PHYS 201L Archimedes’ Principle Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Partner(s):\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_Date:\_\_\_\_\_\_\_\_\_\_\_Time:\_\_\_\_\_\_\_\_\_\_\_\_

$F\_{b}=m\_{f}g$ or $F\_{b}=ρ\_{f}v\_{f}g$ Density of water = 1 g/cm3 = 1000 kg/m3.

Follow the following link, watch the video, and answer the questions below: <https://www.youtube.com/watch?v=eQsmq3Hu9HA>

1. Define mass using words, identify it as a vector or scalar, and state its SI unit.

1. Define weight using words, identify it as a vector or scalar, and state its SI unit.

1. What determines that an object will float or sink in a fluid?
2. State Archimedes’ principle.
3. Do the Horse problem from the video:

ARCHIMEDES' PRINCIPLE

Purpose: To verify Archimedes' principle and use it to determine the density of
 a) heavy solids     b) a light solid      c) a liquid

Apparatus: Electronic balance (0.1g) with weigh below hook, analytical balance (0.001g), ring stand, lab-jack, string loop, wooden block, Al block, steel block, brass weight, lead block, US coin nickel, 2-hydrometers, 2- graduated cylinders (500-ml), copper sulfate solution, beaker(250 ml), vernier caliper, and wiper paper.

Theory:
[Archimedes's principle](https://www.youtube.com/watch?v=eQsmq3Hu9HA) - The buoyant force acting on a partially or fully submerged object in a fluid is equal to the weight of the fluid it displaces.

$F\_{b}=m\_{f}g$ or $F\_{b}=ρ\_{f}v\_{f}g$ Density of water = 1 g/cm3 = 1000 kg/m3.

Procedure:

1) Set up the ring stand about a foot above the lab-table.

2) Attach the weigh-below-hook to the underside of the electronic balance and place it on the O-ring, and tare the scale.

3) Hang the aluminum block from the hook and measure its mass, which is the mass in air. Record this mass in the Data Table, next page.

4) Place the lab-jack under the hanging aluminum block and put the beaker with water on it.

5) Slowly raise the lab-jack and submerge the aluminum block in water.

6) Observe the reading of the electronic balance, as you submerge the block, and describe it below. Also explain what you observe.

|  |
| --- |
|  |

7) The scale reading when the block is fully submerged is the mass in water. Record this in the data table, next page.

8) Remove the aluminum block from the hook and put the beaker with water on top of the electronic balance, figure **a** above. Tare the scale, figure **b** above.

9) Hold the aluminum block above the beaker and slowly lower it and submerge it in water, while holding it, as shown in figure **c** above.

10) The scale reading will give the mass of the displaced water. Record this in the data table below.

11) Repeat the above measurements for other metals and complete Data Table I, below.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|   | Mass in air | Mass in water | 1Buoyant Force in grams | Mass of displaced water | %Difference | 2Volume   | MeasuredDensity | AcceptedDensity(g/cm3) | %Error |
| Al block |     |   |   |   |   |   |   | 2.7 |  |
| Steelblock |  |  |  |  |  |  |  | 7.8 |  |
| Brass block |     |   |   |   |   |   |   | 8.5 |  |
| Lead block |     |   |   |   |   |   |   | 11.3 |  |
| US coin3:Nickel |  |  |  |  |   |  |  | 8.9 |  |

1Buoyant force in grams = Mass in air - Mass in water.
2To find the volume of the metal block use Archimedes' principle and the fact that the density of water is 1 gram/cm3. $Buoyant force in grams=F\_{b}=ρ\_{f}v\_{f}.$
3Use an analytical balance with 0.001g accuracy.

P1. An iron casting with cavities has a mass of 550-g in air and a mass of 420-g in water. What is the total volume of all the cavities in the casting? The density of iron (that is, a sample with no cavities) is 7.87 g/cm3.

Density of a light solid (wooden block)

1) Find the mass of the wooden block using the electronic balance. Find the dimensions of the wooden block and calculate the volume of the wooden block. Use the mass and volume to calculate the density of the wooden block.

Mass = \_\_\_\_\_\_\_\_    Length = \_\_\_\_\_\_\_\_\_    Width = \_\_\_\_\_\_\_\_\_    Height = \_\_\_\_\_\_\_\_\_\_\_

Volume = \_\_\_\_\_\_\_\_\_\_    Density = \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2) Now you will find the volume of the wooden block using Archimedes' principle. Tie the wooden block with the string loop and hang the lead-sinker.

3) Find the buoyant force when the lead-sinker is in water while the wooden-block is in the air.

4) Find the buoyant force when both are in water.

5) Data from 3) and 4) above can be used to find the volume of the wooden-block.

        Buoyant force when the lead-sinker is in water     = \_\_\_\_\_\_\_\_\_\_\_\_

        Buoyant force when both are submerged in water = \_\_\_\_\_\_\_\_\_\_\_\_

        Buoyant force on the wooden block                    =\_\_\_\_\_\_\_\_\_\_\_\_\_

        Volume of the wooden block                               = \_\_\_\_\_\_\_\_\_\_\_\_

    % Difference for volume (between 1) and 5) above) = \_\_\_\_\_\_\_\_\_\_\_

P2. The density of ice is 917 kg/m3 and the density of seawater is 1025 kg/m3. A swimming polar bear climbs onto a piece of floating ice that has a volume of 5.2 m3. What is the weight of the heaviest bear that the ice can support without sinking completely beneath the water? (start with a FBD for the floating ice)

Density of a liquid

1. Describe the construction of a hydrometer and explain its operation.

2. Use a hydrometer and measure the density of water and CuSo4 solution in g/cm3:

    Density of water = \_\_\_\_\_\_\_\_\_\_\_\_    Density of CuSo4 solution = \_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Using Archimedes’ principle:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Buoyant force in water1 | Volume of object | Buoyant force in CuSO4 | Mass of CuSO4 displaced | Density of CuSO4 |
| Aluminum block |  |  |  |  |  |
| Steel block |  |  |  |  |  |
| Brass block |  |  |  |  |  |
|   Average density of CuSO4 |  |
|   Density of CuSO4 using hydrometer |  |
|   % Difference |  |

1Copy the data from the first data table.

Overall Conclusion for the entire lab, as it relates to the purpose.