PHYS 1441 – Section 002
Lecture #11

Wednesday, Feb. 27, 2008
Dr. Jaehoon Yu

- Newton's Laws of Motion
  - Newton's third law of motion
- Exam problem discussions

Announcements

- Term exam results
  - Average score: 57.6/102
    - Equivalent to 56.5/102
  - Top score: 96/102
- Evaluation criteria
  - Two best of the three term exams: 12.5% each
  - Final exam: 25%
  - Homework: 25%
  - Lab: 15%
  - Quizzes: 10%
  - Extra Credit: 10%
- Colloquium today at 4:00pm in SH101
  - D.J.Larson from Larson Technical Solutions Inc. on Ecofusion

Physics Department
The University of Texas at Arlington

COLLOQUIUM

Ecofusion: An Electron-Cooled, Cellular Approach to Harnessing Fusion Power

Dr. D.J. Larson
Larson Technical Solutions, Inc

4:00 pm Wednesday, February 27, 2007
Room 101 SH

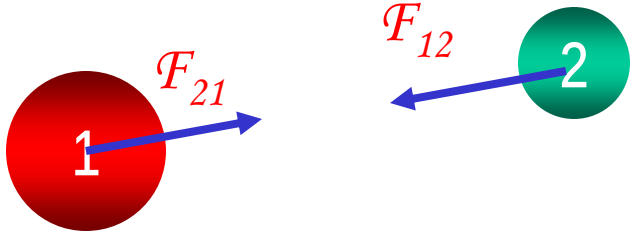
Abstract

A cellular electron-cooled storage ring system for achieving particle-beam fusion-based-energy is described. The system uses multiple electron-cooled, overlapping storage rings to enable colliding-beam fusion. Particles are continuously fed into the storage rings, and the electron cooling systems continuously correct the ion beam trajectories, compensating for various scattering events that occur in the system. This allows for large currents to be built up in the ion storage rings. The rate of fusion reactions that occur in the overlap regions between the storage rings can be increased by focusing to enable power outputs of interest for fusion-based power reactors. The system can be built with technology readily available today.

Refreshments will be served in the Physics Library at 3:30 pm

Newton's Third Law (Law of Action and Reaction)

If two objects interact, the force F_{21} exerted on object 1 by object 2 is equal in magnitude and opposite in direction to the force F_{12} exerted on object 2 by object 1.



$$\vec{F}_{12} = -\vec{F}_{21}$$

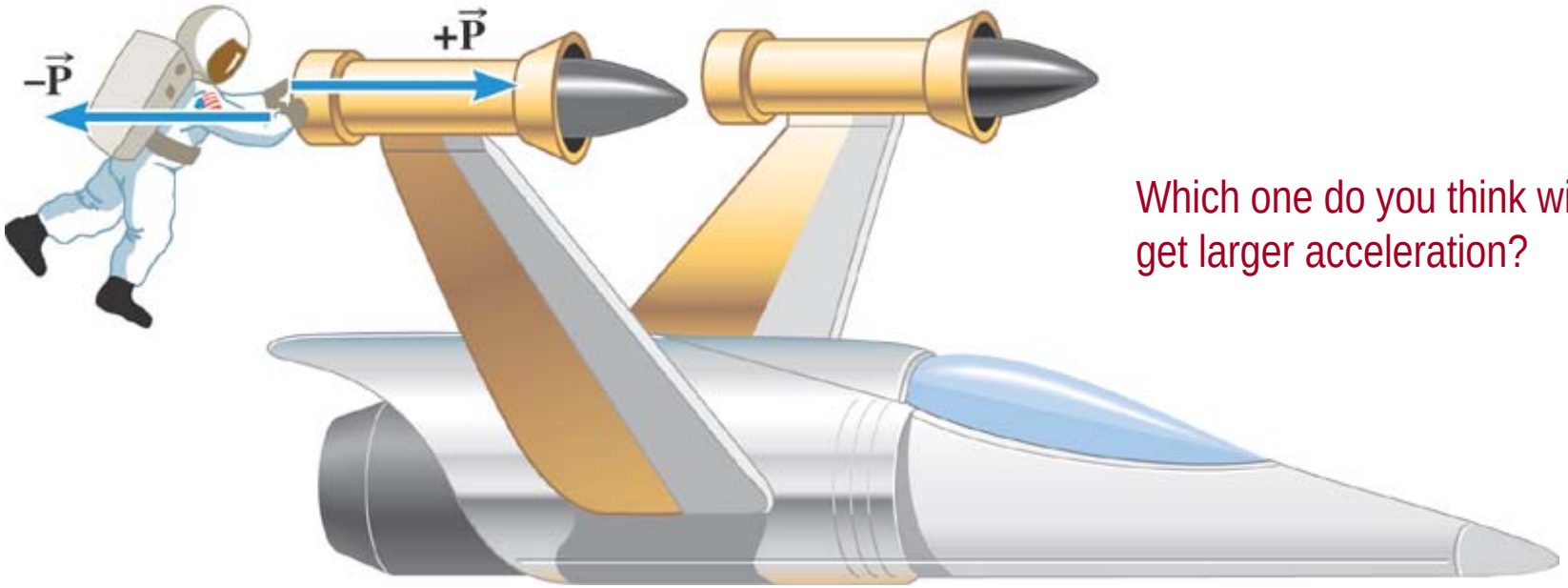
The action force is equal in magnitude to the reaction force but in opposite direction. These two forces always act ***on different objects***.

What is the reaction force to the force of a free falling object?

The gravitational force exerted by the object to the Earth!

Stationary objects on top of a table has a reaction force (called the normal force) from table to balance the action force, the gravitational force.

Ex. 4 The Accelerations Produced by Action and Reaction Forces



Which one do you think will get larger acceleration?

Suppose that the magnitude of the force is 36 N. If the mass of the spacecraft is 11,000 kg and the mass of the astronaut is 92 kg, what are the accelerations?

Ex. 4 continued

Force exerted on the space craft by the astronaut $\sum \vec{\mathbf{F}} = \vec{\mathbf{P}}.$

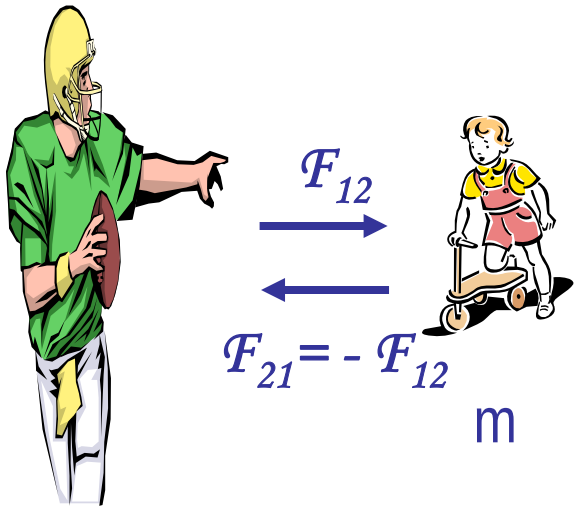
Force exerted on the astronaut by the space craft $\sum \vec{\mathbf{F}} = -\vec{\mathbf{P}}.$

space craft's acceleration $\vec{\mathbf{a}}_s = \frac{\vec{\mathbf{P}}}{m_s} = \frac{+36\ \text{N}}{11{,}000\ \text{kg}} = +0.0033\,\text{m/s}^2$

astronaut's acceleration $\vec{\mathbf{a}}_A = \frac{-\vec{\mathbf{P}}}{m_A} = \frac{-36\ \text{N}}{92\ \text{kg}} = -0.39\,\text{m/s}^2$

Example of Newton's 3rd Law

A large man and a small boy stand facing each other on frictionless ice. They put their hands together and push against each other so that they move apart. a) Who moves away with the higher speed and by how much?



$$\vec{F}_{12} = -\vec{F}_{21} \Rightarrow \left|\vec{F}_{12}\right| = \left|\vec{F}_{21}\right| = F$$

$$\vec{F}_{12} = m\vec{a}_b \Rightarrow F_{12x} = ma_{bx}, \quad F_{12y} = ma_{by} = 0$$

$$\vec{F}_{21} = M\vec{a}_M \Rightarrow F_{21x} = Ma_{Mx}, \quad F_{21y} = Ma_{My} = 0$$

Since $\vec{F}_{12} = -\vec{F}_{21}$ and $\left|\vec{F}_{12}\right| = \left|-\vec{F}_{21}\right| = F$

Establish the equation $\Rightarrow ma_{bx} = F = Ma_{Mx}$ Divide by m $\Rightarrow a_{bx} = \frac{F}{m} = \frac{M}{m}a_{Mx}$

Example of Newton's 3rd Law, cnt'd

Man's velocity

$$v_{Mxf} = v_{Mxi} + a_{Mx}t = a_{Mx}t$$

Boy's velocity

$$v_{bxf} = v_{bxi} + a_{bx}t = a_{bx}t = \frac{M}{m}a_{Mx}t = \frac{M}{m}v_{Mxf}$$

So boy's velocity is higher than man's, if M>m, by the ratio of the masses.

b) Who moves farther while their hands are in contact?

Boy's displacement

$$x_b = v_{bxi}t + \frac{1}{2}a_{bx}t^2 = \frac{M}{2m}a_{Mx}t^2$$

$$x_b = \frac{M}{m}\left(\frac{1}{2}a_{Mx}t^2\right) = \frac{M}{m}x_M$$

Man's displacement

Given in the same time interval, since the boy has higher acceleration and thereby higher speed, he moves farther than the man.