Phy 2053 Announcements

1. Hope you had an enjoyable Spring Break!
2. Reitze and Chan both away attending scientific conferences this week
   - American Physical Society March Meeting
     - http://www.aps.org/meetings/march/index.cfm
   - Laser Interferometer Gravitational-wave Observatory Collaboration meeting
     - http://www.ligo.org/
   - Office hours cancelled for this week
   - Reitze will begin lecturing next week
3. Professor Yelton leading the class today and Thursday
4. Webassign HW set #7 is due this Wednesday, March 18 before midnight

HITT RF Remote Login Procedure:

The radio channel number for this room is "07" (zero, seven).

It is STRONGLY recommended to login your remote for every class just to be sure it is on the correct radio channel and working before class.

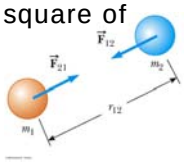
1. PRESS AND HOLD THE DOWN ARROW KEY until the GREEN light on the remote turns RED.
2. PRESS THE "0" KEY and you will see the RED light flash GREEN.
3. PRESS THE "7" KEY and you will see the RED light flash GREEN.
4. PRESS AND RELEASE THE DOWN ARROW KEY again and you will see the red light search for the receiver, if it BLINKS GREEN MULTIPLE TIMES you are logged in.

Newton's Law of Universal Gravitation (Redux)

- Every particle in Universe attracts every other particle with force:

  directly proportional to product of masses

  inversely proportional to square of distance between them.



$$F = G\frac{m_1 m_2}{r^2}$$

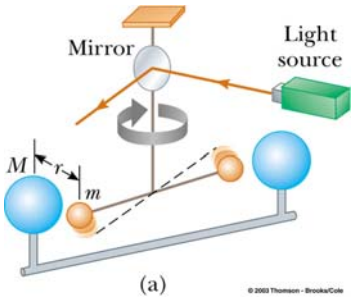
inverse square law

G = universal gravitational constant

$= 6.673 \times 10^{-11}\ N\ m^2/kg^2$

Determining the Gravitational Constant

- Determined experimentally
  - Torsion balance
- Henry Cavendish
  - 1798
- The light beam and mirror serve to amplify the motion



top 10 physics experiments

Applications of Universal Gravitation

The gravitational force of uniform sphere on particle outside sphere is *the same* as force exerted if entire mass of the sphere concentrated at its center (Gauss' Law)

Consequences

- g, acceleration due to gravity
- g will vary with altitude

$$g = G\frac{M_E}{r^2}$$

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TABLE 7.1

Free-Fall Acceleration g at Various Altitudes

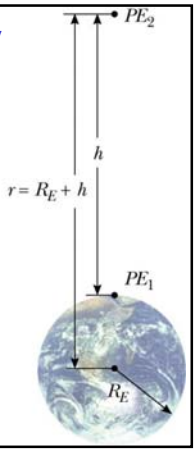
Altitude (km)[a]	g (m/s^2)
1 000	7.33
2 000	5.68
3 000	4.53
4 000	3.70
5 000	3.08
6 000	2.60
7 000	2.23
8 000	1.93
9 000	1.69
10 000	1.49
50 000	0.13

Gravitational Potential Energy

- PE = mgy is valid *only* near the earth's surface
- For objects high above the earth's surface, an alternate expression is needed

$$PE = -G\frac{M_E m}{r}$$

  - Zero reference level is infinitely far from the earth



Escape Speed

- Speed needed for an object "escape" from planet's gravitational pull
- Find by equating kinetic energy and gravitational potential energy
- Note, v is independent of the mass of the object

$$v_{esc} = \sqrt{\frac{2GM_E}{R_E}}$$

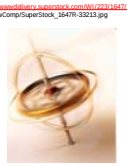
Determines Composition of Planetary Atmospheres!

TABLE 7.2
Escape Speeds for the Planets and the Moon

Planet	v_e (km/s)
Mercury	4.3
Venus	10.3
Earth	11.2
Moon	2.3
Mars	5.0
Jupiter	60.0
Saturn	36.0
Uranus	22.0
Neptune	24.0

Chapter 8

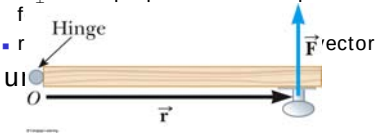
Rotational Equilibrium
and
Rotational Dynamics




http://www.arkansasskatium.com/figure/spin.jpg

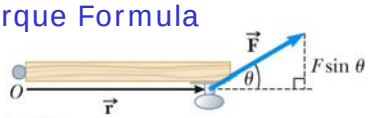
Torque

- Torque, τ, is the tendency of a force to rotate an object about some axis
  - $\tau = r F_\perp$
    - τ is the torque
      - Symbol is the Greek tau
    - $F_\perp$ is the perpendicular component of f
    - r
- SI ui

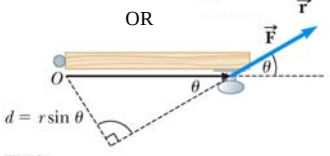


General Torque Formula

Component of F ⊥ r



OR



$\tau = r F \sin\theta$

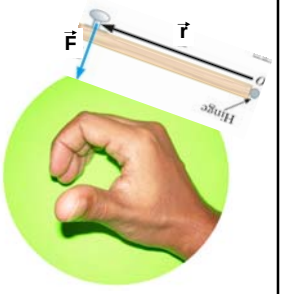
- The *lever arm*, *d*, is the perpendicular distance from the axis of rotation to a line drawn along the direction of the force

$d = r \sin\theta$ so $\tau = F d = F r \sin\theta$

The direction of a torque?

- Point fingers of your right hand in the direction of $\vec{r}$
- Curl your fingers toward the direction of vector $\vec{F}$
- Your thumb points in the direction of the torque

- When an applied force causes an object to rotate counterclockwise, the torque on the object is positive
- When an applied force causes an object to rotate clockwise, the torque on the object is negative



"Follow the thumb"

Torque and Equilibrium

- First Condition of Equilibrium
  - The net external force must be zero

$$\Sigma\vec{\mathbf{F}} = 0 \text{ or}$$

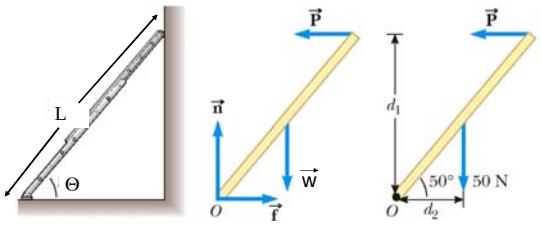
$$\Sigma\vec{\mathbf{F}}_x = 0 \quad \text{and} \quad \Sigma\vec{\mathbf{F}}_y = 0$$

- The Second Condition of Equilibrium states

The net external torque must be zero

$$\Sigma\vec{\tau} = 0$$

Example of a Free Body Diagram--Ladder



- free body diagram shows normal force and force of static friction acting on the ladder at the ground
- The last diagram shows the lever arms for the forces from axis of rotation at ground
- Pick axis and sum torques