6.055J/2.038J (Spring 2010)

Homework 5

*Submit your answers and explanations online by **10pm on Wednesday, 07 Apr 2010**.*

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

Homework is graded with a light touch: P (made a decent effort), D (made an indecent effort), or F (did not make an effort).

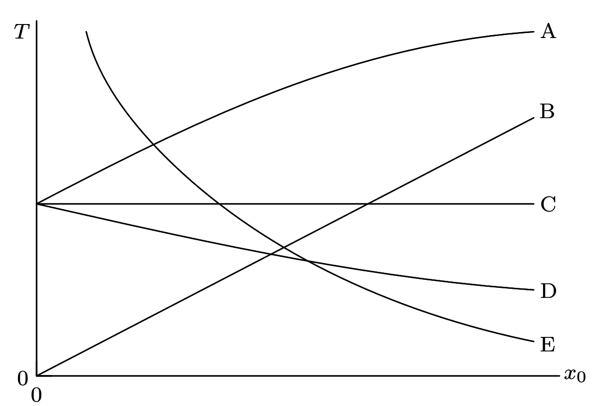
Problem 1 9V battery

Roughly how much energy is stored in a typical (disposable) 9V battery?

$10^{\square} \pm \square$ J *or* $10^{\square} \ldots \square$ J

Problem 2 Non-Hooke's law spring

Imagine a mass connected to a spring with force law $F = Cx^3$ (instead of the usual Hooke's law behavior $F = kx$) and therefore potential energy $V \sim Cx^4$ (where C is a constant). Which curve shows how the system's oscillation period T depends on the amplitude x_0?



- ☐ Curve A
- ☐ Curve B
- ☐ Curve C
- ☐ Curve D
- ☐ Curve E

Comments on page 1

Here is the next homework (due online by Wed at 10pm). Have fun, and feel free to discuss it here on NB or in other ways.

Can someone give a hint here? I know for a capacitor, energy=1/2CVˆ2, but I'm not sure how to do this for a battery. Thanks!

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i'm not really sure how to start this..can someone give me a hint?

What are the important variables and what are their dimensions? We did a similar problem in class using the usual law... looking at that might help)

Problem 3 Power radiated by an accelerating charge
If the velocity and acceleration of a (nonrelativistic) electric charge are doubled, how does the power radiated by the charge change?

- ☐ The power increases by a factor of 16.
- ☐ The power increases by a factor of 8.
- ☐ The power increases by a factor of 4.
- ☐ The power increases by a factor of 2.
- ☐ The power increases by a factor of $\sqrt{2}$.

Problem 4 Local black hole
What is roughly the largest radius the earth could have, with its current mass, and be a black hole (i.e. light cannot escape from its surface)?

$10^{\square \pm \square}$ m *or* $10^{\square \ldots \square}$ m

Problem 5 Wire
Roughly what is the number density of free (conduction) electrons in a copper wire?

$10^{\square \pm \square}$ m^{-3} *or* $10^{\square \ldots \square}$ m^{-3}

Problem 6 Yield from an atomic bomb
Geoffrey Taylor, a famous Cambridge fluid mechanic, annoyed the US government by doing the following analysis. The question he answered: 'What was the energy yield of the first atomic blast (in the New Mexico desert in 1945)?' Pictures declassified by the US government – the pictures even had a scale bar! – provided the tabulated data on the radius of the explosion at various times.

t (ms)	R (m)
3.26	59.0
4.61	67.3
15.0	106.5
62.0	185.0

Use dimensional analysis to work out the relation between radius R, time t, blast energy E, and air density ρ. Then use the data in the table to estimate the blast energy E:

$10^{\square \pm \square}$ J *or* $10^{\square \ldots \square}$ J

Comments on page 2

Hey Sanjoy (and everyone) – I think the gravitational constant, G, has the wrong units listed in the handy numbers handout online. (It should have units of kg^-1*m^3*s^-2, not kg^-1*m^3*s^-1... that messed with my dimensional analysis a bit)