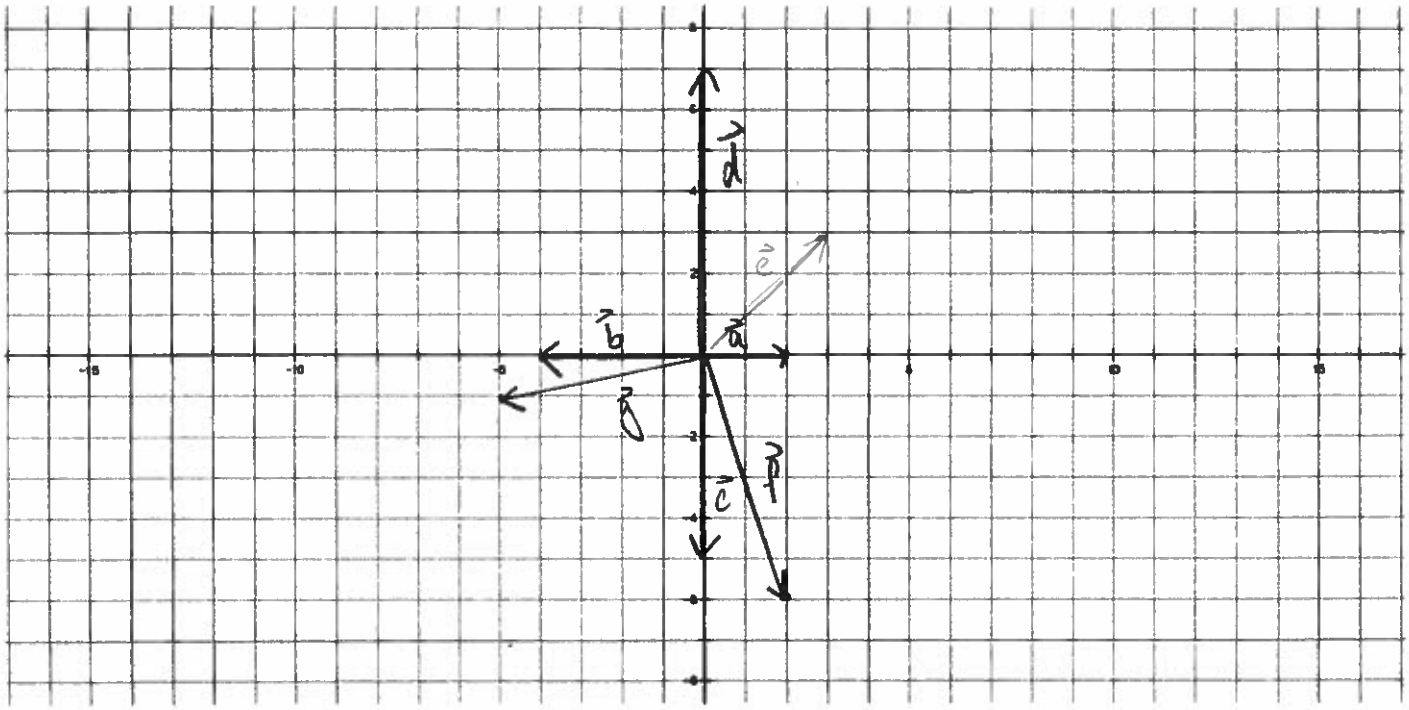
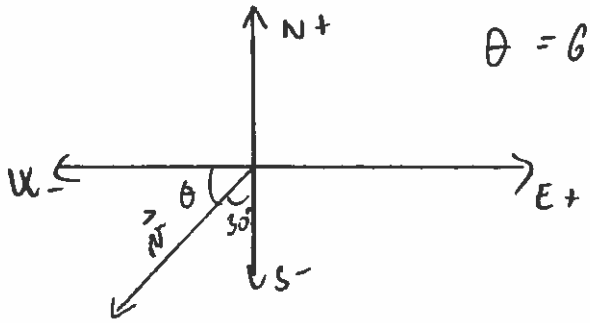
Physics 11 **Motion in Two Dimensions – Vectors**

1. Sketch and label following vectors. Assume a standard coordinate system.

$\vec{a} = [2,0], \vec{b} = [-4,0], \vec{c} = [0,-5], \vec{d} = [0,7], \vec{e} = [3,3], \vec{f} = [2,-6], \vec{g} = [-5,-1]$



2. **a) Sketch a velocity vector $\vec{v}$ = 10 m/s [S 30° W].**



$\theta = 60^\circ$

b) Find the horizontal vector component of $\vec{v}$

$\vec{v}_x = \|\vec{v}\|(\cos\theta)$

$= 5 \text{ m/s } [W]$

OR $= [-5, 0] \text{ m/s}$

c) Find the vertical vector component of $\vec{v}$

$\vec{v}_y = \|\vec{v}\|(\sin\theta)$

$= 10(\sin 60^\circ)$

$= 8.7 \text{ m/s } [S]$

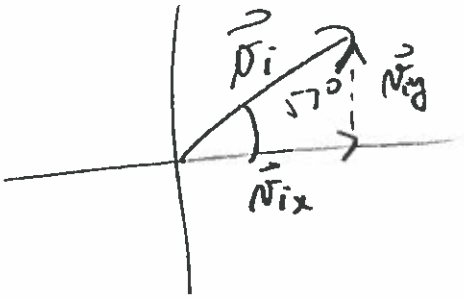
OR $= [0, -8.7] \text{ m/s}$

d) Write the velocity vector in vector notation.

$\vec{v} = [-5, -8.7] \frac{m}{s}$ ← already includes direction

5. An object is thrown with initial velocity of 23 m/s at angle of 57° above horizontal.

a) Sketch the initial velocity vector. Label the angle and both vector components.



b) Calculate the horizontal component.

$$\vec{v}_{ix} = \|\vec{v}_i\| (\cos 57°)$$
$$= 12.5 \text{ m/s } [R]$$
$$= [12.5, 0] \text{ m/s}$$

c) Calculate the vertical component.

$$\vec{v}_{iy} = v_i (\sin 57°)$$
$$= 19.3 \text{ m/s } [\text{up}]$$
$$= [0, 19.3] \text{ m/s}$$

d) Express the initial velocity in vector notation.

$$\vec{v}_i = [12.5, 19.3] \frac{m}{s}$$

6. a) If an object was thrown with initial velocity $\vec{v} = [-5,2]\ m/s$ what do you know about the object's initial speed?

$v = \|\vec{v}\| = ?$

$v^2 = (-5)^2 + 2^2$
$= 25 + 4$

$v = +\sqrt{29}$
$= 5.4 \text{ m/s}$

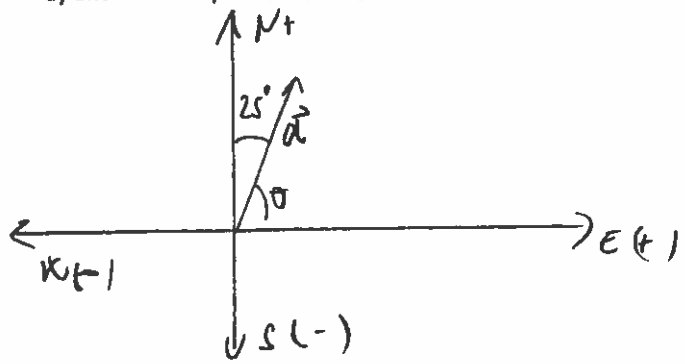
Magnitude is always positive

b) Was the object thrown above or below the horizontal? At what angle?

above the horizontal

$\theta = \tan^{-1}\left(\frac{5}{2}\right)$
$= 22°$

3. a) Sketch a displacement vector $\vec{d}$ = 47 m [25° E of N].



$\theta = 65°$

b) Find the horizontal vector component of $\vec{d}$

$\vec{d}_x = d(\cos\theta)$

$= 47(\cos 65°)$

$= 19.9$ m [E]

OK $= [19.9, 0]$ m

c) Find the vertical vector component of $\vec{d}$

$\vec{d}_y = d(\sin\theta)$

$= 47(\sin 65°)$

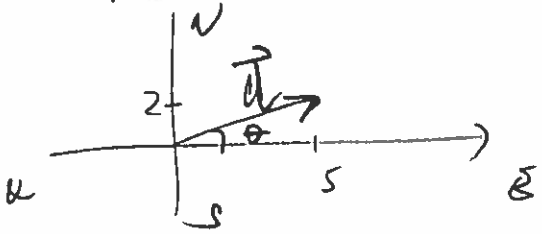
$= 42.6$ m [N]

OK $= [0, 42.6]$ m

d) Write the displacement vector in vector notation.

$\vec{d} = [19.9, 42.6]$ m

4. a) Sketch the displacement vector $\vec{d} = [5,2]m$.



b) Find the magnitude of this displacement vector. (Pythagorean Theorem)

$\|\vec{d}\| = d = ?$

$d^2 = 5^2 + 2^2$

$d = \sqrt{5^2 + 2^2}$

$d = \sqrt{29}$

$d = 5.39$ m

c) Find the direction of this displacement.

$\theta = ?$

$\tan\theta = \frac{\|\vec{d}_y\|}{\|\vec{d}_x\|}$

$\theta = \tan^{-1}\left(\frac{2}{5}\right)$

$= 21.8°$

22° N of E, 68° E of N

Direction: E 22° N, N 68° E.

7. What are the assumptions you make when you consider an object to be experiencing a free-fall?

- close to the Earth surface
- no air or other resistance
- initial velocity is zero ("drop")
- constant acceleration $g = -9.8 \frac{m}{s^2}$

8. Is the acceleration due to gravity dependent on the mass of the object? **Why or why not?**

Mass independent
- an elephant and a feather will take the same time to fall the same distance if there is no air resistance

9. An object was thrown with initial velocity of 12 m/s 15° below horizontal.

a) Sketch the vector and label your diagram.

b) Find the vector components of the object's initial velocity.

$\vec{v}_{ix} = 12(\cos 15°)$
$= 11.6 \text{ m/s } [E]$
$= [11.6, 0] \frac{m}{s}$

$\vec{v}_{iy} = v(\sin 15°)$
$= 3.1 \frac{m}{s} [S]$ or down
$= [0, -3.1] \frac{m}{s}$

c) Express the initial velocity in vector notation.

$\vec{v}_i = [11.6, -3.1] \frac{m}{s}$