

**Round: 11A**

Ice presents a constant danger for ships operating in the Arctic. Ships can sustain damage from collisions or become trapped and unable to move (beset). There are 2 kinds of ice floating in the Arctic: sea ice and icebergs.

1. Describe the seasonal cycle of formation and melting of sea ice. During what months would you expect the sea ice to reach its maximum? Its minimum?

*Sea ice forms in winter (1 pt) and melts in the summer (1 pt). It reaches a maximum in February, March or April (1 pt). It reaches a minimum in August, September or October (1 point).*

2. Sea ice is classified by its thickness and age. Why is multi-year sea ice much stronger than new sea ice?

*When sea ice forms, ice crystals expel salt, which accumulates in pockets of salty brine. These pockets weaken the newly formed ice (1 pt). Over time the brine escapes and is replaced with summer meltwater, which freezes the following winter strengthening the ice (1 pt).*

3. Describe the formation of icebergs.

*Ice forms on land (1 pt) OR ice shelves (1 pt), and breaks off (calves) to become an iceberg (1 pt)*

4. Why does sea ice tend to move faster than icebergs?

*Icebergs have a deeper draft (1 pt), which produces more drag (1 pts)*

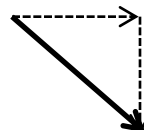
Sea ice that drifts freely moves at about 2% of the wind speed. For this exercise assume sea ice moves 30 degrees to the right or left of the wind direction.

5. A large ice flow is located in the Greenland Sea at 0800 on April 11. Where will it be at 2000 on April 13 if there is a constant wind blowing at 25 knots from the west southwest at 240 degrees? The surface current is flowing directly south at 0.5 knots. Estimate the answer to the nearest nautical mile. Show your work.

*Distance due to wind =  $25 \text{ knots} \times 60 \text{ hours} \times 2\% = 30$  nautical miles (2 points)*

*Distance due to current =  $0.5 \text{ knots} \times 60 \text{ hours} = 30$  nautical miles (1 point)*

*Direction due to wind: wind is from 240 degrees so ice moves toward 60 degrees + 30 degrees = 90 degrees (2 points)*



*Direction due to current = 180 degrees (1 point) Actual direction & distance of travel is 30 nautical miles to the east + 30 miles to the south =  $\sqrt{(30^2 + 30^2)} = 42.4$  nautical miles to the south east (or 135 degrees) (Accept 40 – 45 nautical miles). (3 points)*

Reference

Sea Ice and Products and Services of the National Ice Center: <http://www.meted.ucar.edu/oceans/seaice/print.htm>