ANSWERS

SPH4U0 2D Motion Quiz Name:

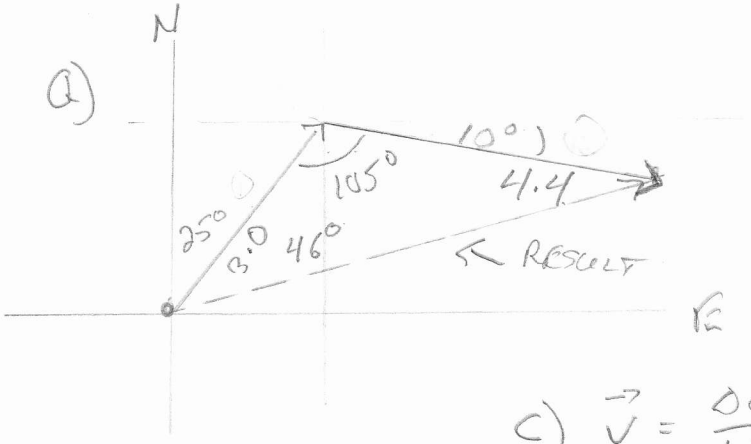
Each question is 5 marks. Answer in the space provided.

$d = v\Delta t$ $a_c = V^2 / r$ $a_c = 4\pi^2 r/T^2$ $a_c = 4\pi^2 rf^2$

SOHCAHTOA $c^2 = a^2 + b^2 - 2ab\cos C$ $\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$

1. Resultant Displacement
   A jogger first runs a distance of 3.0 km in the [N25°E] direction and then 4.4 km in the [E10°S] direction.
   a. Provide a vector diagram (rough sketch or scale drawing) of the jogger's motion. Make sure to indicate the resulting displacement.
   b. Calculate the resulting displacement using a method of your choice (i.e. scale drawing, Sine / Cosine, or vector components.)
   c. If the total trip takes 30 min, calculate the jogger's average velocity.

a)



b) $c^2 = (3.0)^2 + (4.4)^2 - 2(3.0)(4.4)\cos 105°$

$c^2 = 35.2$ $c = 5.9$

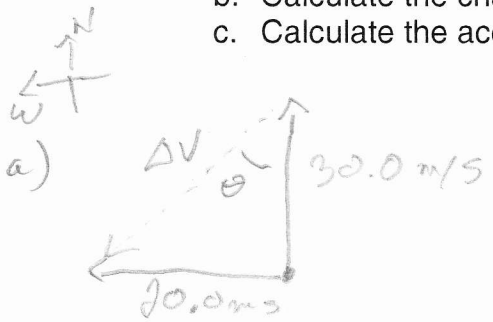
$\frac{\sin B}{4.4} = \frac{\sin 105°}{5.9}$ $\Rightarrow B = 46°$

$\Delta d = 5.9\text{ km } [N71°E]$

c) $\vec{v} = \frac{\Delta d}{\Delta t} = \frac{5.9\text{ km}}{0.5\text{ h}} = 11.8\text{ km/h } [N71°E]$

2. Acceleration Change
   A car is initially moving with a velocity of 30.0 m/s [N] it then changes to a velocity of 20.0 m/s [W].The time taken to change velocity is 10.0 s.
   a. Provide a vector diagram.
   b. Calculate the change in velocity.
   c. Calculate the acceleration.

a)



b) $\Delta V^2 = (30.0)^2 + (20.0)^2$

$\Delta V^2 = 1300$ $\theta = \tan^{-1}\left(\frac{20.0}{30.0}\right)$

$\Delta V = 36.1\text{ m/s}$ $\theta = 33.7°$

$\Delta V = 36.1\text{ m/s } [S\,33.7°\,W]$

c) $a = \frac{\Delta V}{\Delta t} = \frac{36.1}{10.0} = 3.61\text{ m/s}^2$

$a = 3.61\text{ m/s}^2\ [S\,33.7°\,W]$

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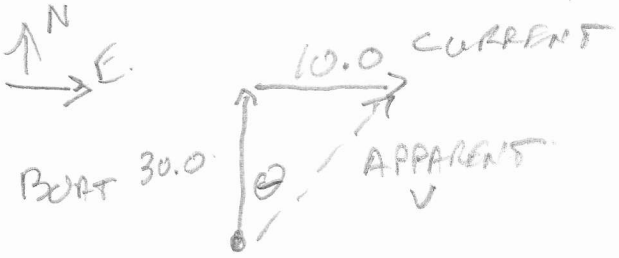
3. Crossing Problem – Type 1
A boat is observed crossing a river. The boat motor provides a velocity of 30.0 km/h [N] in the water. The river has a current of 10.0 km/h flowing [E]. What is the apparent velocity of the boat to someone standing on shore?



FIND V

$V^2 = (30.0)^2 + (10.0)^2$

$V^2 = 1000$

$V = 31.6$ km/h.

FIND θ

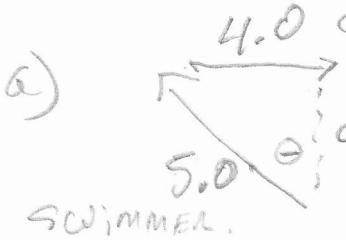
$\theta = \tan^{-1}\left(\frac{10.0}{30.0}\right)$

$\theta = 18.4^\circ$

$\vec{V} = 31.6$ km/h [N 18.4° E]

4. Crossing Problem – Type 2
A swimmer has a speed of 5.0 m/s in the water. The water has a current of 4.0 m/s [E].
   a. What angle to the current must the swimmer swim at in order to swim straight across the river.
   b. If it takes 25.0 s for the swimmer to swim across the river, how wide is the river?

a)



a) FIND θ

$\theta = \sin^{-1}\left(\frac{4.0}{5.0}\right)$

$\theta = 53.1^\circ$

SWIMMER MUST SWIM N 53.1° W INTO THE CURRENT

b) APPARENT SPEED OF SWIMMER IS

$a^2 = c^2 - b^2$

$a^2 = (5.0)^2 - (4.0)^2$

$a^2 = 9.0$

$a = 3.0$ m/s ⇒

$\Delta d = v\Delta t$

$= (3.0)(25.0)$

$= 75.0$ m WIDE

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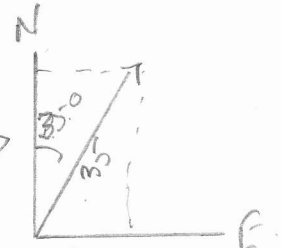
5. Air Navigation Problem
The air velocity of a radio controlled drone is 35 m/s [N35°E]. There is a cross-wind of 7 m/s [N25°W] affecting the flight of the drone.
   a. Determine the components of the drone velocity.
   b. Determine the components of the cross-wind velocity.
   c. Determine the resulting speed of the drone relative to the ground.

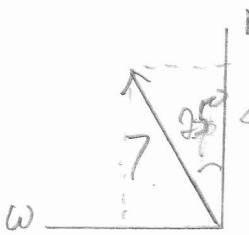
A)



$35\cos 35^\circ$
$28.7\ [N]$

$35\sin 35^\circ$
$20.1\ [E]$

B)



$7\cos 25^\circ$
$6.3\ [N]$

$7\sin 25^\circ$
$3.0\ [W]$

C) $28.7\ [N] + 6.3\ [N] = 35\ [N]$

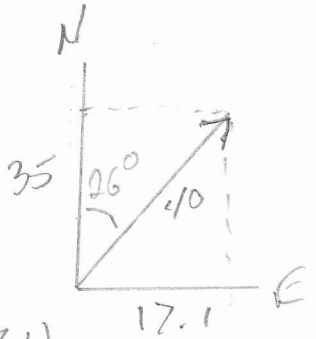
$20.1\ [E] + 3.0\ [W] = 17.1\ [E]$

$a^2 + b^2 = c^2 \Rightarrow c = 40$

$\theta = \tan^{-1}\left(\frac{17.1}{35}\right) \Rightarrow \theta = 26^\circ$

RESULTING GROUND SPEED.

$40\ m/s\ [N26^\circ E]$



6. Circular Motion – Centripetal Acceleration
The centripetal acceleration experienced by a rock in a sling-shot is 1.75×10^3 m/s^2. The radius of the sling-shot is 12 cm.
   a. Calculate the frequency of rotation of the sling-shot.
   b. Calculate the period of rotation of the sling-shot.

$a_c = 1.75 \times 10^3\ m/s^2$

$r = 12\ cm = 0.12\ m$

a) $a_c = 4\pi^2 r f^2$

or

$f = \sqrt{\frac{a_c}{4\pi r}}$

$f = \sqrt{\frac{1.75 \times 10^3}{4\pi^2 (0.12)}}$

$f = \sqrt{369.8}$

$f = 19.2\ Hz$

b) $a_c = 4\pi^2 r / T^2$

or

$T = \sqrt{\frac{4\pi^2 r}{a_c}}$

$T = 0.052\ s$