UNIT 6
Applications of Vectors
L1(7.1) Vectors as Forces

--- APPLICATION PROBLEMS ---

**A Force is a Vector**

\( \text{MAG} \neq \text{DIRECTION} \)

\[ \text{Moving/Pushing/Pull} \]

\[ \text{Not Always} \]

\[ 1 \text{ N} = 1 \text{ kg} \times \frac{1 \text{ m}}{\text{s}^2} \]

\[ 1 \text{ N} = 4.44 \text{ N} \]
Pulling an Object

Ex1: Daddy is towing Nadine on a toboggan. The rope makes an angle of 25° with the horizontal. If Daddy is pulling with a force of 70N.

a) Find the force pulling the toboggan forward.
b) Find the force lifting the toboggan.

\[ \begin{align*}
\text{(Horizontal) x-components: } & \quad \overrightarrow{OA} \\
10A &= 70 \cos 25^\circ \\
&= 63.44 \\
\text{(Vertical) y-components: } & \quad \overrightarrow{OB} \\
10B &= 70 \sin 25^\circ \\
&= 29.58
\end{align*} \]

\[
\therefore \text{The forces pulling forward and lifting the toboggan are 63.44N and 29.58N respectively.}
\]
Ex2: Two forces of 32N and 58N are acting at an angle of 45° to each other. Determine the
a) resultant force.

\[ \text{Resultant Force} = \sqrt{32^2 + 58^2 - 2 \times 32 \times 58 \cos 45°} \]

\[ = \sqrt{4388.85} \]

\[ \approx 85.20 \text{N} \]

b) the equilibrant force.

\[ \text{Equilibrant} = 85.20 \text{N} \text{ [151° CW from 32N force]} \]

The resultant force is approx. 85.20N at an angle of 29° CCW from the 32N force and the equilibrant force is 85.20N at an angle of 151° CW from the 32N force vector.
Object on a Ramp

Ex3: A 20kg trunk is resting on a ramp inclined at 15°. Calculate the components of the force of gravity on the trunk that are parallel and perpendicular to the ramp.

The parallel component points down the ramp. It tends to slide the trunk down the slope. It is opposed by the force of friction acting up the ramp.

The perpendicular component presses the trunk against the ramp.

Force of gravity: $F_g = 9.8 \frac{N}{kg} \cdot m = 20 \cdot 9.8 N = 196 N$

Using the components $x$ and $y$ in the diagram:

$\text{x-comp of gravitational force: } |F_{gx}| = |F_g| \sin 15° = 50.73 N$

$\text{y-comp of gravity force: } |F_{gy}| = |F_g| \cos 15° = 189.32 N$

\[ \therefore \text{The } x \text{ and } y \text{ components of gravity are } 50.73 N \text{ and } -189.32 N \text{ respectively.} \]
Tension

Ex4: A large balloon is tethered to the top of a building by wires. Two of them are at points 20 m apart. The buoyant force of the balloon is 850 N. The wires make angles of 58° and 66° with the horizontal. Find the magnitude of the tension in each wire.

To find $|\vec{T}_1|$: 

$$\frac{|\vec{T}_1|}{\sin 24'} = \frac{850 \text{ N}}{\sin 124'}$$

$$|\vec{T}_1| = \frac{\sin 24' \cdot 850 \text{ N}}{\sin (124')}$$

$$\approx 417.02 \text{ N}$$

To find $|\vec{T}_2|$: 

$$\frac{|\vec{T}_2|}{\sin 32} = \frac{850 \text{ N}}{\sin (124')}$$

$$|\vec{T}_2| = \frac{\sin 32 (850 \text{ N})}{\sin (124')}$$

$$\approx 543.32 \text{ N}$$

\[ \therefore \text{ The tensions in the wires are approx.} \quad 417.02 \text{ N} \quad \& \quad 543.32 \text{ N.} \]

$$|\vec{T}_1| + |\vec{T}_2| = 960.34$$

\[ \text{Why can this happen?} \]

$$|\vec{T}_1| + |\vec{T}_2| = |\vec{R}|$$
The Triangle Inequality:

For vectors $\vec{a}$ and $\vec{b}$, $|\vec{a}| + |\vec{b}| \geq |\vec{a} + \vec{b}|$

Why?
For a triangle to be formed, the sum of any two sides must be greater than the third side.

$$|\vec{a}| + |\vec{b}| > |\vec{a} + \vec{b}|$$

If the vectors $\vec{a}$ and $\vec{b}$ have the same direction, the triangle collapses to a single line giving.

$$|\vec{a}| + |\vec{b}| = |\vec{a} + \vec{b}|$$

Ex5: Which set of forces acting on an object could produce equilibrium?

a) 5 N, 2 N, 13 N  
b) 7 N, 5 N, 10 N
Assigned Work

p.362 #3, 5, 6, 8, 10, 11, 12, 16, 17