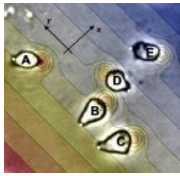
Physics 131-Physics for Biologists I



Professor: Wolfgang Losert
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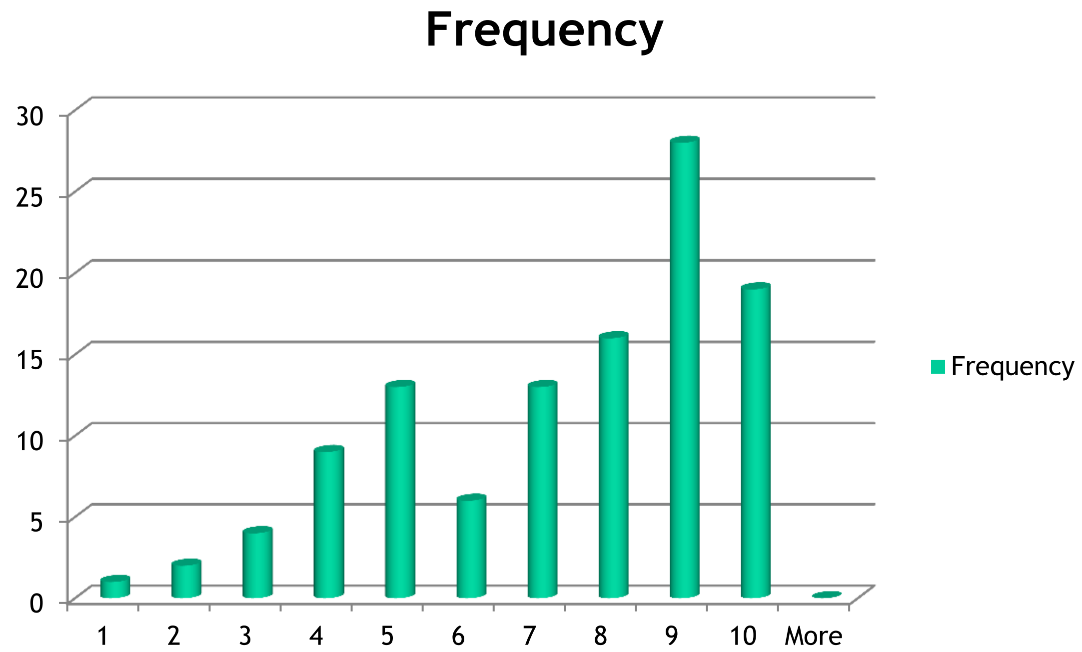
Final exam:

Wednesday December 18th 6.30pm-8.30pm

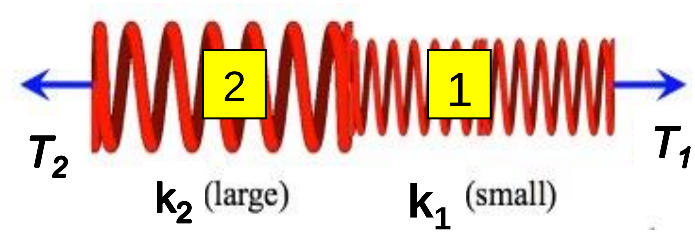
Average: 7.3



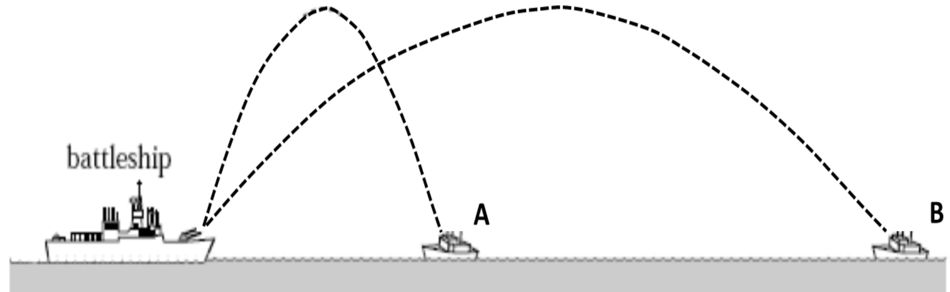
(4 pts) Two massive springs, are linked together and pulled from opposite ends by Tension forces T_1 and T_2. The spring constants are NOT the same: $k_2 >> k_1$. Both massive springs accelerate to the RIGHT as a result of the tension forces.

1a Consider the Tension forces T_1 and T_2

1b: Forces between springs 1 and 2



Problem 2



Problem 3

Protein 1 (a receptor) spreads over an area A_1 according to the following mathematical model: $A_1 = 4D\Delta t$.

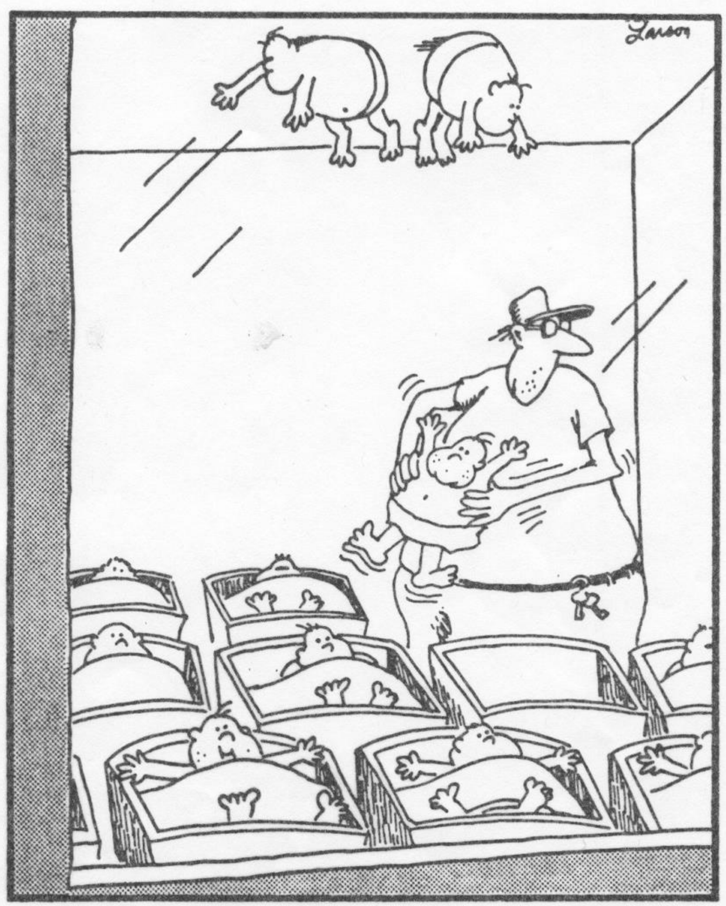
Protein 2 (a molecular motor with velocity v) covers an area A_2 following a different model: $A_2 = v^2(\Delta t)^2$

1. **If Δt is very large then A_1 is smaller than A_2**
2. If Δt is very large then A_2 is smaller than A_1
3. **The two areas will be the same for some time Δt**
4. For very large velocity v protein 2 always covers a larger area independent of Δt

Electrostatic forces

- Like charges repel, unlike charges attract.
- The algebraic sum of postive and negative charges is a constant (i.e, N_{+}- N_{-} = const.)

Which is stronger: Gravitational Forces or electrical Forces?



Late at night, and without permission, Reuben would often enter the nursery and conduct experiments in static electricity.

Consider two examples

1) For people

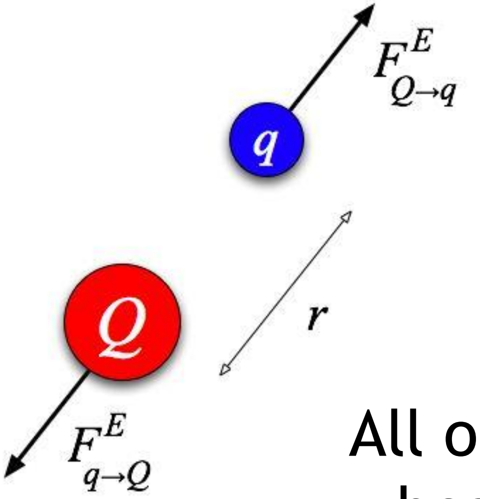
2) For molecules

Why is gravity stronger than typical electrical forces for “macroscopic” objects, but smaller for molecules and atoms?

(Whiteboard, TA & LA)

1) Electrical interactions have a shorter range than gravitational interactions.
2) Electrical forces are weaker than gravitational forces
3) **Another reason**

Positive and Negative charges cancel out in macroscopic objects



Electrical Forces: Coulomb's Law

All objects attract each other with a force whose magnitude is given by

$$\vec{F}_{q\to Q} = \frac{k_C qQ}{r_{qQ}^2}\hat{r}_{q\to Q}$$

k_C is put in to make the units come out right.

$$k_C = 9\times 10^9 \text{ N-m}^2/\text{C}^2$$

(Whiteboard, TA & LA)

Making Sense of Coulomb's Law

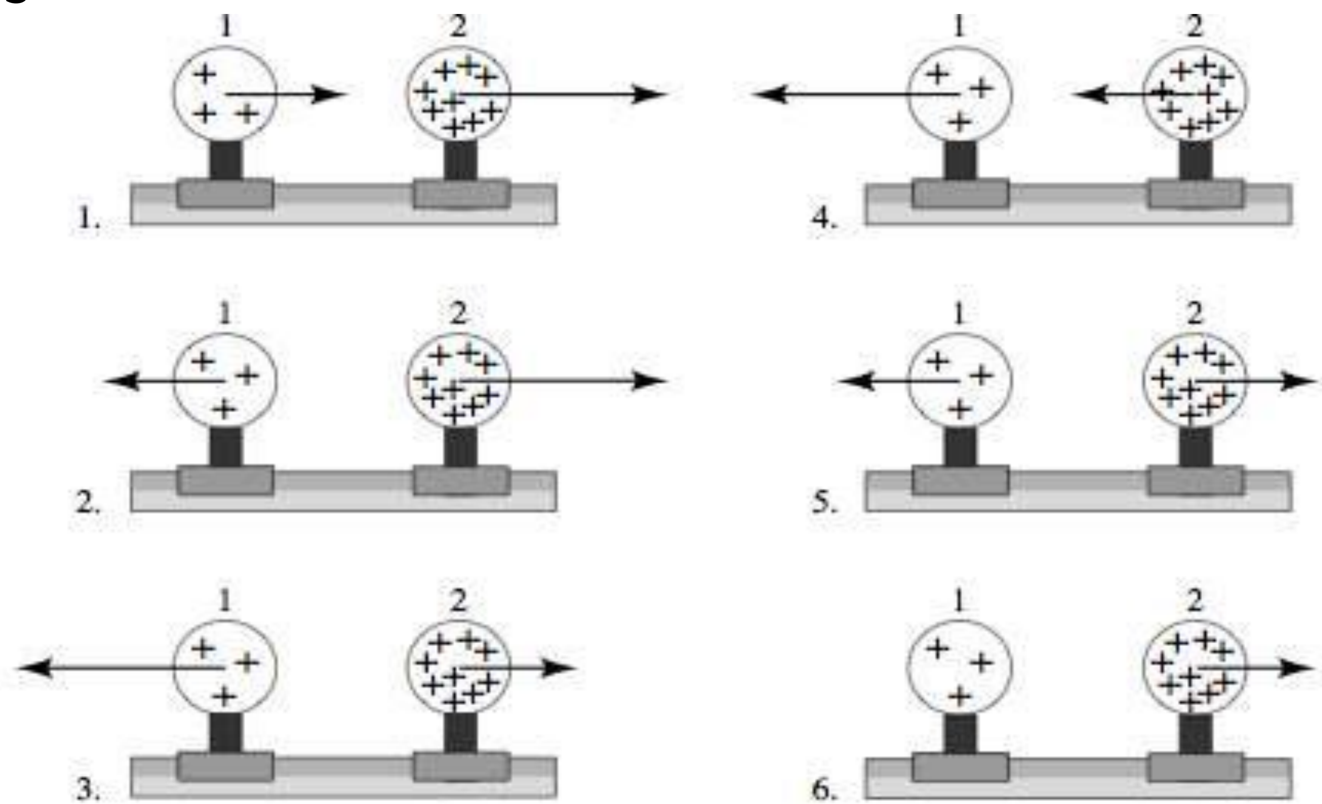
- Changing the test charge
- Changing the source charge
- Changing the distance
- Specifying the direction
- Use Subscripts!

$$\vec{F}_{Q\rightarrow q} = \frac{k_C q Q}{R^2}\hat{r}_{Q\rightarrow q}$$

Charge: A hidden property of matter

- Matter is made up of two kinds of electrical matter (positive and negative) that have equal magnitude and that cancel when they are together and hide matter’s electrical nature.
- Matter with an equal balance is called <u>neutral</u>.

Two uniformly charged spheres are firmly fastened to and electrically insulated from frictionless pucks on an air table. The charge on sphere 2 is three times the charge on sphere 1. Which force diagram correctly shows the magnitude and direction of the electrostatic forces



(5)

7. none of the above