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Density chart of metals

4-4 Density Density is the amount of matter in a given unit of volume. It can be measured in grams per cubic centimeter (g/cm3).   It is a measure of how tightly packed the atoms of a substance are. When we say that ice is less dense than water, we mean that the water molecules are more tightly packed when they are in the liquid state. The formula for determining density is   or One always hears that muscle is denser that fat. This means that I can work out, not lose weight and still lose inches off my waist. This is because 1 pound of muscle will take up less space than 1 pound of fat. Mass is typically measured in grams. Volume is typically measured in ml which is the same thing as cm3 (or cubic centimeters of cc.   1 ml = 1 cm3 = 1 cc) The density of water is 1.00 g/ml. The density of some common elements are shown below: Densities of selected elements   element density (g/cm3) appearance aluminum 2.70 silvery white, metallic antimony 6.68 silvery white, metallic cadmium 8.64 silvery white, metallic carbon (graphite) 2.25 black, dull chromium 7.2 steel gray, hard cobalt 8.9 silvery gray, metallic Copper Gold 8.92 19.3 reddish, metallic yellow, metallic iron 7.86 silver, metallic lead 11.3 silvery-bluish white, soft, metallic manganese 7.2 gray pink, metallic Nickel Platinum 8.9 21.4 silver, metallic silver, metallic silicon 2.32 steel gray, crystalline silver 10.5 silver, metallic tin (gray) 5.75 gray tin (white) 7.28 white metallic Zinc 7.14 bluish white, metallic Sample problem: A solid has a mass of 128 g. It is a rectangular solid 1.0 cm by 2.0 cm by 3.0 cm. What is the density of the solid and what metal is it? Volume = length x width x height = 1 cm x 2 cm x 3 cm = 6 cm3 or 6 ml. D= M/V = 128 g / 6 ml= 21.4 g/ml The metal must be platinum! One can see the usefulness of densities for determining types of metals at this web site: Note: This technical information is supplied as a courtesy by BoltPort. We do not undertake any responsibility for the accuracy of the data and its application on field. This is strictly for reference. This site uses cookies from Google to deliver its services and to analyze traffic. Information about your use of this site is shared with Google. By using this site, you agree to its use of cookies. 1224 1632 Olivia Huels Olivia Huels2021-06-11 14:01:332021-08-12 14:29:20SoFi Stadium 3000 4500 Olivia Huels Olivia Huels2021-04-12 14:03:072021-04-12 14:03:07VCU Institute for Contemporary Art 857 1286 Olivia Huels Olivia Huels2021-03-17 09:53:492021-03-17 10:31:27Amherst College Science Center 2659 4500 Olivia Huels Olivia Huels2021-03-05 14:11:372021-03-10 15:44:46Wynwood GaragePHOTO BY TEX JERNIGAN | ARKO © A. ZAHNER COMPAN 3000 4500 Olivia Huels Olivia Huels2021-02-26 14:48:392021-02-26 14:48:39Exploratory Hall at George Mason University 1920 2880 Olivia Huels Olivia Huels2020-12-18 14:45:492021-07-14 12:23:24Hayward Field Tower 1665 2500 Olivia Huels Olivia Huels2020-11-04 11:22:342021-06-25 14:39:28Brickell FlatironPhoto by Pierre Girad | ARKO 1666 2500 Winifred Wright Winifred Wright2020-07-28 11:38:022021-07-13 16:20:53350 Sparks 1666 2500 Winifred Wright Winifred Wright2020-07-25 17:30:542021-04-12 14:46:02Kravis Bench 1666 2500 Winifred Wright Winifred Wright2020-07-24 17:19:342021-06-25 14:35:22Starbucks Reserve® Roastery The density of an object is the object's mass divided by its volume. The density is characteristic of the material that the object is made of, and its value can help to identify the material. Except for objects with simple shapes, it is difficult to determine the volume directly. A simple way to determine the density of a metal object is to weigh it in air and then weigh it again when it is immersed in a liquid, as explained in the section The science behind density measurements. Water is the most convenient liquid to use, but if an object cannot be immersed in water, then organic solvents such as ethanol or acetone can be used. The density of the object can be calculated from the two weight measurements and the density of the liquid. With the right balance and the right size container, this method can be used on a variety of objects: large or small, metal or non-metal. The method works for complicated shapes, even objects with holes through them, as long as the liquid can penetrate and fill the holes. Once the density is determined, it can be compared to densities of known materials to help narrow down what the object might be made of. This Note describes the procedure and the required materials for determining the density of a metal object. The first step is to carry out the procedure on one or more metal objects of known composition, either a pure metal or an alloy, to gain experience using the method and to confirm that it is being used correctly. Then the density of unknown metals can be determined. Small metal objects that can be immersed in water Balance with below balance weighing capability (that is, can weigh objects suspended underneath it) and that can measure to a resolution of at least 0.01 grams (see the section Balance without below balance weighing capability for how to adapt the procedure for weighing below the balance) Metal wire to attach to hook inside balance (a bent paperclip works well) Support stand or platform to hold the balance so objects can be hung underneath it from the hook Beakers large enough so that the objects can be totally immersed without the liquid overflowing Supports to hold the beakers at the correct height underneath the balance Tap water Calculator   Nylon thread (e.g. fishing line or an equivalent lightweight material) for suspending the objects under the balance Disposable nitrile gloves Optional: Clamps to attach the balance support to the edge of a counter Remove the cover from the underside of the balance to expose the hook inside. Place the balance on a support with a hole that allows access to the internal hook. Attach a wire hook to the internal hook and then tare the balance (set it to zero). Hang an object on the hook beneath the balance using nylon thread or equivalent and weigh it in air. Wear gloves when handling metal objects, especially those suspected of containing lead. Fill the beaker with water and place it under the balance. Lift the beaker until the object is completely immersed. Place a support under the beaker to hold it at the correct height. Make sure there are no bubbles trapped under the object or in voids within the object. Weigh the immersed object. Calculate the density using the equation below. Compare the calculated density with the known densities of metals and alloys, using the table given below or the more comprehensive lists available in the references. Repeat steps 4–9 with the remaining objects. The density ρ of an object or a material is defined as the mass m divided by the volume V; in symbols, ρ = m/V. If the object is weighed in air to determine its actual mass and weighed in a liquid to determine its (apparent) mass in the liquid, then the density of the object is given by: The density of water is 0.998 g/cm3 at 20°C and 0.997 g/cm3 at 25°C. Figure 1 shows examples of eight different metal samples used to demonstrate this procedure. © Government of Canada, Canadian Conservation Institute. CCI 120260-0358 Figure 1. Metal objects used to demonstrate the procedure. The measured densities of the metal samples in Figure 1 are provided below. In the top row, from left to right: Probably cast iron (7.13 g/cm3) High purity aluminum (2.70 g/cm3) Reddish copper alloy (possibly 85% copper and 15% zinc, 8.23 g/cm3) High purity copper (8.88 g/cm3) In the bottom row, from left to right: Cast zinc (alloy unknown, 7.09 g/cm3) High purity lead (11.20 g/cm3) High purity tin (7.27 g/cm3) Yellow cartridge brass (70% copper and 30% zinc, 8.45 g/cm3) In each sample, the density was determined from the above formula. For example, for the aluminum object (b) the mass was found to be 110.18 g in air and 69.45 g in water, giving a density of 2.70 g/cm3. For the cast iron object (a), the mass was 209.47 g in air and 180.13 g in water, giving 7.13 g/cm3. For the lead object (f), the mass was 102.44 g in air and 93.31 g in water, giving 11.20 g/cm3. The measured densities of aluminum, cast iron and lead (2.70, 7.13 and 11.20 g/cm3) are close to the known densities (2.71, 7.20 and 11.33 g/cm3 from Table 1). The aluminum and lead objects are, thus, easily identified by the density. For the cast iron object, the density alone is not enough to rule out other metals, such as zinc (known density 7.13 g/cm3). When the density of an unknown metal falls close to several metals and alloys (e.g. zinc, iron and tin), then other properties, such as magnetism and colour, will need to be determined to help identify it. The known density of selected metals and alloys is given in Table 1, listed in order of increasing density (ASTM 2006, Lide 1998). Table 1: known density of selected metals and alloys Metal or alloyDensity (g/cm3) Aluminum 2.71 Aluminum alloys 2.66–2.84 Zinc 7.13 Iron (grey cast) 7.20 Tin 7.30 Steel (carbon) 7.86 Stainless steels 7.65–8.03 Brass (cartridge: 70% copper, 30% zinc) 8.52 Brass (red: 85% copper, 15% zinc) 8.75 Nickel silver (65% copper, 18% nickel, 17% zinc) 8.75 Bronze (85% copper, 5% tin, 5% zinc, 5% lead) 8.80 Nickel 8.89 Copper 8.94 Silver 10.49 Lead 11.33 Gold 19.30 A balance with below balance weighing capability usually comes with a cover under the internal hook. Figure 2 shows an example of the location of the cover on the bottom of a balance. © Government of Canada, Canadian Conservation Institute. CCI 120260-0359 Figure 2. Balance with below balance weighing capability. Figure 3 shows an expanded view with the cover closed; in Figure 4, the cover is rotated open to reveal the internal hook. © Government of Canada, Canadian Conservation Institute. CCI 120260-0360 Figure 3. Detail of underside of balance, showing the movable metal lid covering the internal hook. © Government of Canada, Canadian Conservation Institute. CCI 120260-0361 Figure 4. Detail of underside of balance, showing the internal hook after the metal lid has been rotated. Figure 5 shows a metal wire bent to form hooks on both ends. Figure 6 shows the hook on one end of the wire attached to the internal hook inside the balance. © Government of Canada, Canadian Conservation Institute. CCI 120260-0363 Figure 5. Wire with ends bent into the shape of a hook. © Government of Canada, Canadian Conservation Institute. CCI 120260-0362 Figure 6. Detail of wire bent into hooks at either end. The top end of the hook is attached to another hook inside the balance. Figure 7 shows the balance being placed over a Plexiglas stand with a hole cut in the top. The hole allows access to the hook on the underside of the balance. © Government of Canada, Canadian Conservation Institute. CCI 120260-0365 Figure 7. Balance being placed on a Plexiglas stand with the hook about to pass through the hole in the stand. Figure 8 shows the balance on a Plexiglas stand with a rectangular coupon of pure copper being weighed in air. Figure 9 shows the balance on a Plexiglas stand with a rectangular coupon of pure copper being weighed in water. A smaller Plexiglas stand is used to support the beaker at the correct height. © Government of Canada, Canadian Conservation Institute. CCI 120260-0366 Figure 8. Rectangular coupon of pure copper being weighed in air. © Government of Canada, Canadian Conservation Institute. CCI 120260-0367 Figure 9. Rectangular coupon of pure copper immersed in water. Figure 10 shows an example of an object with an opening that has trapped air bubbles. Be careful not to trap air bubbles in the object as this will result in an inaccurate reading. © Government of Canada, Canadian Conservation Institute. CCI 120260-0375 Figure 10. Three air bubbles trapped in an opening. If it is not appropriate to immerse an object in water, such as iron because it is so susceptible to rusting, then an organic solvent such as acetone or anhydrous ethanol can be used. Proper ventilation and appropriate personal protective equipment needs to be used. Refer to the safety data sheet (SDS) of the specific solvent for the recommended equipment. The density of acetone is 0.790 g/cm3 and the density of anhydrous ethanol is 0.789 g/cm3, both at 20°C. For someone who might need to use one of these other liquids, try measuring the density to place the object in a liquid and measure the volume of liquid displaced. This can be used on small objects that fit into a graduated cylinder, for example, to decide if the object is made of lead or a less dense metal. The procedure is as follows. Find a graduated cylinder with a diameter not much larger than the object. Determine the mass of the object with a suitable balance. Add water to the graduated cylinder, and record the initial volume. Submerge the object fully in the water, being careful to avoid bubbles, and then record the volume a second time. The volume of the object is equal to the difference in the final and initial volumes read from the graduated cylinder, and the density is the mass divided by the volume of the object. As an example, a figurine of a moose was measured. The mass was 4.088 g. Figure 13 shows the figurine outside the graduated cylinder, and Figure 14 shows it immersed. The water in the graduated cylinder rose from 5.0 mL to 5.6 mL when the figurine was immersed, giving a change in volume of 0.6 mL. Ignoring any errors in measuring the volume, the density is calculated to be 4.088 g / 0.6 mL = 6.8 g/cm3. (Note: 1 mL = 1 cm3.) That is less than the density of zinc and could suggest an alloy of zinc and a lighter metal, perhaps magnesium or aluminum. But given the small volume, there are uncertainties in the measurement. The volume can be measured only to the nearest 0.1 mL with the graduated cylinder used, so the volume could be between about 0.5 mL and 0.7 mL. Thus the density could be anywhere from 4.088 g / 0.7 mL = 5.8 g/cm3 to 4.088 g / 0.5 mL = 8.2 g/cm3. From this range of measurements, the figurine could be zinc, iron, tin, steel or other alloys, but it is not pure aluminum or pure lead. In fact, analysis showed it to be tin, which has a density of 7.30 g/cm3. © Government of Canada, Canadian Conservation Institute. CCI 120260-0374 Figure 13. Small metallic object before immersing in water in a 25 mL graduated cylinder. Note the level of the water. © Government of Canada, Canadian Conservation Institute. CCI 120260-0374 Figure 14. Small metallic object after immersing in water in a 25 mL graduated cylinder. The level of the water is about 0.6 mL more than before the object was immersed. The above procedures can be used for more than just identifying metals through their density. In casting a sculpture, one needs to estimate the amount of metal needed to fill a mold of a model of the sculpture. If the model being cast can be weighed, then the volume of the model can be determined by the techniques above. Then the mass m of metal needed can be calculated from the volume V of the model and the density ρ of the metal by m = ρV. (Keep in mind that extra metal is usually needed to fill the channels that guide the molten metal into the mold.) Special thanks to Meaghan Whalley, Lucy 't Hart and Catherine Machado, former CCI interns, for their help with developing this Note. ASTM G1-03. "Standard Practice for Preparing, Cleaning, and Evaluating Corrosion Test Specimens." In Annual Book of ASTM Standards, vol. 03.02. West Conshohocken, PA: American Society for Testing and Materials, 2006, pp. 17–25. Heath, T.L. Archimedes. New York, NY: MacMillan, 1920. Lide, D.R., ed. CRC Handbook of Chemistry and Physics, 79th ed. Boca Raton, FL: CRC Press, 1998, pp. 12-191–12-192. 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