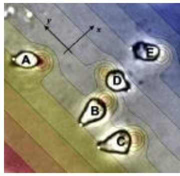
Physics 131-Physics for Biologists I



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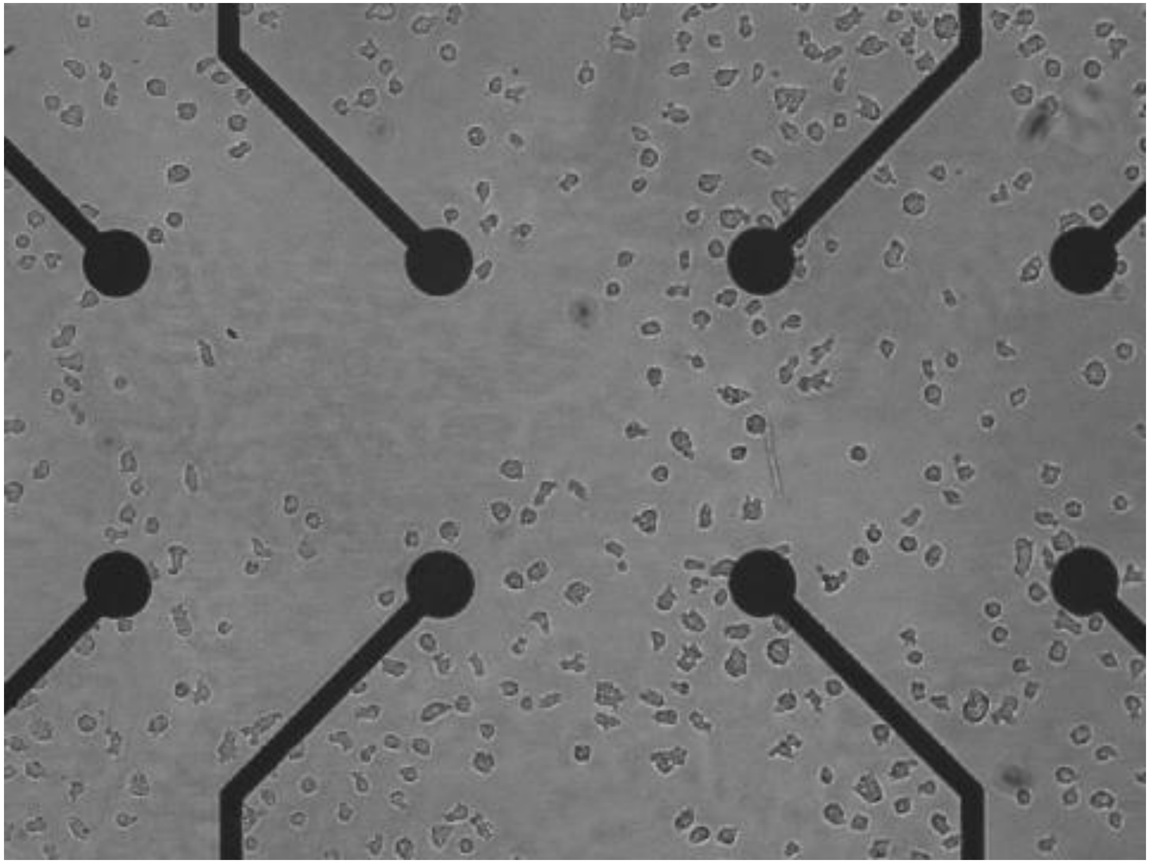
Electric Fields

Momentum



Fields

- A *field* is a concept we use to describe anything that varies in space. It is a set of values assigned to each point in space (e.g., temperature or wind speed).
- A *force field* is an idea we use for non-touching forces. It puts a force vector at each point in space, summarizing the effect of all objects that would exert a force on a particular object placed at that point.
- A *gravitational* or *electric field* is a force field with something (a "coupling strength") divided out so the field no longer depends on what test object is used.

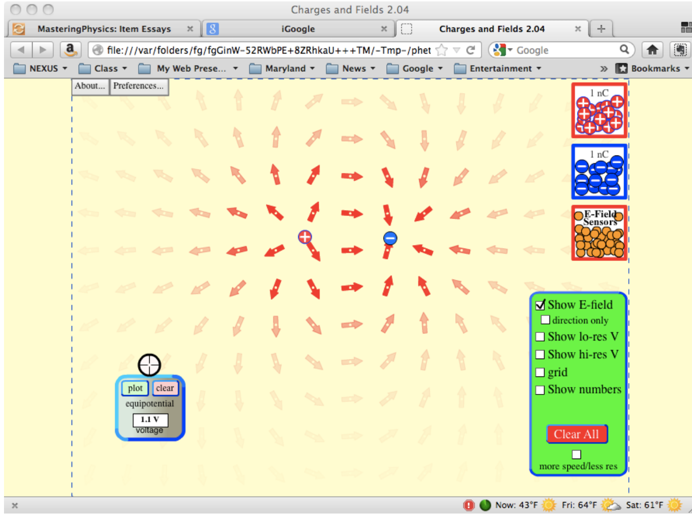
$$\vec{g} = \frac{\vec{F}_{\text{acting on } m}}{m} \qquad \vec{E} = \frac{\vec{F}_{\text{acting on } q}}{q}$$

Making sense

For one source charge

$$\vec{F}_q = \frac{k_C q Q_1}{r_1^2}\hat{r}_1 \qquad \vec{E} = \frac{\vec{F}_q}{q} = \frac{k_C Q_1}{r_1^2}\hat{r}_1$$

Notice that $E = F_q/q$ does NOT depend on *q*!



http://phet.colorado.edu/en/simulation/charges-and-fields

For many sources

$$\vec{F}_q = \frac{k_C q Q_1}{r_1^2}\hat{r}_1 + \frac{k_C q Q_2}{r_2^2}\hat{r}_2 + \frac{k_C q Q_3}{r_3^2}\hat{r}_3 + \ldots$$

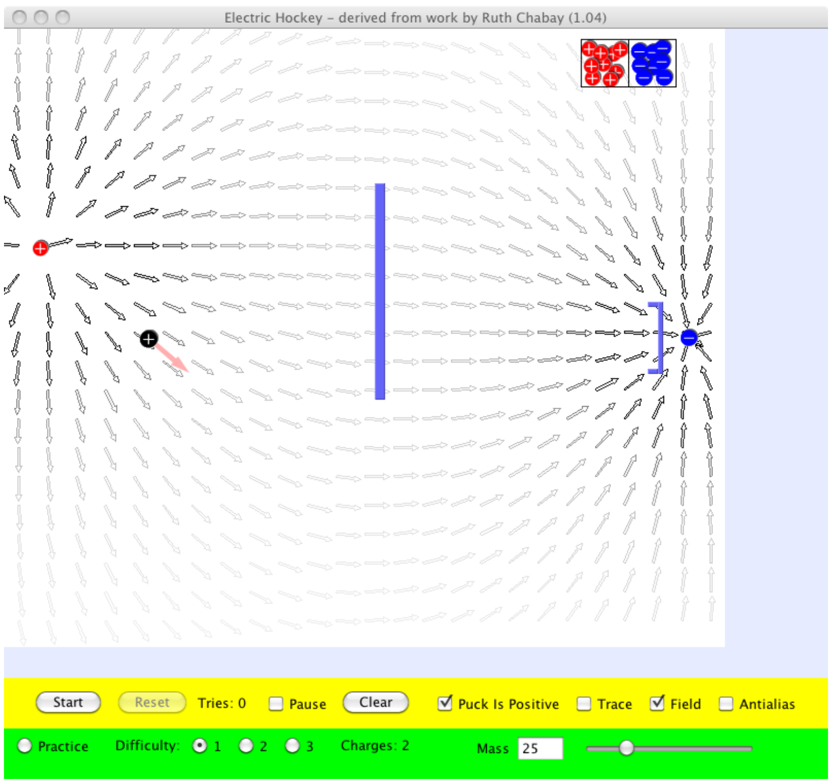
$$\vec{E} = \frac{\vec{F}_q}{q} = \frac{k_C Q_1}{r_1^2}\hat{r}_1 + \frac{k_C Q_2}{r_2^2}\hat{r}_2 + \frac{k_C Q_3}{r_3^2}\hat{r}_3 + \ldots$$

What is the direction & magnitude of the field at points A and B

(Whiteboard, TA & LA)

Electric Field Hockey

Sketch out an arrangement of charges that will bring the + charged puck into the goal



http://phet.colorado.edu/en/simulation/electric-hockey

Momentum

Momentum: Definition

Connecting motion more directly to Force

$$\vec{F}^{net} = m\vec{a} = m\frac{\Delta\vec{v}}{\Delta t} = \frac{\Delta\left(m\vec{v}\right)}{\Delta t}$$

Since mass m does not change with time

We define <u>momentum</u>: $\vec{p} = m\vec{v}$

Net Forces directly changes Momentum!

$$\vec{F}^{net} = \frac{\Delta\left(m\vec{v}\right)}{\Delta t} = \frac{\Delta\vec{p}}{\Delta t}$$

The Impulse-Momentum Theorem

$$\vec{F}^{net} = \frac{\Delta\vec{p}}{\Delta t}$$

- Multiply by Δt

$$\Delta\vec{p} = \vec{F}^{net}\Delta t$$

- Define Impulse

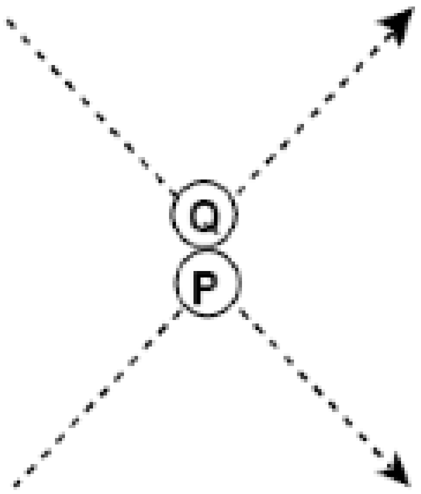
$$\vec{\mathscr{I}}^{net} = \vec{F}^{net}\mathrm{D}t$$

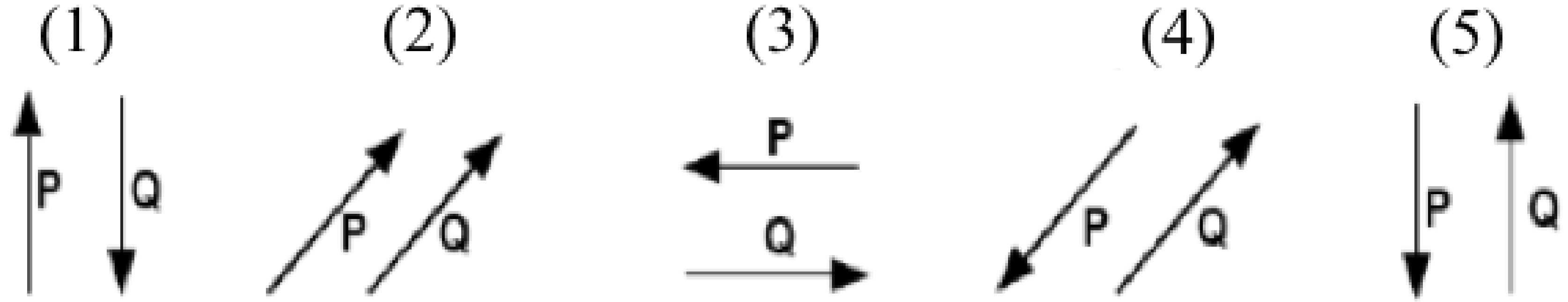
- Combine to get Impulse-Momentum Theorem

$$\mathrm{D}\vec{p} = \vec{\mathscr{I}}^{net}$$

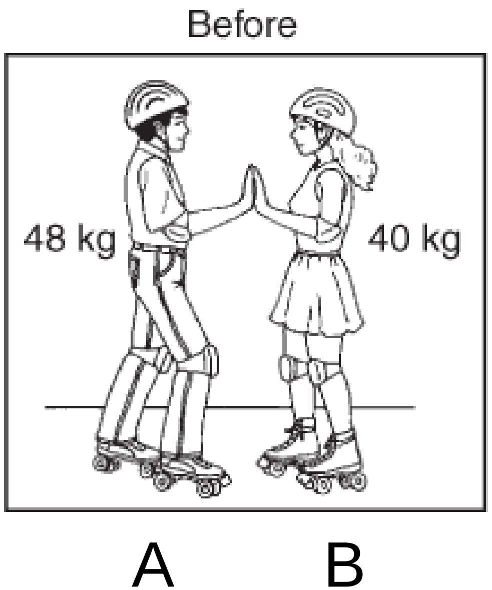
Whiteboard, TA & LA

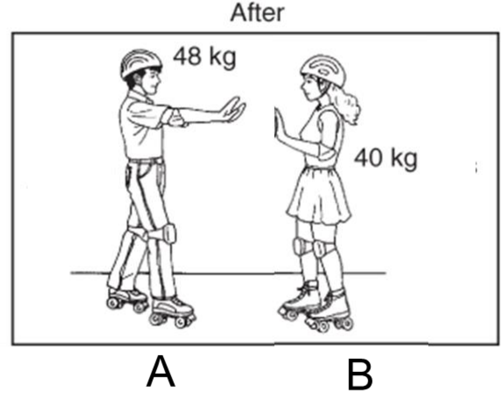
The diagram at the right depicts the path of two colliding steel balls rolling on a table. Which set of arrows best represents the direction of the change in momentum of each ball?

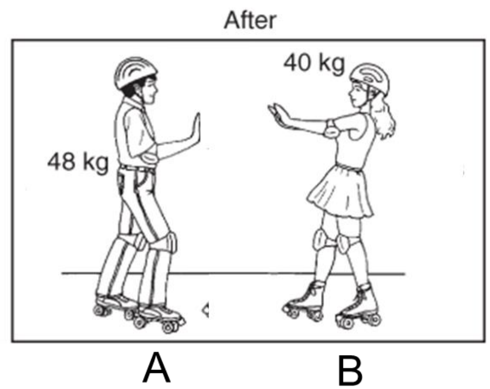




Whiteboard, TA & LA







1. Whoever gets pushed will reach a higher momentum *(magnitude)*
2. Whoever gets pushed will reach a higher speed
3. Whoever pushes will reach a higher momentum *(magnitude)*
4. Whoever pushes will reach a higher speed
5. Both A and B move with the same momentum *(magnitude)*
6. Both A and B move with the same speed