Announcements

1. HW10 due April 15
2. Midterm2:

   exam and solution posted in course website

   if you want to look at your scantron, see Prof. Reitze before end of Tuesday

   If you forgot to bring ID during exam, you must see Prof. Reitze with your ID or your exam will not be graded.

3. Final exam:

   April 25, 10 am to noon

   roughly ½ of questions on topics covered in midterms,

   the rest on Chapters 9, 13, 14

Buoyant Force

- The magnitude of the buoyant force always equals the weight of the displaced fluid

$$B = \rho_{fluid} V_{fluid} g = w_{fluid}$$

- The buoyant force equation is the same for a totally submerged object of any size, shape, or density

Totally Submerged Object

$$B = \rho_{fluid} V_{fluid} g = w_{fluid}$$

$$mg = \rho_{object} V_{object} g$$

For completely submerged object:

$$V_{object} = V_{fluid\ displaced}$$

If $\rho_{object} < \rho_{fluid}$, $mg < B$

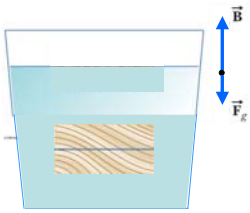
If $\rho_{object} > \rho_{fluid}$, $mg > B$

Floating Object

If $\rho_{object} < \rho_{fluid}$, $mg < B$ when object is fully submerged

$F_{net} = B - F_g > 0$

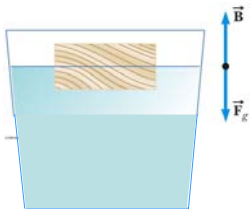
Object rises



Floating Object

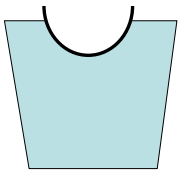
$$V_{object} \neq V_{fluid\ displaced}$$

- The forces balance
- $$\frac{\rho_{obj}}{\rho_{fluid}} = \frac{V_{fluid}}{V_{obj}}$$



Will it float?

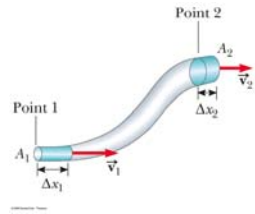
1. Concrete block
2. ✔ Concrete bowl
3. Iron cylinder
4. ✔ Wood cylinder
5. ✔ Water bottle



43. A 1.00-kg beaker containing 2.00 kg of oil (density = 916 kg/m^3) rests on a scale. A 2.00-kg block of iron (density = 7.86×10^3 kg/m^3) is suspended from a spring scale and is completely submerged in the oil. Find the equilibrium readings of both scales.

Equation of Continuity

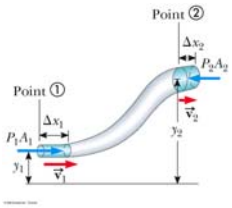
- $A_1v_1 = A_2v_2$
- The product of the cross-sectional area of a pipe and the fluid speed is a constant
  - Speed is high where the pipe is narrow and speed is low where the pipe has a large diameter
- Av is called the *flow rate (volume per time).*



Bernoulli's Equation

$$P + \frac{1}{2}\rho v^2 + \rho g y = \text{constant}$$

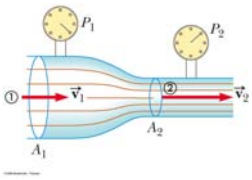
- States that the sum of the pressure, kinetic energy per unit volume, and the potential energy per unit volume has the same value at all points along a streamline



Just due to energy conservation

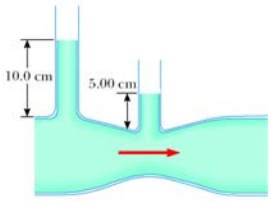
Applications of Bernoulli's Principle: Venturi Tube

- Shows fluid flowing through a horizontal constricted pipe
- Speed changes as diameter changes
- Can be used to measure the speed of the fluid flow
- Swiftly moving fluids exert less pressure than do slowly moving fluids



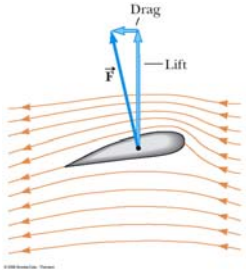
$$P + \frac{1}{2}\rho v^2 + \rho g y = \text{constant}$$

55. The inside diameters of the larger portions of the horizontal pipe depicted in Figure P9.55 are 2.50 cm. Water flows to the right at a rate of 1.80×10^{-4} m^3/s. Determine the inside diameter of the constriction.



Application – Airplane Wing

- The air speed above the wing is greater than the speed below
- The air pressure above the wing is less than the air pressure below
- There is a net upward force
  - Called *lift*
- Other factors are also involved



13. Vibrations and Waves

Found everywhere in the universe and in daily life.

- hearing and vision.
- Ultrasound diagnostics.

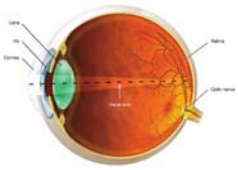


Image: Absorption, Transmission, and Reflection of ultrasound

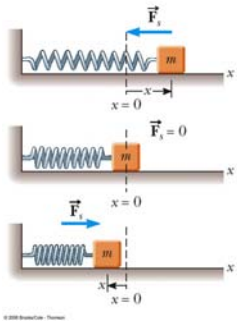
Vibrations and Waves

Hooke's law
F = -kx

1. Force is proportional to displacement from equilibrium position
2. Force always opposes x

F = -kx

1. Force always points towards the equilibrium position
2. It is called the **restoring force.**



Simple harmonic motion

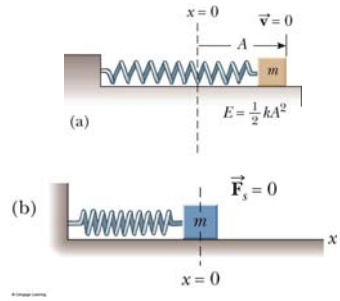
Simple harmonic motion

- Amplitude, A
  - The amplitude is the maximum position of the object relative to the equilibrium position
  - In the absence of friction, an object in simple harmonic motion will oscillate between the positions x = ±A

Time period T and frequency f

- The period, T, is the time that it takes for the object to complete one complete cycle of motion
  - From x = A to x = - A and back to x = A
- The frequency, f, is the number of complete cycles or vibrations per unit time
  - $f = 1 / T$
  - Frequency is the reciprocal of the period
  - Units are cycles per second (s^{-1}) or hertz (Hz)

Energy keeps going back and forth between kinetic and potential.



At x = A,
K.E = 0
P.E = ½ K A^2

At x = 0,
P.E. = 0
K.E. = ½ mv_2

- Conservation of Energy allows a calculation of the velocity of the object at any position in its motion

$$v = \pm\sqrt{\frac{k}{m}\left(A^2 - x^2\right)}$$

The ± indicates the object can be traveling in either direction