1 **Unit 6: Mass, Density, Weight, Buoyancy, Etc.**
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2 **Mass, Density & Weight**
Definitions

- Mass =
- Weight =
- Density =

3 **The Science of Everyday Gravity**
- What's *universal* about Newton's Universal Law of Gravitation?
- The Law:
- Why don't we ever notice the gravity between two objects?

4 **Cavendish's Torsion Balance**

6 **Gravity and Orbit**
Why are astronauts weightless in orbit?

7 **Density**

8 **Density**
- air ≅ 1 g/l
- water = 1 g/ml = 1 g/cm^3
  - –1-l bottles of air and water
- light metals ≅ 2-10 g/ml
- heavy metals ≅ 10-20 g/ml
- Hg = 13.6 g/ml
- Pb = 11.3 g/ml
- U = 19 g/ml
- Stainless Steel 7.8 g/ml

10 **Buoyancy**

12 **Buoyancy**
•Sink, Float or Neutral Buoyancy

14 **Buoyancy Examples**
- The hydrometer

15 **Buoyancy Examples**

16 **Buoyancy Examples**
- Weight of object = weight of fluid displaced
- $V\rho$ = (X%V) ρ_w
- ρ = X% ρ_w

17 **Buoyancy Examples**

ρ = X% ρ_w

20 **The Tip of the Iceberg**

22 **Icebergs**

27 **The Plimsoll Line**
- TF – Tropical Fresh Water
- F – Fresh Water
- T – Tropical Seawater
- S – Summer Seawater
- W – Winter Seawater
- WNA – Winter North Atlantic

28 **The Plimsoll Line**

29 **Buoyancy Examples**
- What is a KT explanation of buoyancy?

30 **Fish and Swim Bladders**
- Some fish regulate their buoyancy with an air bladder (sharks and rays swim or sink).
- Absent in fast-moving fish that ascend rapidly.
- Fish adjust amount of air through a gas gland.

34 **The Buoyant Effect of Air**
- Do humans weigh less because of the atmosphere?

37 **Buoyancy Examples**
- The Cartesian diver
- From *Titanic*: "This ship can't sink." "She's made of iron, sir. I assure you she can. And she will."
- Ice floats, so will the level of your drink increase or decrease when the ice melts? How about the total volume?
- A classic: You're in a boat in a swimming pool holding a bowling ball. Throw the bowling ball into the water. Does the water in the swimming pool rise or go down? What if you throw in a block of wood that floats?

38 **Bernoulli's Principle**
- Increased fluid velocity produces lower pressure.

39 **Bernoulli's Principle**

- Increased fluid velocity produces lower pressure.

40 **Bernoulli's Principle**

45 **Scaling**

- Strength to weight ratio

46 **Scaling**

- http://www.ftexploring.com/think/superbugs_p2.html

47 **Scaling**

- http://eesc.columbia.edu/courses/ees/life/lectures/lect03.html