ON-LINE SAILBOAT PHYSICS
NAT. GEO. ACTIVITY

NAME:

1.) Draw the force diagram for a boat sailing directly downwind:

a.) When the boat has not reached maximum velocity. wind
Write an equation for ΣF (include $F_{friction}$ & F_{wind})

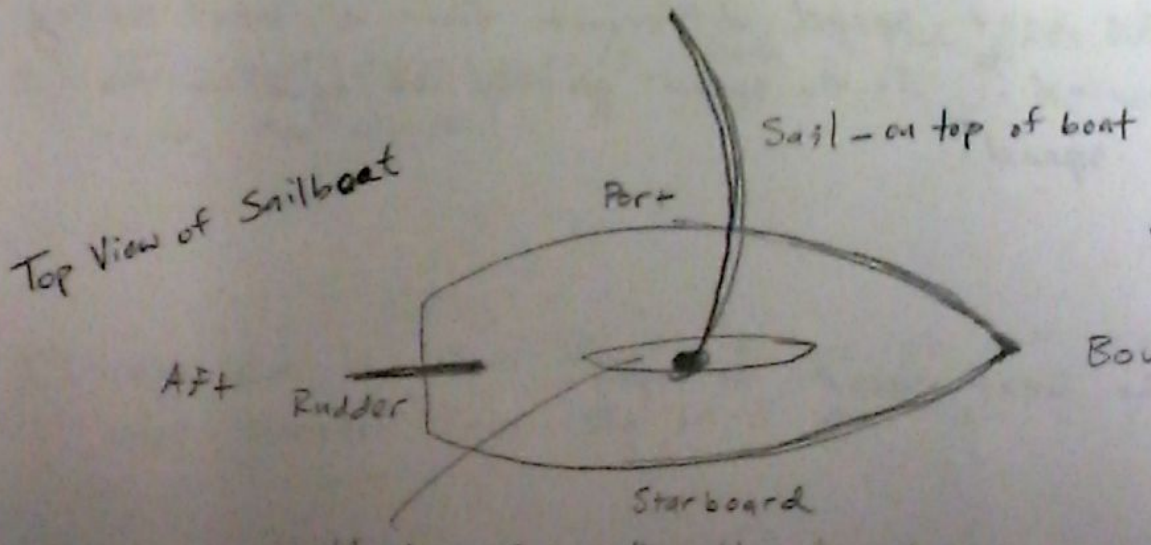
Draw a motion map:

b.) When the boat has reached maximum velocity. wind
Write an equation for ΣF (include $F_{friction}$ & F_{wind})
Draw a motion map:

c.) Using the nat geo "SAILING SIMULATOR" adjust your rudder and sail such that you can find the maximum velocity from the boat orientation mentioned in 1part b.
*Keep wind speed at same knots, be certain the sail surface is perpendicular to the wind and the rudder is parallel to the wind direction. What is the "boat speed"? 5

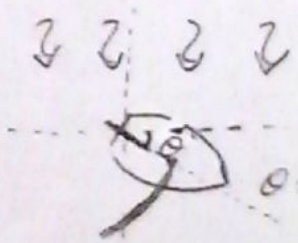
d.) Why can a boat sailing directly down wind not sail faster than the wind speed? (think about ΣF)

e.) Convert boat speed to mph. 1 knot = 1.15078 mph



* Before proceeding, read "Hewitt - Sail Boat Physics"

2.) Draw the force diagram for a boat sailing across the wind at a negative ≈ 30° angle to the direction of the wind. Assume the sail remains relatively perpendicular to the boat direction. (rudder)



a.) When the boat has not reached max velocity. Write an equation for ΣF (include F_{keel}) Draw a motion map.

b.) When the boat has reached max velocity. Write an equation for ΣF (include F_{keel}) Draw a motion map.

c.) Using the "sailing simulator" from nat geo, determine the max velocity of the boat sailing across wind, sails perpendicular to boat direction, at an approximately $-30°$ angle to the wind. Keep wind speed at same knots. What is the boat speed?

d.) Why is the boat speed different from a boat sailing directly downwind? Is the speed greater / less / equal to the previous boat speed?

e.) Convert the boat speed to mph.

* Before proceeding, watch Mathysics of Sailing - KQED Quest video.

3.) Draw the force diagram for a boat sailing into the wind at a slight angle. The sail should be almost parallel with the wind direction.

a) Not reached max velocity.
Write an equation for ΣF (include F_{Lift})
Draw a motion map

b) Reached max velocity.
Write an equation for ΣF (include F_{Lift})
Draw a motion map.

c.) Using the nat geo sailing simulator, determine the maximum velocity of a boat sailing into the wind. You may need to attempt several different rudder and sail configurations. What is the boat speed?

d.) Convert knots into mph.

e.) In your own words, how is it possible to sail into the wind?

f.) Why does the sail "Flap" if you do not offset the sail parallel from the wind direction?

4.)

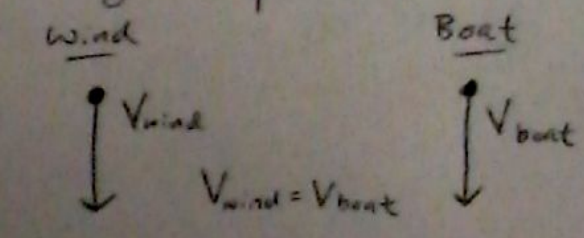
a.) Try "tacking" into the wind. Describe what happens below:

b.) Keeping wind speed at 15 knots, attempt to maximize the boat speed. Draw your boat, sail and wind orientations below.

c.) In 5 sentences or more, explain what you learned from this lab activity.

hint:

Motion Map when $\Sigma F = 0$
Sailing Directy Downwind at Max Speed



Motion Map when $\Sigma F = 0$
Sailing Across the Wind at Max Speed