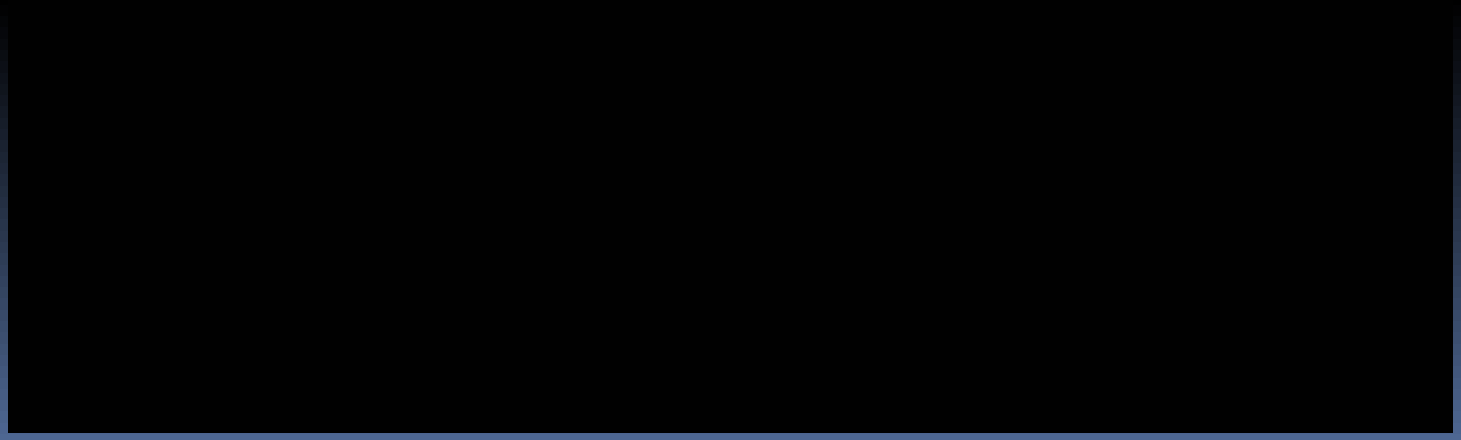
DEVIL PHYSICS
THE BADDEST CLASS ON CAMPUS

AP PHYSICS

GIANCOLI LESSON 10-7 BUOYANCY AND ARCHIMEDES' PRINCIPLE

Video: Archimedes Principle



Buoyancy

- Stuff floats
- Stuff in water seems lighter than stuff on land
- This is because the fluid is exerting a pressure on the object that opposes the gravity force (weight)
- Fluid pressure increases with depth
- When the fluid pressure equals the weight, the object will stop sinking

Buoyant Force

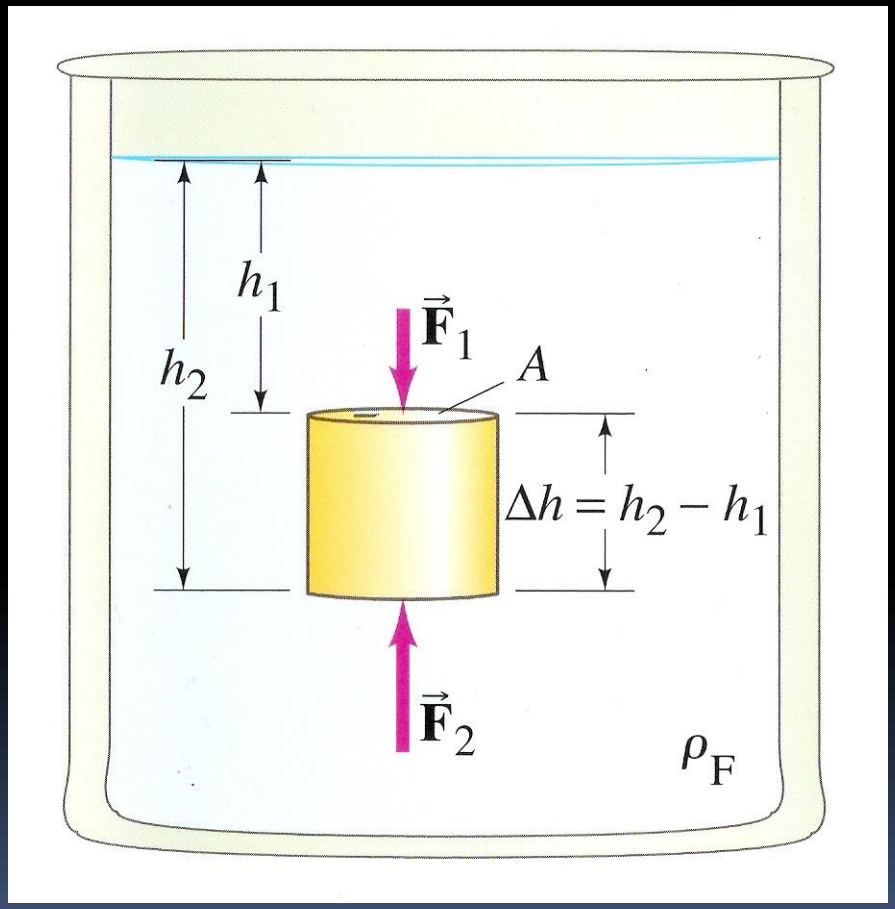
- The force of fluid pressure that opposes weight

$$P_1 = \rho_F g h_1$$

$$\frac{F_1}{A} = \rho_F g h_1$$

$$F_1 = \rho_F g h_1 A$$

$$F_2 = \rho_F g h_2 A$$



Buoyant Force

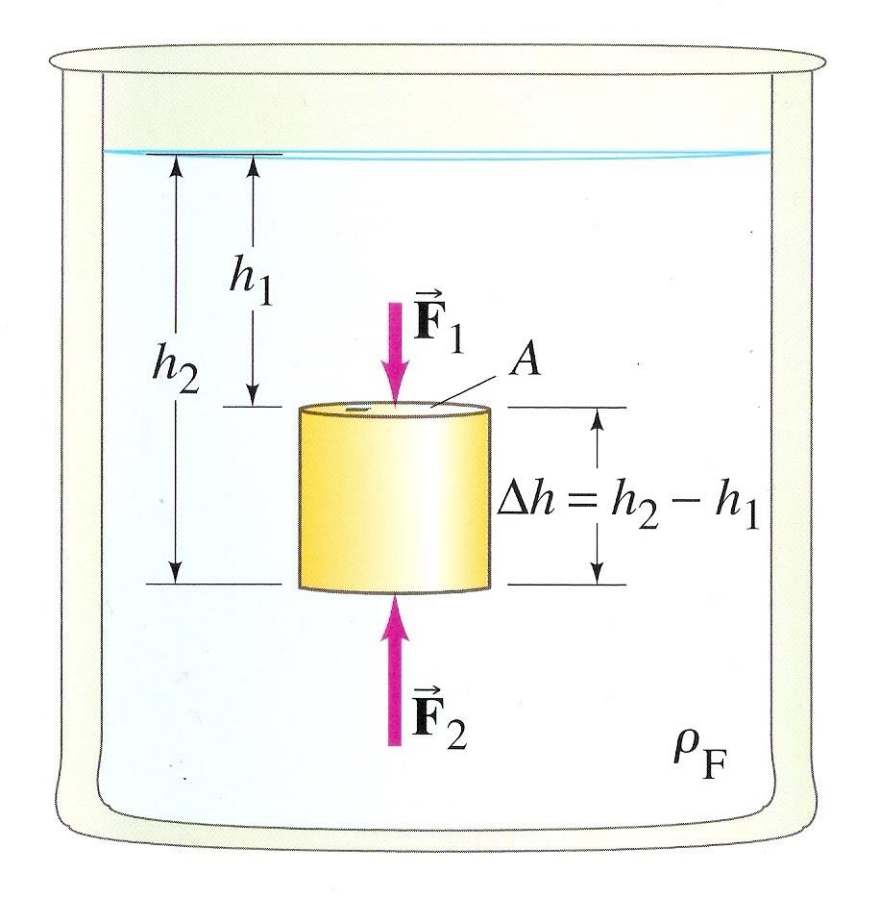
- The force of fluid pressure that opposes weight

$$F_1 = \rho_F g h_1 A$$

$$F_2 = \rho_F g h_2 A$$

$$F_{net} = F_2 - F_1$$

$$F_{net} = \rho_F g A (h_2 - h_1)$$



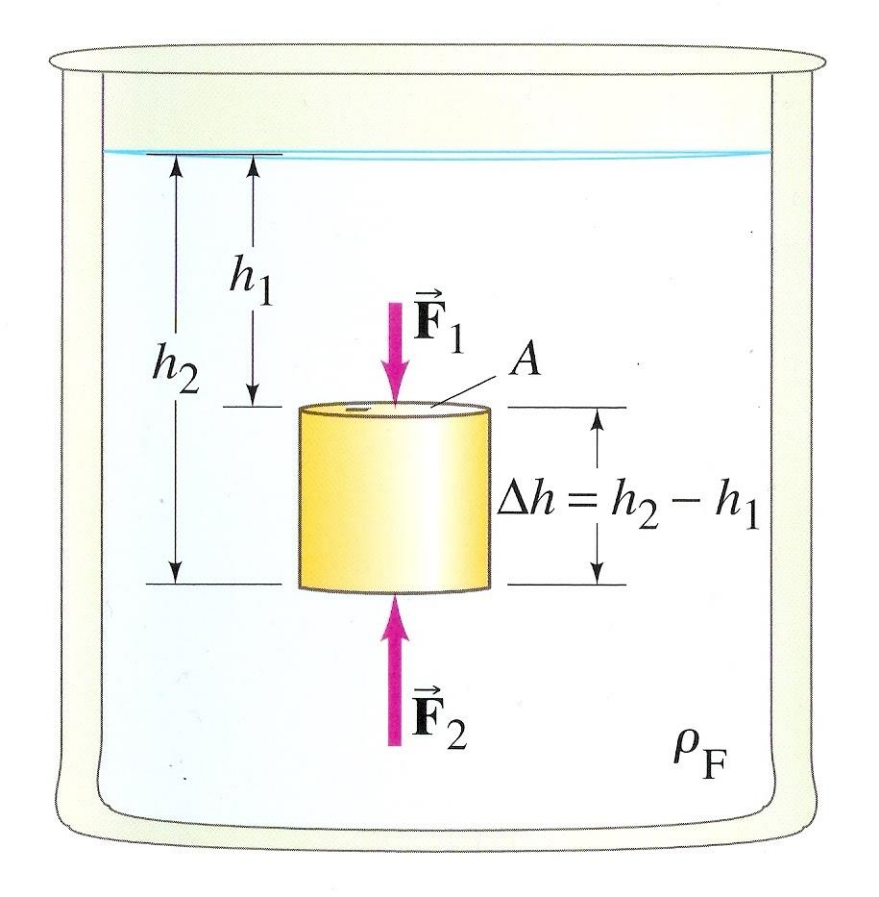
Buoyant Force

- The force of fluid pressure that opposes weight

$$F_{net} = \rho_F g A (h_2 - h_1)$$

$$F_{net} = \rho_F g A h_{cylinder}$$

$$F_{net} = \rho_F g V_{cylinder}$$

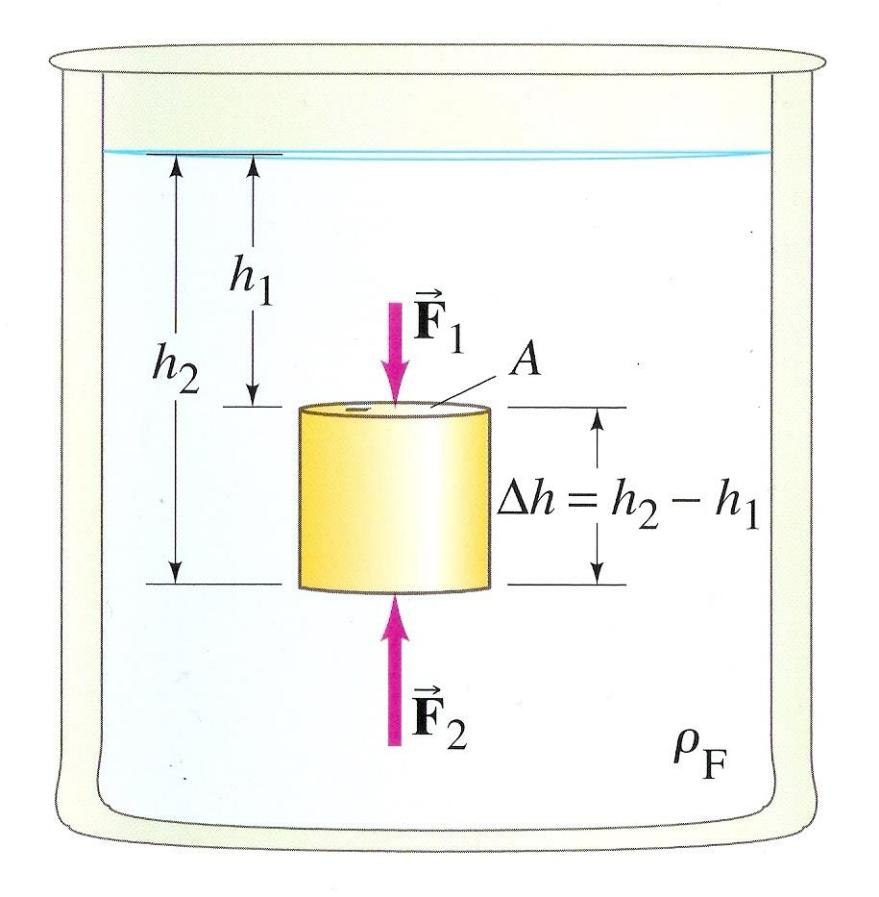


Buoyant Force

- The force of fluid pressure that opposes weight

$$F_{net} = \rho_F g V_{cylinder}$$

$$F_B = \rho_F g V_{cylinder}$$



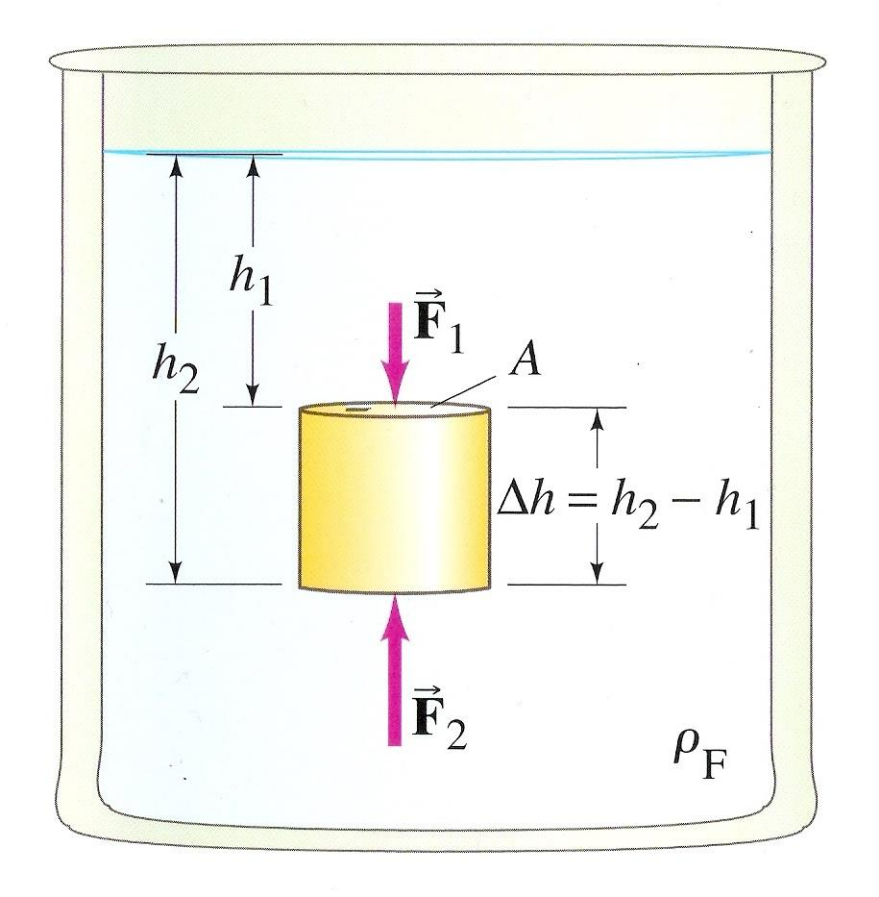
Archimedes' Principle

- The force of fluid pressure that opposes weight

$$F_{net} = \rho_F g V_{cylinder}$$

$$F_B = \rho_F g V_{cylinder}$$

- **The volume of the cylinder displaces the same volume of water that was there before the cylinder was immersed**



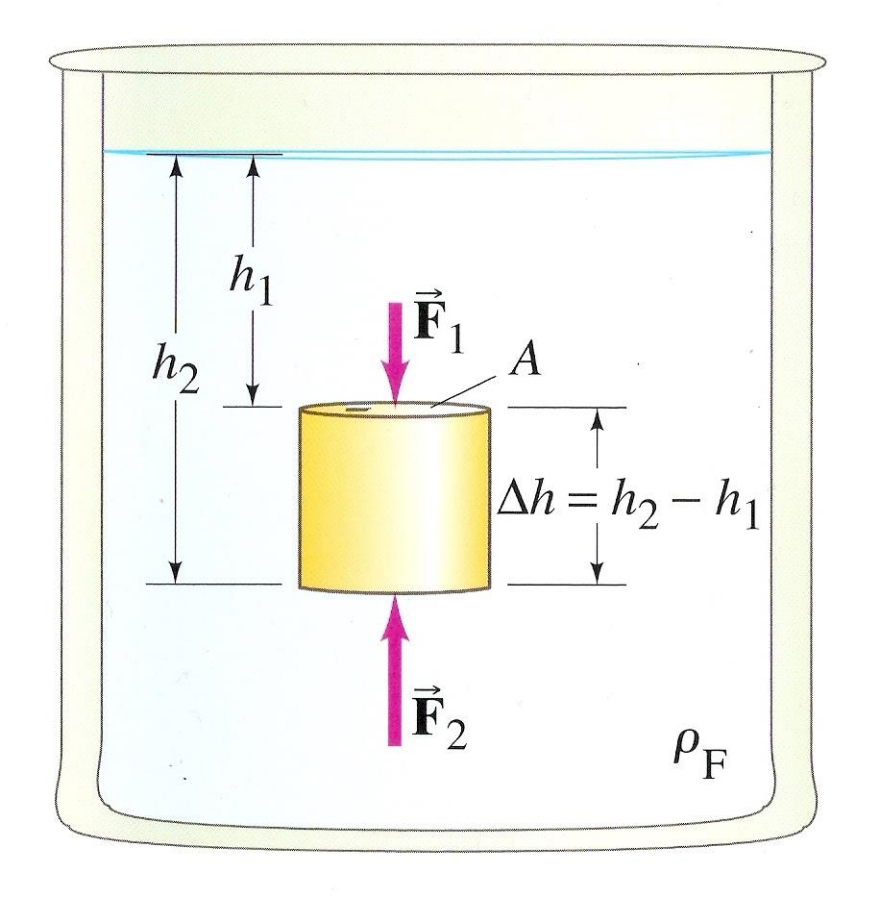
Archimedes' Principle

- The force of fluid pressure that opposes weight

$$F_{net} = \rho_F g V_{cylinder}$$

$$F_B = \rho_F g V$$

- ***The buoyant force on a body immersed in a fluid is equal to the weight of the fluid displaced by that object***



Sample Problem

- *An 180kg treasure chest sits 30m below the surface of the ocean. The dimensions of the chest are 0.6m x 0.4m x 0.4m. How much work will it take to bring it to the surface and then lift it 1.5m to the deck of the boat?*

Sample Problem

- ***An 180kg treasure chest sits 30m below the surface of the ocean. The dimensions of the chest are 0.6m x 0.4m x 0.4m. How much work will it take to bring it to the surface and then lift it 1.5m to the deck of the boat?***

$$W_{surface} = Fd_{surface}$$

$$F_{pull} = F_g - F_B$$

$$F_B = \rho_F g V$$

$$F_g = mg$$

Sample Problem

- ***An 180kg treasure chest sits 30m below the surface of the ocean. The dimensions of the chest are 0.6m x 0.4m x 0.4m. How much work will it take to bring it to the surface and then lift it 1.5m to the deck of the boat?***

$$W_{surface} = Fd_{surface}$$

$$F_{pull} = mg - \rho_F gV$$

$$F_{pull} = 82N$$

$$W_{surface} = 2.47x10^4\ J$$

Sample Problem

- ***An 180kg treasure chest sits 30m below the surface of the ocean. The dimensions of the chest are 0.6m x 0.4m x 0.4m. How much work will it take to bring it to the surface and then lift it 1.5m to the deck of the boat?***

$$W_{deck} = Fd_{deck}$$

$$F_{pull} = mg$$

$$F_{pull} = 1.77x10^{3}\,N$$

$$W_{deck} = 2.65x10^{3}\,J$$

Archimedes and the King's Crown

- The King asked Archimedes to determine whether his crown was pure gold or a fake
- Archimedes knew the specific gravity of gold and could determine the mass of the crown, but could not figure out how to determine the volume of the irregularly shaped crown
- One day when he got into the bathtub, the water spilled out over the sides

Archimedes and the King's Crown

- He realized that the increase in volume of the tub water was equal to his volume because his body was displacing the water
- If he could weigh the water that was displaced, he could use the density of water to determine the volume of the displaced water and thus determine the volume of his body
- The same could be done with the king's crown

Archimedes and the King’s Crown

- Let’s try it

Floating Objects

- An object floats on a fluid if its density is less than that of water
- An object sinks if its density is greater than that of water
- ***What is your specific gravity?***

Floating Objects

- An object floats on a fluid if its density is less than that of water
- An object sinks if its density is greater than that of water
- ***What is your specific gravity?***
  - ***1.003 to 1.030***

Floating Objects

- ***A log has a density of 0.6 x 10^3 kg/m^3 and has a mass of 1200kg.***
  - ***Prove that it will float.***
  - ***If it is held under water and then released, what will be its acceleration toward the surface?***

Floating Objects

- *A log has a density of 0.6 x 10^3 kg/m^3 and has a mass of 1200kg.*
  - *Prove that it will float.*
    - $F_{net} = \rho g V - mg$
    - $F_{net} = (1x10^3)(9.81)(1200/0.6x10^3) - (1200)(9.81)$
    - $F_{net} = 7848$
  - *If it is held under water and then released, what will be its acceleration toward the surface?*

Floating Objects

- *A log has a density of 0.6 x 10^3 kg/m^3 and has a mass of 1200kg.*
  - *Prove that it will float.*
    - $F_{net} = 7848$
  - *If it is held under water and then released, what will be its acceleration toward the surface?*
    - $F = ma$
    - $\frac{F}{m} = a = \frac{7848}{1200} = 6.54\, m/s^2$

QUESTIONS?

Homework

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