6.055J/2.038J (Spring 2008)

Homework 2

Do the following warmups and problems. Due in class on **Monday, 03 Mar 2008**.

Open universe: *Collaboration, notes, and other sources of information are* **encouraged.** *However, avoid looking up answers until you solve the problem (or have tried hard). That policy helps you learn the most from the problems.*

Bring a photocopy to class on the due date, *trade it for a solution set, and figure out or ask me about any confusing points. Your work will be graded lightly: P (made a reasonable effort), D (did not make a reasonable effort), or F (did not turn in).*

Warmups

1. **Fish tank**

   Estimate the mass of a typical home fish tank (filled with water and fish): a useful exercise before you help a friend move who has a fish tank.

2. **Bandwidth**

   Estimate the bandwidth (bits/s) of a 747 crossing the Atlantic filled with CDROM's.

3. **Integrals**

   Evaluate these definite integrals:

   a. $\displaystyle\int_{-10}^{10} x^3 e^{-x^2}\, dx$

   b. $\displaystyle\int_{-\infty}^{\infty} \frac{x^3}{1 + 7x^2 + 18x^8}\, dx$

Problems

4. **Number sum**

   Use symmetry to find the sum of the integers between 200 and 300 (inclusive).

5. **Repainting MIT**

   Estimate the cost to repaint all indoor walls in the main MIT classroom buildings. [with thanks to D. Zurovcik]

6. **Raindrop speed**

    a. How does a raindrop's terminal velocity v depend on the raindrop's radius r?

    b. Estimate the terminal speed for a typical raindrop.

    c. How could you check your estimate in part (b)?

7. Mountains

Look up the height of the tallest mountain on earth, Mars, and Venus, and explain any pattern in the three values.

8. Your turn to create

Invent – but do not solve! – a question for which proportional reasoning or symmetry would help solve.

Particularly enjoyable questions might appear on the website or as examples in lecture or the notes (let me know if you do *not* want your name attributed in case your question gets selected).

Optional

9. Heat equation

In lecture we used symmetry to argue that the temperature at the center of the metal sheet is the average of the temperatures of the sides.

Check this result by making a simulation or, if you are bold but crazy, by finding an analytic solution of the heat equation.