Most Confusing Stuff

Units!!!!!

- How to convert units (Get the 1 the right way up)
- Always carry units around in problems!
- **Your answer to a question should always include units!**
- **Use dimensional analysis to make sure you've solved a problem correctly – do the units make sense?**
- **Distance = meters (m), Time = seconds (s), Mass = kilograms (kg) ALWAYS!!!**

1. Glenda and Harold are attempting to cross a river in a kayak. The river flows due west at 2.3 m/s. Glenda and Harold head the kayak due south and row at 1.7 m/s (relative to the water).

Determine the resultant velocity of the boat - both magnitude and direction.

Purpose: more flexibility with trig functions (see review for Exam 1: pushing box across floor, with and without frictional forces)

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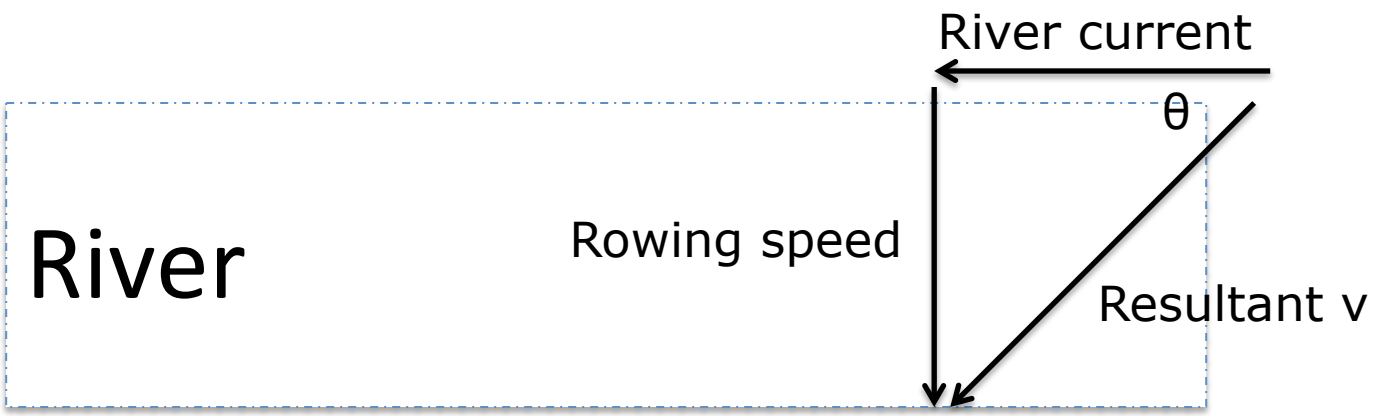

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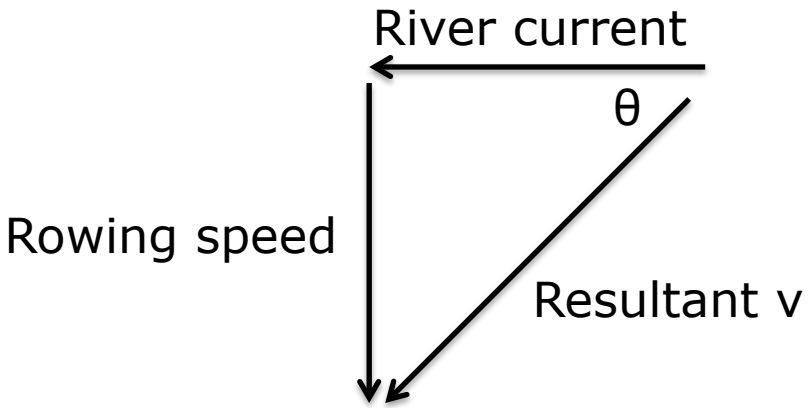

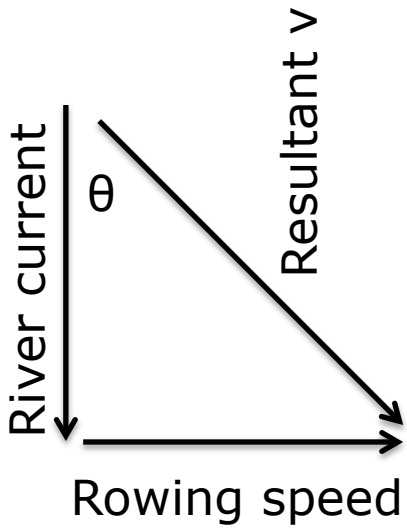

This is a right triangle! $A^2 = Ax^2 + Ay^2$

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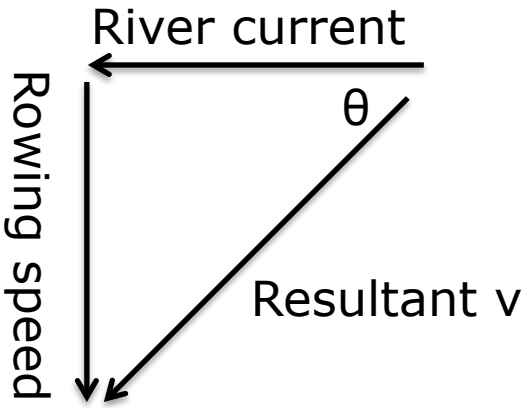
v = 2.86 m/s

Direction: use trig!
tan θ = 1.7 / 2.3

θ = 36.50 degrees, south of west



Special case of motion: **projectile motion** (2D motion)

- Has some initial velocity!
- Curved path of motion, or trajectory
- **Understand motion by splitting it into 2 independent parts, one for the x direction and one for the y direction**
- **x direction: no acceleration because v_x always points in same direction and is constant because we assume a lack of air resistance.**
  - $x = x_0 + v_{0x} * t$
  - x = final position in x, x_0 = starting position in x, v_{0x} = starting velocity in x direction, t = total time of travel

Special case of motion: **projectile motion** (2D motion)

- **y direction: constant acceleration downard due to gravity!**
  - $v_y = v_{0y} + a^* t$ ➔ $v_y = v_{0y} - g^* t$
  - v_y = final velocity in y, v_{0x} = starting velocity in y direction, a = acceleration DOWNWARD due to gravity, t = total time of travel
  - $y = y_0 + (v_{0y} * t) – (½ *g* t^2)$
  - y = final position in y, y_0 = starting position in y

Special case of motion: **projectile motion** (2D motion)

- Max range in x when object starts and returns to the same y position:
  - $x = x_0 + ((v_{0x} * 2\, v_{0y}) / g)$
- Max distance traveled in x is when starting angle is 45°

- Max height in y occurs when $v_y = 0$ (at top of trajectory)
  - $y = y_0 + (½ * (v_{0Y}^2 / g))$

- Your ability to hit a target a certain x and y distance away from where you fire your object depends on BOTH the firing angle and the initial velocity

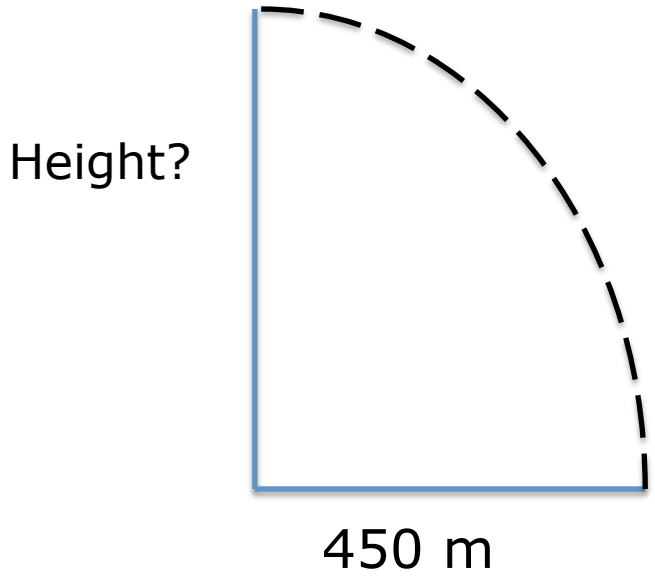
3. A plane is dropping a care package onto a village. The plane moves horizontally with a ground speed of 72.0 m/s. The package will be dropped a horizontal distance of 450 m from the intended target location. At what altitude must the plane be flying in order to successfully accomplish this feat?

Purpose: 2-D motion! Don’t forget that you often have to solve an equation in one dimension to get necessary information to allow you to solve in the other dimension

3. A plane is dropping a care package onto a village. The plane moves horizontally with a ground speed of 72.0 m/s. The package will be dropped a horizontal distance of 450 m from the intended target location. At what altitude must the plane be flying in order to successfully accomplish this feat?

- Plane is traveling at 72.0 m/s entirely in the x direction when it drops the package.

- Therefore v_{0x} of the package is also 72.0 m/s.



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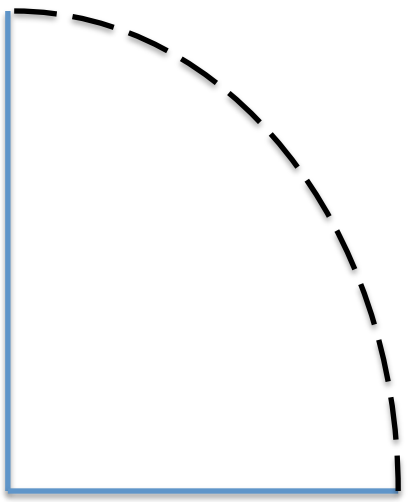
Use $x = x_0 + v_{0x} * t$ to find out how long it takes for the package to travel the 450 m.

Use $y = y_0 + (v_{0y} * t) - (\frac{1}{2} * g * t^2)$ to calculate the height required, where y_0 = height when you drop the package.



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Use $\mathbf{x = x_0 + v_{0x} * t}$

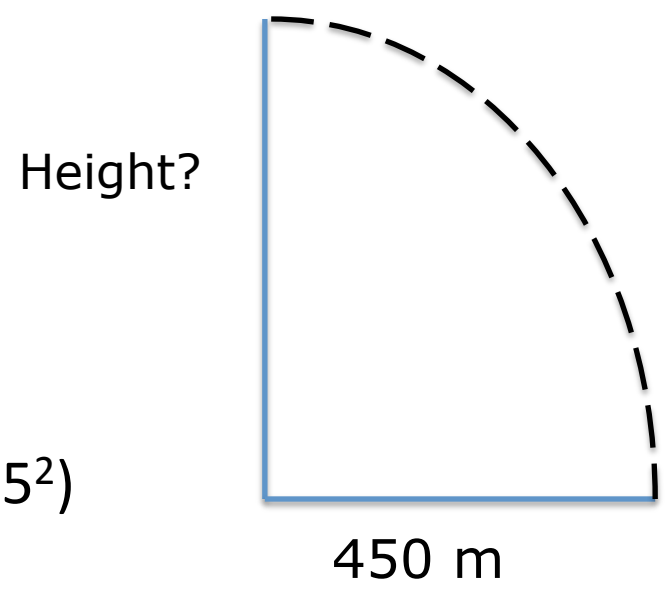
450 m = 0 + (72.0 m/s) * t

t = 6.25 s

Use $\mathbf{y = y_0 + (v_{0y} * t) - (\frac{1}{2} * g * t^2)}$

0 = drop height + 0 – (1/2 * 9.8 * 6.25^2)

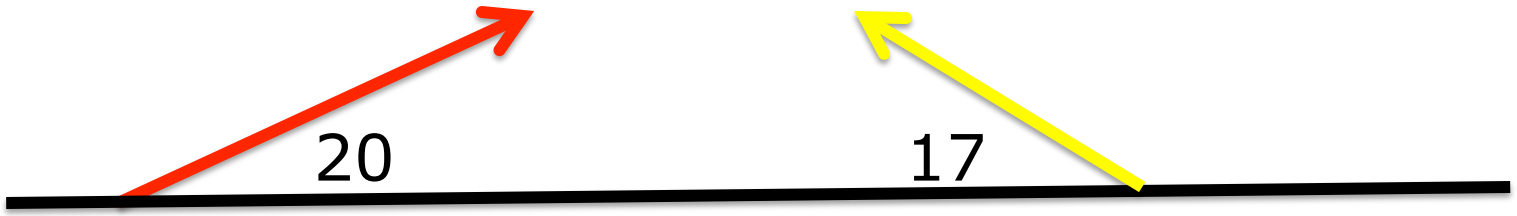
drop height = 191.4 m



Conservation of Momentum

- Total momentum of a group of objects is the same before and after they interact, if no external forces act upon them
  - $p_{final} = p_{initial}$
- Momentum is a vector, so conservation law **holds for magnitude AND direction**
- Conservation of momentum means the momentum in the x direction and in y direction are separately conserved
  - $p_{x,\ initial} = p_{x,\ final}$
  - $p_{y,\ initial} = p_{y,\ final}$

4. The block and clay ball collide and stick together. What is the final velocity of the system?



4.0 kg block
3.5 m/s at an angle of
20 degrees North-East

5.0 kg clay ball
4.9 m/s at an angle of
17 degrees North-West

Purpose: 2-D motion in conservation of momentum! Momentum is conserved separately in each dimension!!!

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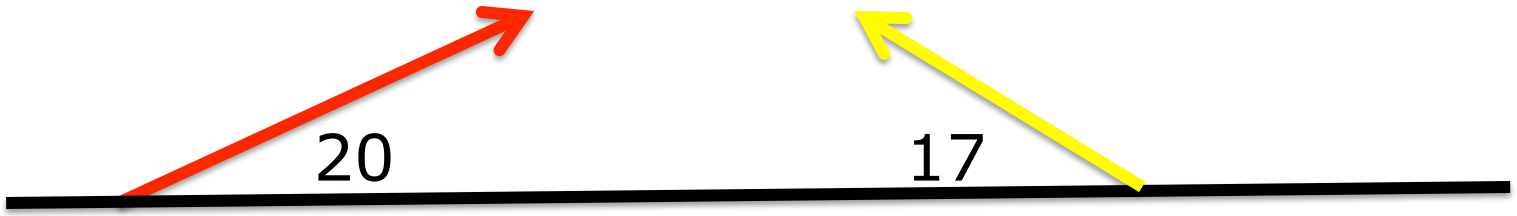

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Red block: p_{ix} = 4.0 kg * (3.5 m/s * cos 20), East

p_{iy} = 4.0 kg * (3.5 m/s * sin 20), North

Yellow ball: p_{ix} = 5.0 kg * (4.9 m/s * cos 17), West

p_{iy} = 5.0 kg * (4.9 m/s * sin 17), North

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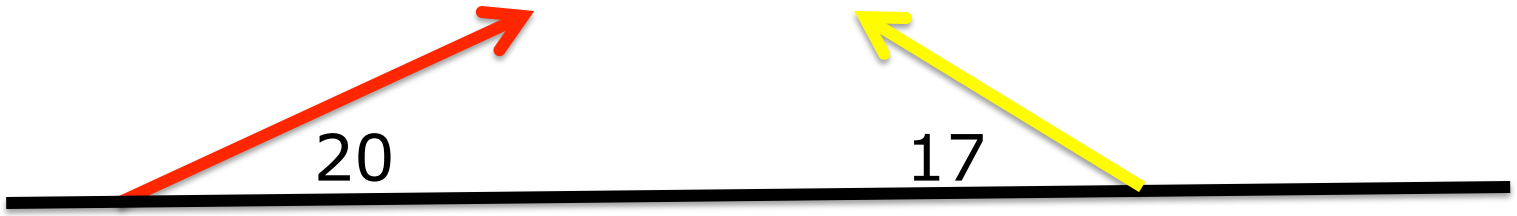

4.0 kg block
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$p_{ix} = p_{fx}$

$4.0\ kg * (3.5\ m/s * \cos 20) - 5.0\ kg * (4.9\ m/s * \cos 17) = (4.0 + 5.0)kg * v_{fx}$

$p_{iy} = p_{fy}$

$4.0\ kg * (3.5\ m/s * \sin 20) + 5.0\ kg * (4.9\ m/s * \sin 17) = (4.0 + 5.0)kg * v_{fy}$

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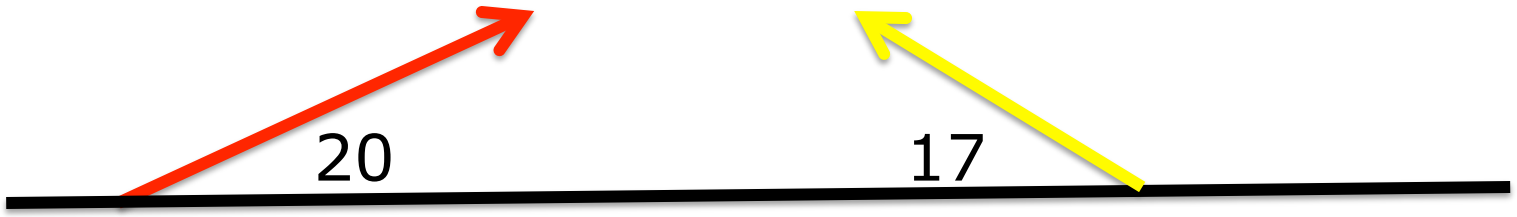
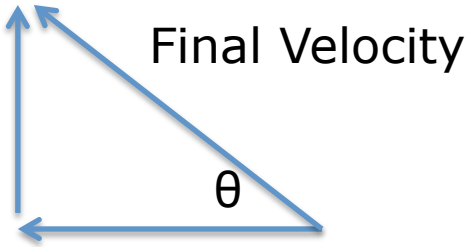


v_{fx} = -1.14 m/s, or 1.14 m/s West

v_{fy} = +1.33 m/s, or 1.33 m/s North



Final velocity: draw a picture, use Pythagorean theorem and trig:

$v^2 = v_{fx}^2 + v_{fy}^2$, v = 1.75 m/s

tan θ = 1.33 / 1.14, θ = 49.4 degrees north of west

Electricity

- **Electric Force** $F_{ele} = k \bullet \frac{q_1 \bullet q_2}{d^2}$
  - k = 9 x 10^9 N m^2/C^2
- **Electric field, E = F/q (vector!)** $E_{ele} = \frac{k \bullet q}{d^2}$
  - Points away from a + charge, toward a – charge
- DO NOT CONFUSE THE TWO!

5. What is the strength of the electric field felt 5 μm from a 2 mC charge? What force will a 1 mC charge feel if placed at this distance?

Purpose: *LOTS* of confusion over E and F equations, REMEMBER TO CHECK UNITS!!

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Use

$$E_{ele} = \frac{k \bullet q}{d^2}$$

DO NOT FORGET THE DISTANCE IS SQUARED!!!

and then: **E = F/q**

F = E * q!!!

5. What is the strength of the electric field felt 5 μm from a 2 mC charge? What force will a 1 mC charge feel if placed at this distance?

$$E_{ele} = \frac{(9x10^{9}\,\frac{Nm^{2}}{C^{2}}) \bullet (2x10^{-3}C)}{(5x10^{-6}m)^{2}} = \quad 7.2 \times 10^{17}\ \text{N/C}$$

E = F / q, so F = E * q, or E * (1 mC)

F = (7.2 x 10^{17} N/C) * (1 x 10^{-3} C) = 7.2 x 10^{14} N

6. What is the DIRECTION of the electric field from a 2 mC charge? What DIRECTION is the force on a 1 mC charge placed 5 μm from the 2 mC charge?

The E-field always points away from a positive charge, so the direction of the E-field is away from the charge.

The force between two like charges is repulsive, so the force will act to push the two charges apart.

Spare vector problem

2. Glenda and Harold are attempting to cross a river in a kayak. The river flows due west at 2.3 m/s. Glenda and Harold head the kayak 19 degrees south of west, and row at 2.9 m/s (relative to the water).

Determine the rowing speed if they had chosen instead to row directly across the river (due south)

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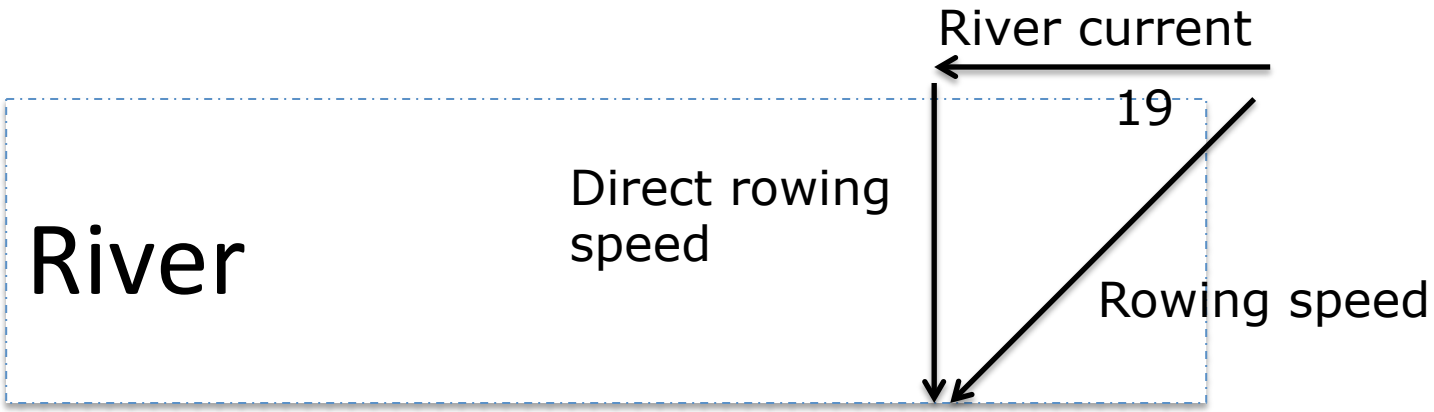

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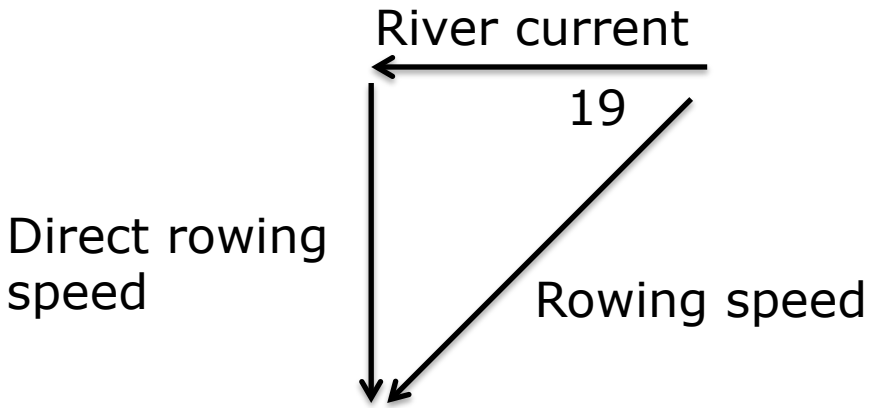

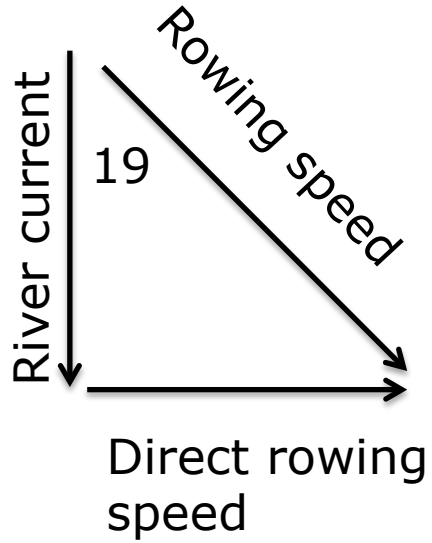

Use trig functions! sin 19 = Direct rowing speed / Rowing speed

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sin 19 = Direct rowing speed / 2.9

Direct rowing speed = 0.94 m/s