

## Astronomy 505: Homework #7 (Radiation)

For each question, focus on the critical motivating physics. Give counter examples, sketch figures, and make your arguments as thorough and convincing as possible.

1. Which of the launch plans listed below is most energy efficient for sending a spaceship to the Moon? Head (1) south from New Mexico, (2) north from California, (3) east from Florida, or (4) east from Moscow. (3 pts)
2. One piece of metal is at the temperature of melting ice, while a second piece is twice as hot. What are their temperatures, in degrees Celsius? (3 pts)
3. Two bullets of equal size, mass, and speed are fired at a block of wood. One is made of rubber, and one of aluminum.
  - (a) Which is more likely to knock over the block? (2 pts)
  - (b) Which is more likely to damage the block? (2 pts)
4. As you empty a gallon jug of liquid, it gurgles. As it empties, how will the frequency of the sound change? (4 pts)
5. A metal disk with a central hole is heated until it expands. What will be the effect on the diameter of the central hole? (5 pts)
6. Consider the four sailboats shown below (numbered one through four, from left to right), noting the orientation of the sails with respect to both the wind and the keels. Which boat will move forward with the greatest speed? (8 pts)

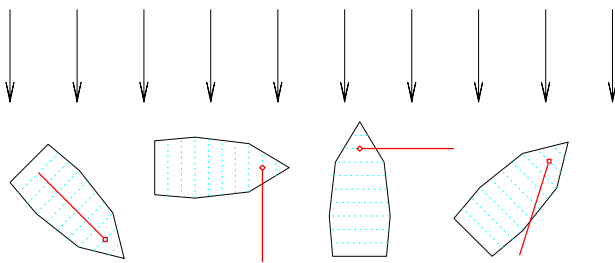


Figure 1: Four little sailboats, on a windy day.

7. You order a cup of coffee at a sidewalk cafe in winter, and once it arrives you realize that you must now wait till a friend arrives before drinking it. If you take cream with your coffee, should you add it now or later in order to have as hot a drink as possible in twenty minutes? (8 pts)
8. Consider an open cart (with no top) rolling along a frictionless track in the rain.
  - (a) After a significant amount of rain has collected in the cart, what will the effect be on the speed, momentum, and kinetic energy of the cart? (5 pts)
  - (b) After the rain stops, a hole in the cart floor is opened and the water drains out. What will the effect be on the speed, momentum, and kinetic energy of the cart? (5 pts)
9. Two cubes of solid metal are each heated by a single hot source.
  - (a) If one cube has a white surface and the other has a black surface, which cube radiates the most energy? (5 pts)
  - (b) If each cube has a large inner cavity reached by a small hole in the surface, faced with the same material as the outer surface, which cavity radiates the most energy? (5 pts)

*Hint: Be sure to distinguish between radiation and reflection.*