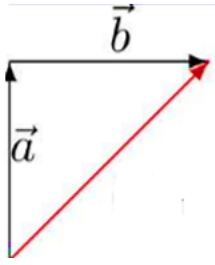
SUBJECT and GRADE	TECHNICAL SCIENCES Grade 11	
TERM 1	Week 6	
TOPIC	Resultant of forces in two dimensions	
RESOURCES	***Paper based resources***	
	Technical Sciences Learner Textbook Page pp37-40	
AIMS OF LESSON	At the end of this lesson you should be able to: • Use the head-to-tail method to determine the resultant of two vectors at right angles to each other • Use the theorem of Pythagoras to determine the resultant of two vectors at right angles to each other	
INTRODUCTION	From previous lessons, you learned of the **resultant vector**: Definition: The resultant vector is the **single** vector that has the **same effect** as all the other vectors together. The symbol used for resultant: $\overrightarrow{F_{net}}$ **OR** $\overrightarrow{F_R}$ In simple terms, the resultant vector or force tells you what the combined effect of the vectors or forces working on an object has. It has the same effect as the other vectors together. For this lesson, we will look at the resultant of vectors acting perpendicular to each other.	
CONCEPTS AND SKILLS	Perpendicular vectors are vectors that act at **right angles** (90°) to each other. The size of the resultant vector can be determined by using two methods: • Head-to-tail graphical method OR • Calculation using Theorem of Pythagoras Head-to-tail method The **magnitude** and **direction** of the resultant is obtained by drawing a straight line from the tail of the second vector to the head of the first vector.  A straight line is drawn from the tail of Vector $\vec{a}$(second vector), to the head of the Vector $\vec{b}$ (first vector). The straight line that was drawn is therefore the **resultant** and the **hypotenuse** of the right angled triangle formed. A straight line is drawn from the tail of Vector $\vec{a}$(second vector), to the head of the Vector $\vec{b}$ (first vector). The straight line that was drawn is therefore the **resultant** and the **hypotenuse** of the right angled triangle formed.	Can you? •Draw a vector diagram with the head-to-tail method •Measure with a protractor •Use the theorem of Pythagoras?

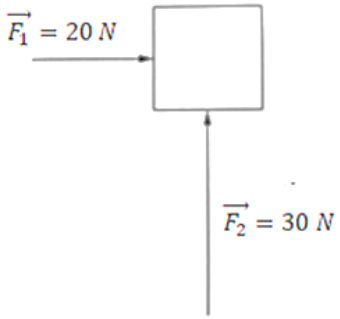
As these vectors are in different directions, we cannot simply add their magnitudes to get the resultant like we do with linear vectors. We can, however, add these vectors graphically with a **vector diagram**.

Graphical method of determing resultant force ($\overrightarrow{F_R}$):

- Use an appropriate scale to draw the forces (vectors)
- Draw the resultant from tail of one to head of the other vector
- Measure the resultant with a ruler – this will give you the magnitude of the resultant.
- Use a protractor to measure the angle at the tail of $\overrightarrow{F_R}$ - this will give you the direction of the resultant.

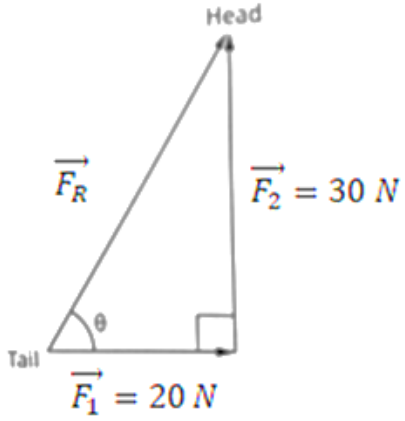
Remember, a vector has magnitude AND direction.

Example:
Two forces are applied on a block. One force is 20 N East and the other one is 30 N due North. Draw a vector diagram showing the magnitude and direction of the resultant force.



Steps to follow:

- Draw a rough sketch to illustrate the forces.
- Choose an appropriate scale to represent the vectors. A scale of 1cm: 10 N can be used.
- Align the two vectors head to tail. First draw $\overrightarrow{F_1} = 20\ N$ as a 2cm line east or the right and complete the arrow(arrowhead must touch the line).
- Draw $\overrightarrow{F_2} = 30\ N$ as a 3 cm **arrow** from the head of $\overrightarrow{F_1}$ upwards.
- Draw $\overrightarrow{F_R}$ from the tail of $\overrightarrow{F_1}$ to the head of $\overrightarrow{F_2}$.



- Measure the magnitude of $\overrightarrow{F_R}$ with a ruler and convert it back to Newton with the chosen scale.
- Measure the angle θ at the tail of the resultant $\overrightarrow{F_R}$.
- Indicate the magnitude of $\overrightarrow{F_R}$ on the vector diagram.

The magnitude of $\overrightarrow{F_R}$ = 3,6 cm which converts to 36 N (x 10). The angle of θ is measured at 56°.
Final answer: $\overrightarrow{F_R}$ = 36 N, 56° North of East.

<u>Theorem of Pythagoras</u>
Instead of measuring the resultant, the Theorem of Pythagoras can be used the calculate the magnitude of the resultant.

The theorem of Pythagoras states that in a right triangle, the sum of the squares of the lengths of the sides is equal to the square of the length of the hypotenuse (p25).

In above example, the two forces are perpendicular to each other, therefore we can calculate the magnitude of the hypotenuse, which is the resultant force.

$$\left(\overrightarrow{F_R}\right)^2 = \left(\overrightarrow{F_1}\right)^2 + \left(\overrightarrow{F_2}\right)^2$$
$$\left(\overrightarrow{F_R}\right)^2 = (20)^2 + (30)^2$$
$$\left(\overrightarrow{F_R}\right)^2 = 400$$
$$\therefore \overrightarrow{F_R} = \sqrt{1300} = 36{,}06\ N$$

The results of the graphical method and the calculation correlate with one another.

ACTIVITIES/ ASSESSMENT	Complete Exercise 1.8 on pages 39 to 40
CONSOLIDATION	You should now be able to: • Define resultant vector/force. • Use both the graphical head-to-tail method and the theorem of Pythagoras to determine the resultant of two vectors acting perpendicular to one another. Remember: The Head-to-tail graphical determination is also used for vectors at an angle, i.e., when the angle is not 90°.
VALUE	Whenever you are required to do measurements with a ruler and protractor, you must take extra care to be very meticulous and accurate in your approach.