4.6 Unit 4 Pretest Review – Geometric Vectors with solutions

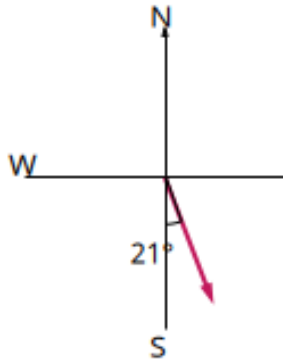
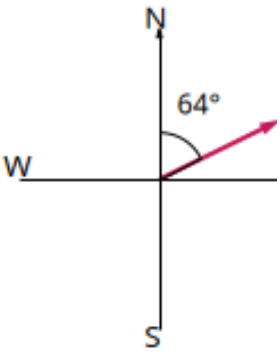
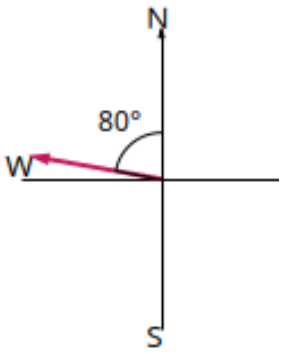
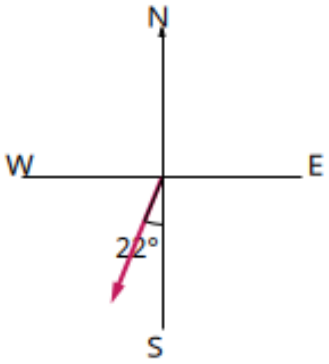
This document was composed and formatted by Annie Bernatchez.

The course material originated from www.jensenmath.ca

This review covers all of Unit 4: Geometric Vectors, and is meant to be used to prepare for the unit test.

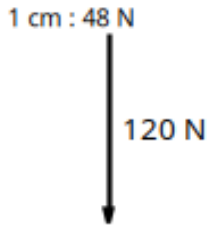
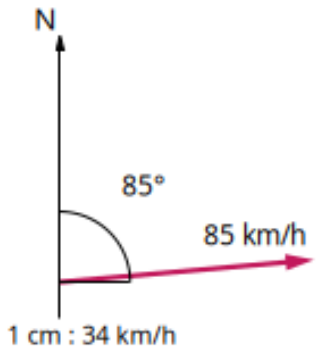
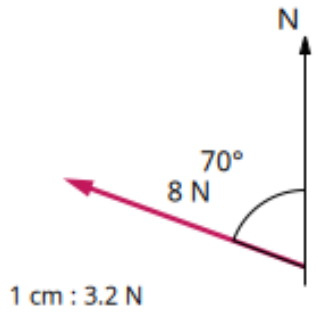
Section 1: 4.1 – Quadrant Bearings

1) Convert each true bearing to its equivalent quadrant bearing.

a) 159°	b) 064°	c) 280°	d) 202°
			
$S21°E$	$N64°E$	$N80°W$	$S22°W$

Section 2: 4.1 – Scale Vector Diagrams

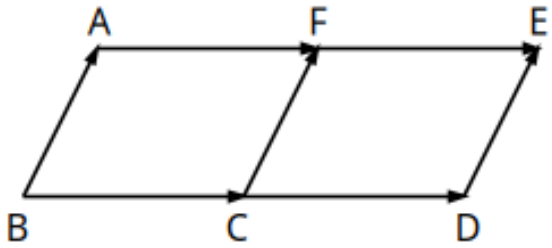
2) Use an appropriate scale to draw each vector. Label the magnitude, direction, and scale.

a) a force of 120 N downward	b) a velocity of 85 km/h at a true bearing of 085°	c) a force of 8 N at a quadrant bearing of $N70°W$
		

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Section 3: 4.1 – Equivalent Vectors

3) Name all the equivalent vectors in the diagram.



$\overrightarrow{AE} = \overrightarrow{BD}$, $\overrightarrow{EA} = \overrightarrow{DB}$, $\overrightarrow{AF} = \overrightarrow{BC}$, $\overrightarrow{FA} = \overrightarrow{CB}$, $\overrightarrow{FE} = \overrightarrow{CD}$, $\overrightarrow{EF} = \overrightarrow{DC}$, $\overrightarrow{AB} = \overrightarrow{FC} = \overrightarrow{ED}$, $\overrightarrow{BA} = \overrightarrow{CF} = \overrightarrow{DE}$

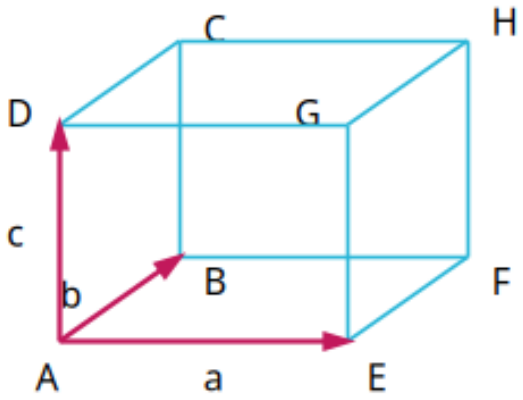
Section 4: 4.1 – Opposite Vectors

4) State the opposite of each vector.

a) 150 km/h on a quadrant bearing of $S50°W$ 150 km/h $N50°E$	b) $\overrightarrow{AB}$ $-\overrightarrow{AB} = \overrightarrow{BA}$
c) $\vec{v}$ $-\vec{v}$	d) 200 N upward 200 N downward

Section 5: 4.2 – Vector Sums and Differences in a Prism

5) The diagram shows a rectangular prism. Name the resulting vector that each sum or difference represents.

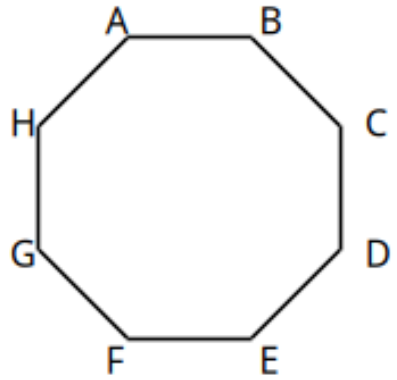


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a) $\vec{a} + \vec{b} =$ $\overrightarrow{AF}$	b) $\vec{b} + \vec{c} =$ $\overrightarrow{AC}$
c) $\vec{a} - \vec{c} =$ $\overrightarrow{DE}$	d) $\vec{c} - \vec{b} =$ $\overrightarrow{BD}$
e) $\vec{c} - \vec{a} =$ $\overrightarrow{ED}$	f) $\vec{a} - \vec{b} =$ $\overrightarrow{BE}$

Section 6: 4.2 – Vector Expressions in an Octagon

6) The diagram shows a regular octagon. Write a single vector that is equivalent to each vector expression.

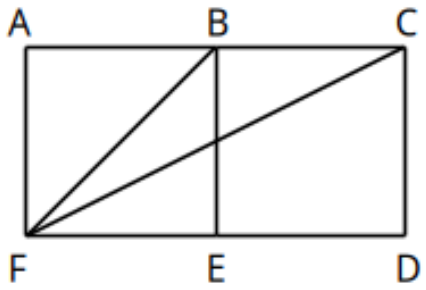


a) $\overrightarrow{HA} + \overrightarrow{AB} =$ $\overrightarrow{HB}$	b) $\overrightarrow{GH} - \overrightarrow{GF} =$ $\overrightarrow{FH}$
c) $\overrightarrow{FE} + \overrightarrow{BA} =$ $\vec{0}$	d) $\overrightarrow{GA} - \overrightarrow{EH} + \overrightarrow{DG} =$ $\vec{0}$

d) $\overrightarrow{GA} - \overrightarrow{EH} + \overrightarrow{DG} = \overrightarrow{GA} + \overrightarrow{HE} + \overrightarrow{DG} = \overrightarrow{GA} + \overrightarrow{AD} + \overrightarrow{DG} = \vec{0}$

Section 7: 4.2 – Vector Expressions in Two Squares

7) The diagram shows two squares. Name a single vector equivalent to each expression.



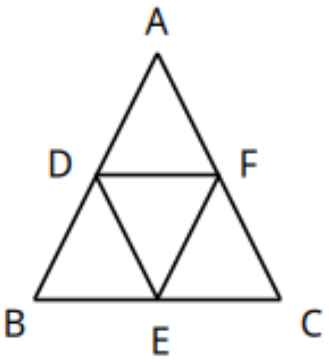
a) $\overrightarrow{FA} - \overrightarrow{FE} =$ $\overrightarrow{EA}$	b) $-\overrightarrow{EB} + \overrightarrow{EF} - \overrightarrow{AF} =$ $\overrightarrow{BA}$	c) $\overrightarrow{AE} + \overrightarrow{ED} - \overrightarrow{CD} =$ $\overrightarrow{AC}$

Section 8: 4.2 – Midpoint Triangle Vector Expressions

8) Equilateral triangle DEF joins the midpoints of equilateral triangle ABC. Write an expression that is equivalent to

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each single vector.

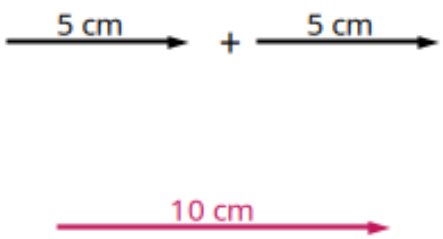


a) $\overrightarrow{AF}$ in terms of $\overrightarrow{AC}$	b) $\overrightarrow{AE}$ in terms of $\overrightarrow{AB}$ and $\overrightarrow{BC}$	c) $\overrightarrow{AB}$ in terms of $\overrightarrow{AF}$ and $\overrightarrow{EC}$
$0.5\overrightarrow{AC}$	$\overrightarrow{AB} + 0.5\overrightarrow{BC}$	$2\overrightarrow{AF} - 2\overrightarrow{EC}$

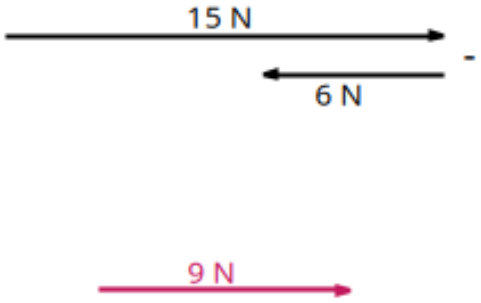
Section 9: 4.2 – Drawing Vector Sums and Differences

9) Draw a diagram to represent each vector sum or difference.

a)



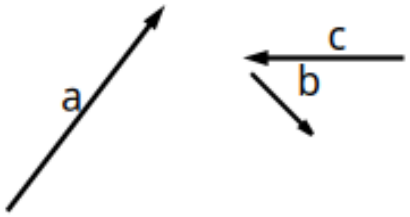
b)

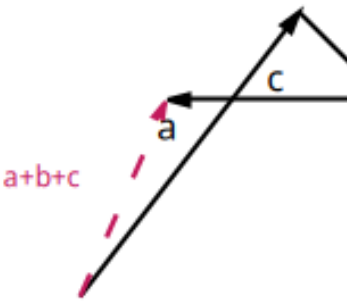
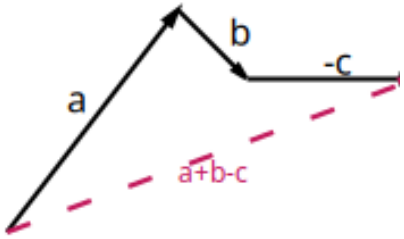
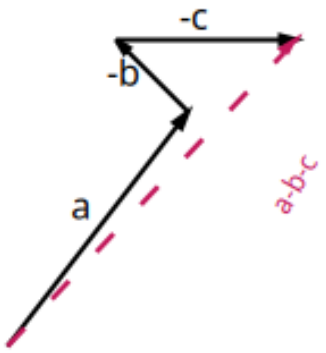


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Section 10: 4.2 – Drawing Combined Vector Expressions

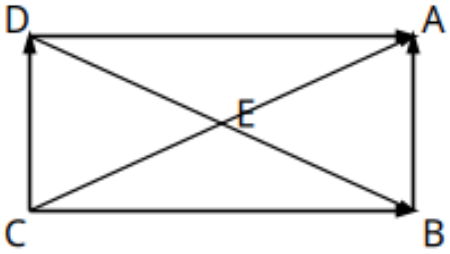
10) Use the following set of vectors to draw a diagram of each expression.



a) $\vec{a} + \vec{b} + \vec{c}$	b) $\vec{a} + \vec{b} - \vec{c}$	c) $\vec{a} - \vec{b} - \vec{c}$
		

Section 11: 4.2 – Parallelogram Diagonals

11) ABCD is a parallelogram, and E is the intersection point of the diagonals AC and BD. Name a single vector equivalent to each expression.



a) $\overrightarrow{AE} + \overrightarrow{EB} =$ $\overrightarrow{AB}$	b) $\overrightarrow{AE} + \overrightarrow{AE} =$ $\overrightarrow{AC}$

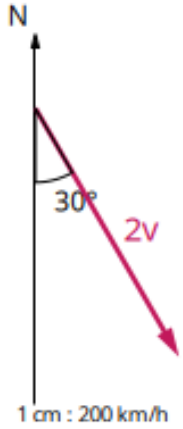
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c) $\overrightarrow{BA} + \overrightarrow{AE} + \overrightarrow{ED} + \overrightarrow{DC} =$ $\overrightarrow{BC}$	d) $\overrightarrow{AB} - \overrightarrow{DB} =$ $\overrightarrow{AD}$
e) $\overrightarrow{AB} - \overrightarrow{CB} - \overrightarrow{DC} =$ $\overrightarrow{AD}$	

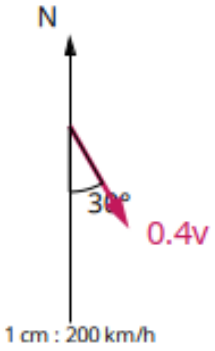
Section 12: 4.3 – Scalar Multiples Scale Diagram

12) Let $|\vec{v}| = 500$ km/h, at a quadrant bearing of $S30°E$. Draw a scale diagram illustrating each related vector.

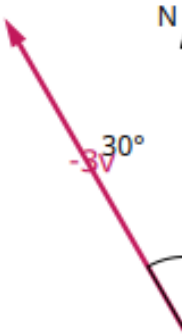
a) $2\vec{v}$



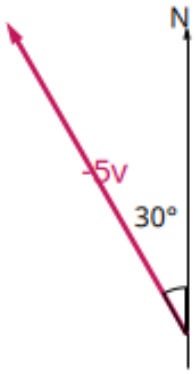
b) $0.4\vec{v}$



c) $-3\vec{v}$

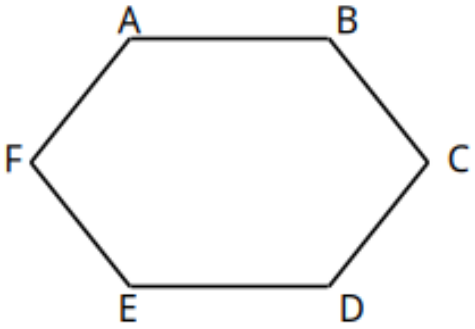


d) $-5\vec{v}$



Section 13: 4.3 – Hexagon Vector Expressions

13) In hexagon ABCDEF, opposite sides are parallel and equal, and $\overrightarrow{FC} = 2\overrightarrow{AB}$. Let $\overrightarrow{AB} = \vec{u}$ and $\overrightarrow{FA} = \vec{v}$. Express each vector in terms of $\vec{u}$ and $\vec{v}$.



a) $\overrightarrow{CF} =$ $-2\vec{u}$	b) $\overrightarrow{FB} =$ $\vec{v} + \vec{u}$	c) $\overrightarrow{FD} =$ $2\vec{u} - \vec{v}$
d) $\overrightarrow{CA} =$ $-2\vec{u} + \vec{v}$	e) $\overrightarrow{EB} =$ $2\vec{v}$	f) $\overrightarrow{BE} =$ $-2\vec{v}$

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Section 14: 4.2 – Magnitude of Vector Sum and Difference

14) The vectors $\vec{d}$ and $\vec{e}$ are such that $|\vec{d}| = 3$ and $|\vec{e}| = 5$, and the angle between them is 30°. Determine each of the following:

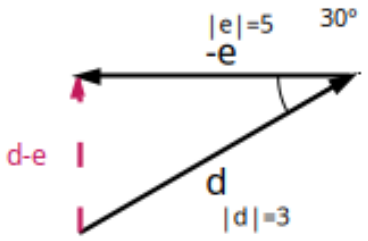
a) $|\vec{d} + \vec{e}|$



$|\vec{d} + \vec{e}|^2 = 3^2 + 5^2 - 2(3)(5)\cos(150)$

$|\vec{d} + \vec{e}| = \sqrt{34 + 15\sqrt{3}} \approx 7.7$ units

b) $|\vec{d} - \vec{e}|$



$|\vec{d} - \vec{e}|^2 = 3^2 + 5^2 - 2(3)(5)\cos(30)$

$|\vec{d} - \vec{e}| = \sqrt{34 - 15\sqrt{3}} \approx 2.83$ units

c) a unit vector in the direction of $\vec{d} + \vec{e}$

$\frac{1}{\sqrt{34 + 15\sqrt{3}}}(\vec{d} + \vec{e})$

Section 15: 4.4 – Resultant of Two Forces

15) Given $|\vec{F_1}| = 85$ N and $|\vec{F_2}| = 125$ N and they are acting at an angle of 140° to each other…

a) Find the magnitude of the resultant.

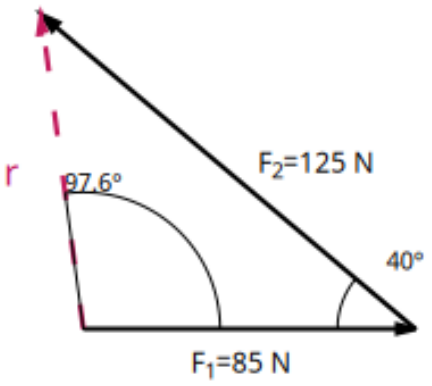
$|\vec{r}|^2 = 85^2 + 125^2 - 2(85)(125)\cos(40)$

$|\vec{r}| \approx 81.1$ N

b) Describe the direction of $\vec{F_1} + \vec{F_2}$ relative to $\vec{F_1}$.

$\cos\theta = \frac{125^2 - 85^2 - 81.1^2}{-2(85)(81.1)}$

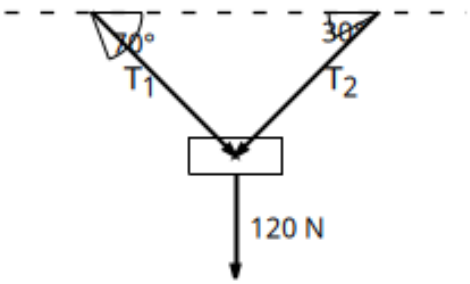
$\vec{F_1} + \vec{F_2}$ makes an angle of 97.6° with $\vec{F_1}$.



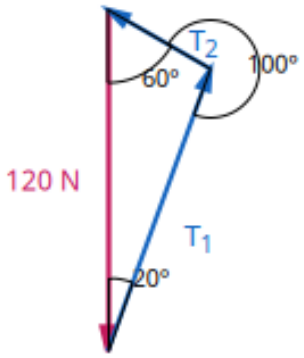
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Section 16: 4.4 – Tension: Sign on Two Chains

16) A 120 N sign is hanging from two chains attached to a ceiling as shown.



a) Draw the vector diagram that illustrates this situation.



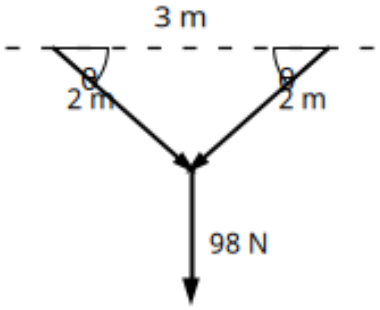
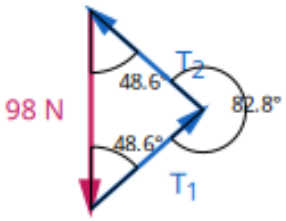
b) Determine the magnitude of the tensions in the chains.

$\frac{\lvert\vec{T_1}\rvert}{\sin 60} = \frac{120}{\sin 100}$ $\lvert\vec{T_1}\rvert \approx 105.5$ N	$\frac{\lvert\vec{T_2}\rvert}{\sin 20} = \frac{120}{\sin 100}$ $\lvert\vec{T_2}\rvert \approx 41.7$ N

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Section 17: 4.4 – Tension: Sign on a Single Chain

17) A sign weighing 98 N is suspended from the middle of a 4 m long chain. The ends of the chain are attached to a ceiling at points 3 m apart. Determine the tensions in the chains.

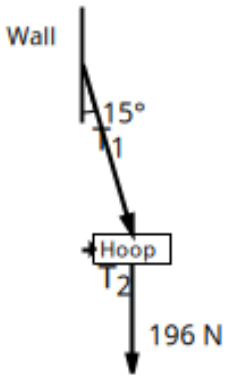
Position Diagram	Vector Diagram
	

$$\cos\theta = \frac{1.5}{2}$$
$$\theta \approx 41.4°$$

$\frac{\lvert\vec{T_1}\rvert}{\sin 48.6} = \frac{98}{\sin 82.8}$ $\lvert\vec{T_1}\rvert \approx 74.1$ N	$\frac{\lvert\vec{T_2}\rvert}{\sin 48.6} = \frac{98}{\sin 82.8}$ $\lvert\vec{T_2}\rvert \approx 74.1$ N

Section 18: 4.4 – Tension: Basketball Hoop

18) A community center plans to install a new basketball hoop on the side of the building. The hoop and backboard have a combined weight of 196 N and are supported by a brace and a wire. Determine the magnitude of the tensions in the wire and the brace.



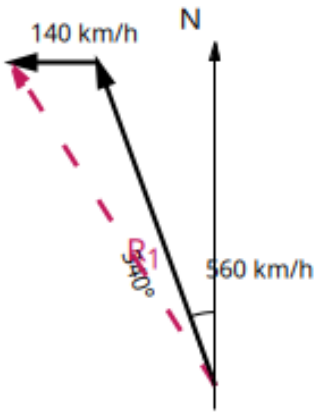
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$\cos(15°) = \frac{196}{\lvert\vec{T_1}\rvert}$ $\lvert\vec{T_1}\rvert \approx 202.9$ N	$\tan(15°) = \frac{\lvert\vec{T_2}\rvert}{196}$ $\lvert\vec{T_2}\rvert \approx 52.5$ N

Section 19: 4.4 – Airplane Ground Velocity

19) An airplane is flying at 560 km/h on a heading of 340°. The wind is blowing at 140 km/h from the east.

a) Draw a vector diagram of this situation.



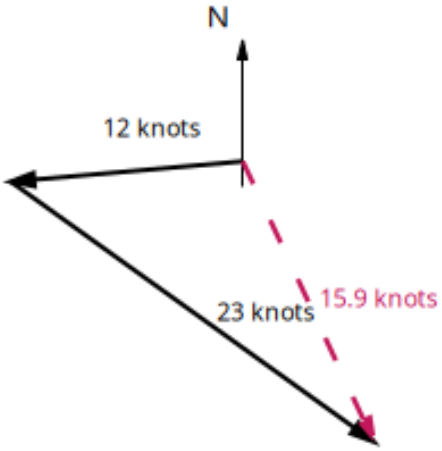
b) Determine the ground velocity of the airplane.

The ground velocity is 622 km/h at a bearing of 328°.

Section 20: 4.4 – Sailboat Navigation

20) A sailor wishes to sail to a port that is located $S25°E$ of his present position. The average speed of his sailboat is 23 knots and the wind is blowing from $N85°E$ at 12 knots.

a) Draw a vector diagram of this situation.



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b) In which direction should the sailor sail?

$S54.4°E$

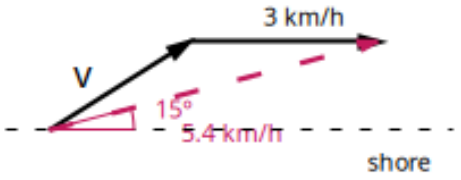
c) What will the sailboat's groundspeed be?

15.9 knots

Section 21: 4.4 – Canoe River Crossing

21) A canoeist leaves a dock and paddles her canoe at an angle across a river. The current is flowing at 3 km/h. The resulting velocity of the boat is 5.4 km/h downstream, in a direction that forms a 15° angle with the adjacent shore.

a) Draw a vector diagram of this situation.



b) Determine the canoeist's velocity relative to the water.

$$|\vec{u}|^2 = 5.4^2 + 3^2 - 2(5.4)(3)\cos(15°)$$

$|\vec{v}| \approx 2.6$ km/h at an angle of 32.2° with the adjacent shore.

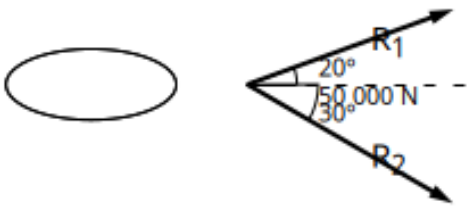
c) How far downstream will she be in 20 min?

$$d = 5.4 \times \frac{20}{60} = 1.8 \text{ km}$$
$$\cos(15°) = \frac{x}{1.8}$$

$x \approx 1.7$ km

Section 22: 4.4 – Cruise Ship Tow Ropes

22) A cruise ship is being pulled into a dock using two ropes, as shown in the diagram. Find the magnitude of the force in each rope if a resultant force of 50 000 N is needed to pull the cruise ship at the desired speed.

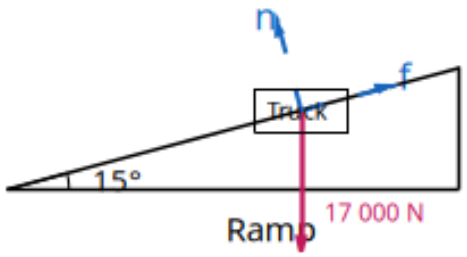
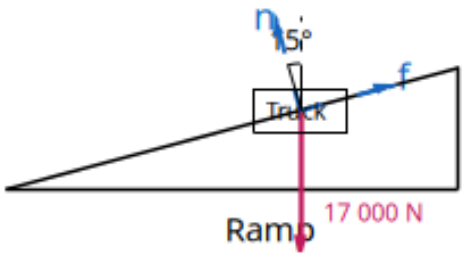


$\frac{\lvert\vec{R_1}\rvert}{\sin 20} = \frac{50000}{\sin 130}$	$\frac{\lvert\vec{R_2}\rvert}{\sin 30} = \frac{50000}{\sin 130}$
$\lvert\vec{R_1}\rvert \approx 32\,635.2$ N	$\lvert\vec{R_2}\rvert \approx 22\,323.8$ N

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Section 23: 4.5 – Truck on a Ramp

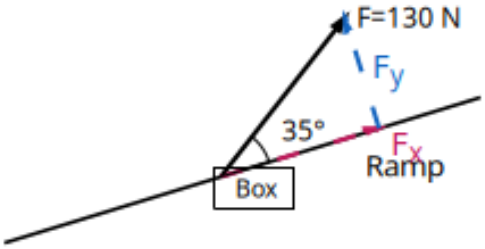
23) A truck weighing 17 000 N is resting on a ramp that is inclined at an angle of 15° to the horizontal. Resolve the weight of the truck into the rectangular components keeping it at rest.

Position Diagram	Vector Diagram
	

$\cos(15°) = \frac{\lvert\vec{n}\rvert}{17000}$ $\lvert\vec{n}\rvert \approx 16\,420.7$ N	$\sin(15°) = \frac{\lvert\vec{F}\rvert}{17000}$ $\lvert\vec{F}\rvert \approx 4399.9$ N

Section 24: 4.5 – Dragging a Box up a Ramp

24) A rope attached to a box is being used to drag it up a ramp. A 130 N force is applied to the box at an angle of 35° to the ramp.



a) Find the magnitude of the force in the direction of motion of the box. $\lvert\vec{F_x}\rvert = 130\cos(35)$ $\lvert\vec{F_x}\rvert \approx 106.5$ N	b) Find the magnitude of the force perpendicular to the direction of motion of the box. $\lvert\vec{F_y}\rvert = 130\sin(35)$ $\lvert\vec{F_y}\rvert \approx 74.6$ N

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Section 25: 4.4 – Resultant of Two Forces at an Angle

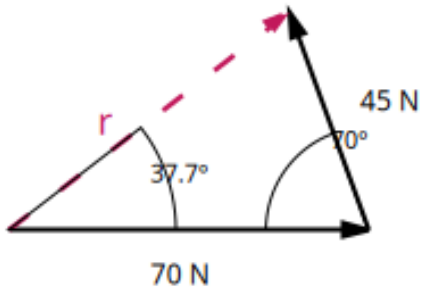
25) Suppose forces of 45 N and 70 N act at an angle of 110° to each other. Find the magnitude (to 1 decimal place) and direction (to the nearest degree) of the resultant force. State the direction as an angle off the 70 N force.

$|\vec{r}|^2 = 70^2 + 45^2 - 2(70)(45)\cos(70°)$

$|\vec{r}| \approx 69.1$ N

$\cos\theta = \dfrac{45^2 - 69.1^2 - 70^2}{-2(69.1)(70)}$

$\theta \approx 37.7°$



69.1 N at an angle of 37.7° with the 70 N force.

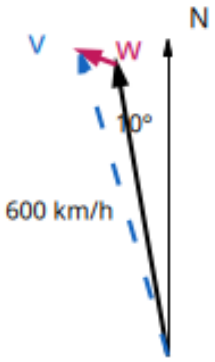
Section 26: 4.4 – Airplane Ground Velocity and Wind Speed

26) A plane is headed $N10°W$ with a speed of 600 km/h. An east wind (i.e. wind FROM the east towards the west) causes it to travel at $N16°W$. Find the resultant ground speed of the plane, and the speed of the wind, each to 1 decimal place.

$\dfrac{|\vec{v}|}{\sin 100} = \dfrac{|\vec{w}|}{\sin 6} = \dfrac{600}{\sin 74}$

$|\vec{v}| \approx 614.7$ km/h (ground speed)

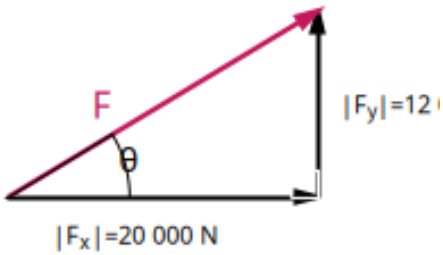
$|\vec{w}| \approx 65.2$ km/h (wind speed)



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Section 27: 4.5 – Resultant from Components

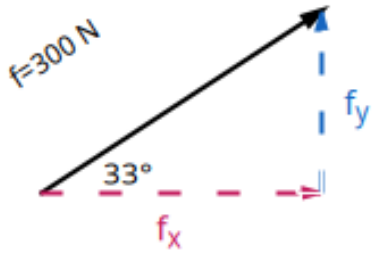
27) The force at which a tow truck pulls a car has a horizontal component of 20 000 N and a vertical component of 12 000 N. What is the resultant force on the car?

$\lvert\vec{F}\rvert^2 = 12000^2 + 20000^2$ $\lvert\vec{F}\rvert \approx 23\,323.8$ N $\tan\theta = \frac{12000}{20000}$ $\theta \approx 31°$	

A force of 23 323.8 N at an angle of 31° with the horizontal.

Section 28: 4.5 – Horizontal and Vertical Components

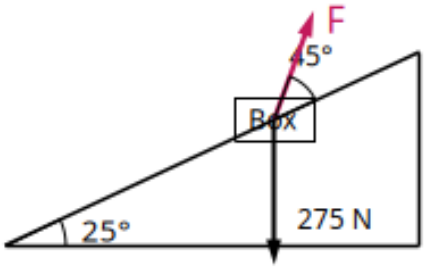
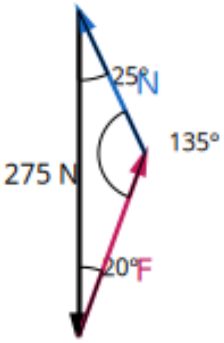
28) Determine the magnitude of the horizontal and vertical vector components of a 300 N force acting at an angle of 33° to the horizontal.

$\lvert\vec{f_x}\rvert = 300\cos(33°)$ $\lvert\vec{f_x}\rvert \approx 251.6$ N	
$\lvert\vec{f_y}\rvert = 300\sin(33°)$ $\lvert\vec{f_y}\rvert \approx 163.4$ N	

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Section 29: 4.5 – Box on a Frictionless Ramp

29) A box with a mass of 275 N rests on a frictionless ramp inclined at an angle of 25° to the level ground. What force must be applied to the box at an angle of 45° to the ramp so that it remains at rest?

Position Diagram	Force Triangle
	

$$\frac{|\vec{F}|}{\sin 25} = \frac{275}{\sin 135}$$

$|\vec{F}| \approx 164.36$ N

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