session 2 — 9 sep. 25

* Adding forces

Topic IA 3
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What is vector? 2m/s ↗

Magnitude
v = 2m/s ↗ 20°
θ = 20°
↳ Direction

Q. Find value of v? [2]
↳ V = 2m/s 1/2
θ = 20° with horizontal

* Vectors operations:
- → By calculations
- → By drawing

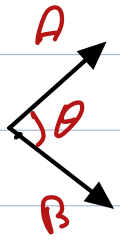
(1) By drawing

- In some

$\vec{A} + \vec{B} = \vec{R} = \vec{A} + \vec{B}$

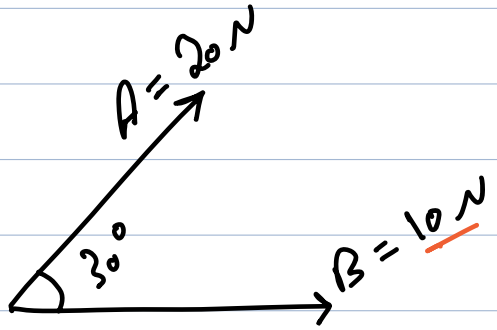
$-\vec{A} + \vec{B} = \vec{R} = \vec{B} - \vec{A}$

- has an angle



Two ways: → ① Parallelogram Law

① Parallelogram Law



For figure find Resultant Vector By drawing

↳ Sol.

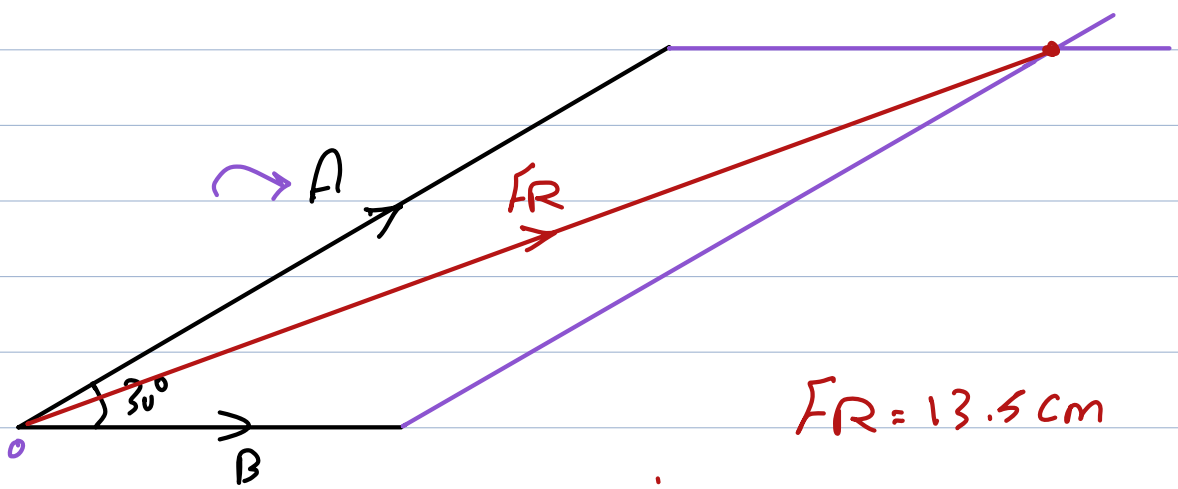
steps: ① scale: $20\ N = 10\ cm$ $\quad x = \frac{10 \times 10}{20}$

$10\ N = x = 5$

$x = 13.5\ cm \rightarrow x = \frac{13.5 \times 20}{10} = 27\ N$

② Draw vectors using ruler and protractor

③ Complete Parallelogram

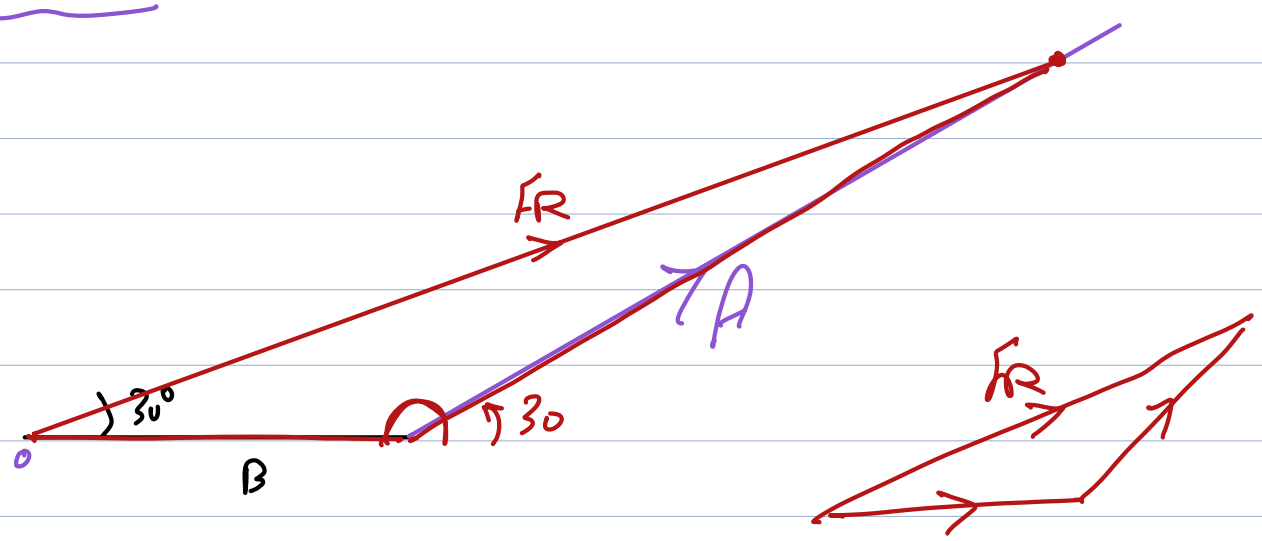


$F_R = 13.5\ cm$

Answer: $F_R = 27\ N \rightarrow$ Mag
$\theta = 20° \rightarrow$ dir
} F_R

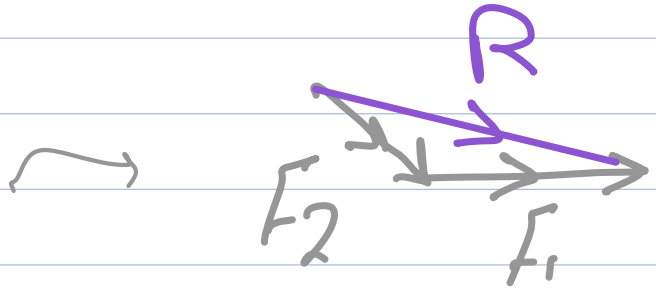
④ Draw diagonal (F_R)
⑤ Measure diagonal
⑥ Convert to N using the scale
⑦ Find the angle with horizontal (Direction)

② Triangle law

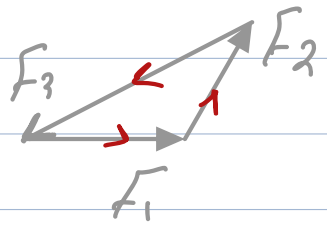


Hint:

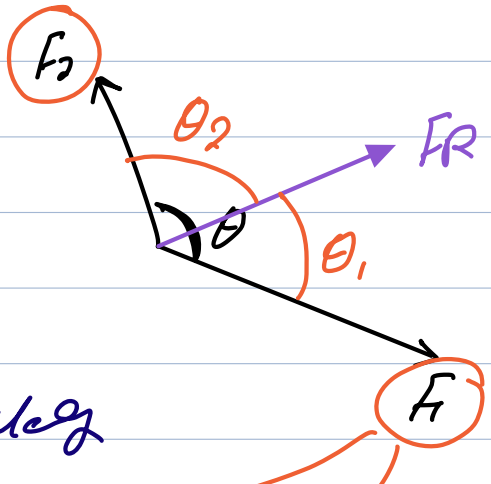
1. For two vectors the resultant is the third side to complete a triangle.



2. For 3 forces in equilibrium they form a Complete Triangle.



② By Calculations :



- In General (at any angle)

$$FR = \sqrt{F_1^2 + F_2^2 + 2F_1F_2\cos\theta} \rightarrow \text{Mag}$$

$$\tan\theta_1 = \frac{F_1 \sin\theta}{F_1\cos\theta + F_2}$$

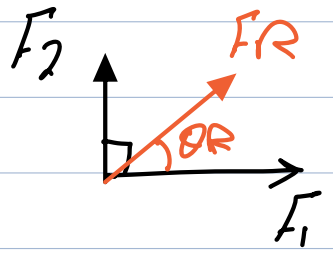
$$\tan\theta_2 = \frac{F_2 \sin\theta}{F_2\cos\theta + F_1}$$

$$\theta = \tan^{-1}(\text{ans}) = \square \text{ deg}$$

- Special Case: If forces are perpendicular

$$F_R = \sqrt{F_1^2 + F_2^2}$$ → Mag

$$\tan\theta_R = \frac{F_2}{F_1} = \frac{F_y}{F_x}$$ → Dir. with horizontal



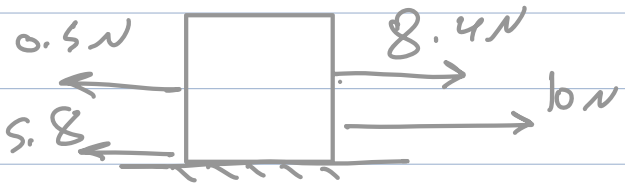
$$\theta_R = \tan^{-1}(\text{ans}) = \text{Deg}$$

CHECKPOINT

1. Work out the resultant force on a toy car if it has the following forces acting on it:
   - rubber band motor driving forwards 8.4 N
   - air resistance 0.5 N
   - friction 5.8 N
   - child's hand pushing forward 10 N.

Sol:

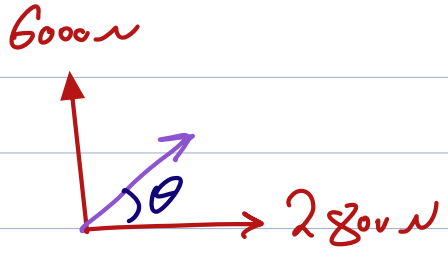
Draw F.B.D



$8.4 + 10 - 0.5 - 5.8 = 12.1\ N$ forward

2. As a small plane accelerates to take off, the lift force on it is 6000 N vertically upwards, whilst the thrust is 2800 N horizontally forwards. What is the resultant of these forces on the plane?

Sol.

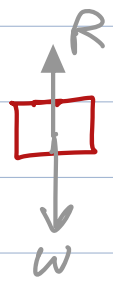


$F_R = \sqrt{F_1^2 + F_2^2}$

$= \sqrt{6000^2 + 2800^2} = 6621\ N$ → Ans

direction with horizontal $= \tan^{-1}\left(\frac{6000}{2800}\right) = 65^\circ$

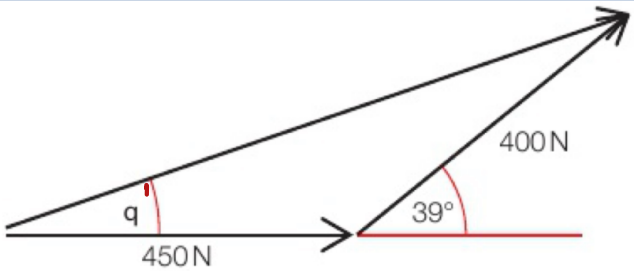
3. Draw a free-body force diagram of yourself sitting on your chair.



4. (a) Draw the scale diagram of **fig E**, and work out what the resultant force would be.
(b) Use the parallelogram rule, as in **fig F**, to check your answer to part (a).

800 N

H.W



20 cm ×
10 cm ×

H.W

5. In order to try and recover a car stuck in a muddy field, two tractors pull on it. The first acts at an angle of 20° left of the forwards direction with a force of 2250 N. The second acts 15° to the right of the forwards direction with a force of 2000 N. Draw a scale diagram of the situation and find the resultant force on the stuck car.

Resolving Vectors (Topic 1A 7)

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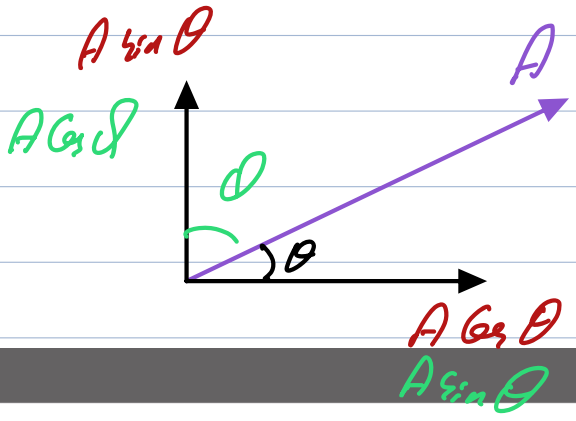

CHECKPOINT

SKILLS INTERPRETATION

1. (a) On graph paper, draw a velocity vector for a stone fired from a catapult at 45° to the horizontal. Your arrow should be 10 cm long, representing a velocity of 10 m s^{-1}. Draw onto your diagram the horizontal and vertical components that would make up the overall velocity. Use a ruler to measure the size of the horizontal and vertical components, and convert these lengths into metres per second using the same scaling.

(b) Find the horizontal and vertical velocity components for this catapult stone by calculation, and compare with your answers from part (a).

2. A javelin is thrown at 16 m s^{-1} at an angle of 35° up from the horizontal. Calculate the horizontal and vertical components of the javelin's motion.

3. A ladder is leant against a wall, at an angle of 28° to the wall. The 440 N force from the floor acts along the length of the ladder. Calculate the horizontal and vertical components of the force from the floor that act on the bottom of the ladder.

4. A plane is flying at 240 m s^{-1}, on a bearing of 125° from due north. Calculate its velocity component due south, and its velocity component due east.

1, 2, 4

H.W

3. A ladder is leant against a wall, at an angle of 28° to the wall. The 440 N force from the floor acts along the length of the ladder. Calculate the horizontal and vertical components of the force from the floor that act on the bottom of the ladder.

By resolving

Horizontal $= 440 \cos 28 = 207\ N$

Vertical $= 440 \sin 28 = 388\ N$