85 \, m/s$

20. A rock is released from the top of a 30 m-high cliff at the same time as a ball is thrown upwards from the base of the cliff at 20 m/s. How much time elapses before they collide?

$V_0 = 0$

$d_1 =$

d_2

$V_0 = 20 \, m/s$

$d_1 + d_2 = 30m$ $d_1 = V_0 t + \frac{1}{2}at^2$ $d_2 = V_0 t + \frac{1}{2}at^2$

$d_1 = \frac{1}{2}(9.8)t^2$ $d_2 = 20t + \frac{1}{2}(-9.8)t^2$

$\frac{1}{2}(9.8t^2) + 20t - \frac{1}{2}(9.8)t^2 = 30$

$20t = 30$

$t = 1.5s$

Answers: 1) D, 2) A, 3) C, 4) A, 5) A, 6) A, 7) C, 8) B, 9) D, 10) C, 11) A, 12) 2.0 m/s², 13) 22 m/s, 14) 80 m, 15) 1.5 s