I'm not a bot

Negative buoyancy is when the gravitational pull on a diver is greater than the buoyant force. This means that the diver is being pulled downward, and that the buoyant force is doing negative work (work that is in the opposite direction of the displacement). Positive buoyancy is the opposite situation in which the buoyant force of the diver is greater than the gravitational pull, which makes the diver move upwards. Usually, a person's weight is slightly more than the weight of the displaced amount of water. For example, a person who weighs 80kg displaces 79dm2 of water, which weighs 79kg, that is, he has about 1kg of negative buoyancy. As for your question whether this negative buoancy is a unique feature for black people, the answer is no. it is related to the person's density. The state of being thick, sticky, and semifluid in consistency, due to internal friction. How well did you know this? 2 3 4 Will the flow rate be faster if the substance is more viscous? No. More viscous means it is thicker so more viscous would make the substance thick and slow to pour. How well did you know this? 2 3 4 What determines the viscosity of a substance? The question is asking: what determines if the substance will be thick or thin? The internal resistance or friction between the particles determines the viscosity. How well did you know this? 2 3 4 What factor has an effect on viscosity? Temperature Viscosity will decrease with increased temperature because as particles move more quickly, they interact for shorter time (shorter interactions) reducing internal friction or stress and therefore decreasing viscosity. How well did you know this? 2 3 4 How can viscosity be measured? Using the ramp test, you can measure viscosity. Ramping the temperature during a flow test is a fast test method to determine the temperature dependence of a material’s viscosity. In a flow temperature ramp, the temperature is varied continuously and the instantaneous viscosity is recorded. How well did you know this? 2 3 4 The amount of matter in a given volume How well did you know this? 2 3 4 What density of a substance depend on? It depends on the particles of a substance and whether the substance is a solid liquid or gas How well did you know this? 2 3 4 What is the formula for density? Density (d) = mass (m) / volume (v) density is mass divided by volume How well did you know this? 2 3 4 Ships contain a large quantity of air and the average density of the ship is lighter than the density of water How well did you know this? 2 3 4 Under what conditions could density remain constant? Density does not change as long as the temperature, pressure, and material stays the same. Side-note:Density is NOT constant when the temperature changes, but for liquids and solids it doesn’t change very much with temperature or pressure. Liquids and solids expand only slightly with increasing temperature, and they compress only slightly with increasing pressure, so their densities are approximately constant under most ordinary conditions. How well did you know this? 2 3 4 Why does the density change as you heat a substance? As energy is added, the particles move quickly and farther apart, thus increasing the volume. The density increases because mass remains constant but the volume increases How well did you know this? 2 3 4 It is a push or pull of an object, and is measured in Newtons (N). E.g. buoyant force, normal force, gravitational force How well did you know this? 2 3 4 It is the tendency of a substance to float. This is a force that keep a boat above water instead of sinking if the boat is designed correctly. The boat doesn’t keep rising though since there is an opposing force of gravity pushing it towards the center of the Earth. How well did you know this? 2 3 4 Why do buoyant objects float? They take up space in a fluid, pushing some of it away of displacing it causing them to float, because the fluid pushes back against the force of gravity How well did you know this? 2 3 4 What is the buoyant force? The buoyant force pushes objects away from the center of the Earth (up). How well did you know this? 2 3 4 How quickly a fluid can flow How well did you know this? 2 3 4 It shows how heavily a ship can be loaded in different weather conditions How well did you know this? 2 3 4 How do hot air balloons work? As the air inside the balloon is heated, the balloon becomes less dense than the surrounding air. The buoyant force of the air will push the hot air balloon upwards, until the buoyant force equals the force of gravity. At that point the balloon will remain at the same altitude (distance from the surface of the Earth). How well did you know this? 2 3 4 What is the unit used for mass in the density equation? grams (g) This can take the metric prefixes such as kilograms kg when measuring mass in general. Density is measured mostly in grams per volume rather than kg per volume, but make sure to always show your units. How well did you know this? 2 3 4 What is the unit used for volume in the density equation? How well did you know this? 2 3 4 What are the units used for density? g/cm3 3 should be superscript as in centimeters cubed How well did you know this? 2 3 4 What is pressure measured in? How well did you know this? 2 3 4 What is the formula for pressure? Pressure (P)= force (N)/ area (m2) 2 should be subscript as in meters squared Pressure is measured in Pascals which is equivalent to Newton per meter squared How well did you know this? 2 3 4 How does drinking out of a straw work? When we suck on the straw that lessens the pressure on the outside in the water or fluid and increases the pressure on the inside of the straw How well did you know this? 2 3 4 What does Pascal's Law state? An enclosed fluid transmits pressure in all directions equally What is a pneumatic device? It is a pressure system that uses air instead of water What is a hydraulic device? It is a pressure system that uses water instead of air What are the key properties of fluids? * mass * volume * density * viscosity * flow rate * buoyancy ## Footnote These properties are fundamental in understanding the behavior and applications of fluids. What will you be able to define after completing this section? Viscosity and describe how temperature affects it ## Footnote Understanding viscosity is crucial for fluid mechanics. What can you calculate and compare related to fluids? Densities and relate them to the particle model of matter ## Footnote This involves understanding how density connects with the arrangement of particles in matter. What methods can you describe to alter density in fluids? Methods of altering density in fluids ## Footnote Techniques may include changing temperature or pressure. What concept explains buoyancy? Buoyancy ## Footnote This principle explains why objects float or sink in fluids. What is pressure in the context of fluids? Pressure and examples of its use ## Footnote Pressure is a key concept in fluid dynamics and engineering applications. What can you compare regarding the compressibility of fluids? Compressibility of liquids and gases ## Footnote Understanding compressibility is important for applications in various fields, including engineering and physics. Any matter that has no fixed shape and takes the shape of its container ## Footnote This definition includes both liquids and gases. How does the air in a bicycle tire behave as a fluid? It takes the shape of the tire ## Footnote This illustrates the fluid property of adapting to the shape of its container. What role does viscosity play in fluid applications? It affects how fluids flow and their resistance to motion ## Footnote Viscosity is crucial for understanding the efficiency of fluid-based systems. What advantage do hydraulics provide on Earth's surface? They make it possible for one person to lift and move huge loads ## Footnote This principle is widely used in machinery and construction. What must an engineer understand to design a hydraulic arm? How forces are transmitted through a fluid and how fluids behave under pressure ## Footnote This knowledge is essential for effective hydraulic system design. How quickly fluids flow, determined by internal resistance or friction ## Footnote Viscosity affects how fluids behave in different conditions. What factors determine the viscosity of a fluid? Internal resistance and friction between particles ## Footnote Higher friction results in higher viscosity. How do particles behave in a liquid compared to a gas regarding viscosity? In a liquid, particles slide and roll over each other; in a gas, they move more freely ## Footnote This difference affects the viscosity of each state. What happens to fluids with high viscosity? They do not flow as easily as fluids with low viscosity ## Footnote Examples include ketchup (high viscosity) and juice (low viscosity). What viscosity number range does the Society of Automotive Engineers (SAE) assign to motor oils? Between 5 and 50 ## Footnote Higher numbers indicate higher viscosity. What is an example of a motor oil suitable for summer use? SAE 30 oil ## Footnote It is designed for higher temperatures. What does multi-grade motor oil like SAE 10W30 provide? Easier flow at cold temperatures and resistance to thinning in heat ## Footnote This makes it versatile for different weather conditions. Fill in the blank: The greater the friction between particles in a fluid, the _______ the viscosity. higher ## Footnote This relationship is crucial in understanding fluid dynamics. True or False: Fluids with low viscosity flow more easily than those with high viscosity. True ## Footnote This is a fundamental property of fluids. What would happen to shampoo if it had a higher viscosity? It would be hard to get out of the bottle ## Footnote This illustrates how viscosity affects everyday products. What would happen to shampoo if it had a lower viscosity? You would probably use more to wash hair ## Footnote Lower viscosity leads to increased usage. What is one major factor that can affect the viscosity of a fluid? Temperature ## Footnote Viscosity generally decreases as temperature increases for most fluids. What happens to the viscosity of syrup when poured on hot pancakes? It decreases ## Footnote The heat from the pancakes lowers the viscosity of the syrup, allowing it to flow more easily. What is the ramp method used for? Measuring viscosity ## Footnote This method involves pouring a fluid down a ramp and timing how long it takes to reach the bottom. What is the process for comparing the viscosities of different fluids using the ramp method? Pour the same amount of each fluid and time them ## Footnote This allows for a direct comparison of how quickly each fluid flows. How can you investigate the effect of temperature on viscosity using the ramp method? Test the same fluid at different temperatures ## Footnote First test at room temperature, then warm it or cool it, and test again. What happens to the viscosity of olive oil when placed in a refrigerator? It increases ## Footnote Cooling the olive oil in the refrigerator raises its viscosity, making it thicker. What is the expected viscosity of hot tar spread on a road? Lower viscosity ## Footnote The heat reduces the viscosity of the tar, allowing for easier spreading. What does the viscosity of engine oil do when poured into a hot engine? Decreases ## Footnote The heat from the engine lowers the viscosity of the oil, enabling better lubrication. Fill in the blank: The ramp method involves _______ a fluid down a ramp. pouring ## Footnote This method is essential for measuring how fast different fluids flow. Viscosity is a fluid's internal resistance or friction that keeps it from flowing ## Footnote Viscosity determines how easily a fluid flows; high viscosity means high resistance. How does temperature affect viscosity? As the temperature of a liquid increases, its viscosity decreases; as temperature decreases, viscosity increases ## Footnote This relationship is crucial in understanding fluid dynamics. What happens to the flow of a fluid as its temperature increases? The fluid flows faster ## Footnote Increased temperature provides energy that allows particles to move more freely. What is the particle model of matter? The particle model states that a liquid is made of particles that can slide and roll over each other ## Footnote This model helps explain the behavior of liquids, including viscosity. What effect does adding heat to a liquid have on its particles? The particles slide and roll more quickly ## Footnote This increased motion results in lower viscosity. What happens to viscosity when the temperature of a liquid drops? Viscosity increases ## Footnote The particles slow down, leading to slower fluid flow. Fill in the blank: A fluid with a _______ viscosity has a large amount of internal resistance or friction. How did Aboriginal peoples in Alberta use viscous materials? They used thick, viscous bitumen from the oil sands to seal their canoes ## Footnote This demonstrates an understanding of fluid characteristics in practical applications. What material did Aboriginal peoples use to make glue for building canoes? Tree sap ## Footnote Tree sap was utilized for its adhesive properties, showcasing knowledge of fluid characteristics. True or False: Higher temperatures always result in higher viscosity. False ## Footnote Higher temperatures actually decrease viscosity. What is the reason the grape sinks in some liquids and not in others? The reason is a property of fluids called density. Density is the amount of matter in a given volume. How should density be considered when examining the results of an investigation? Think about density as you examine the results. Fill in the blank: Density is the amount of matter in a given _______. True or False: Density is not relevant to the sinking of the grape in liquids. What does the particle model of matter state? All matter is made of tiny particles, and different substances are made of different particles. How does the density of a fluid relate to its particles? The density of a fluid depends on the particles it is made of. If the density of an object is greater than the density of the fluid, what happens? If the density of an object is less than the density of the fluid, what happens? What is the formula for calculating density? Density (d) = Mass (m) / Volume (V) What are the common units for the density of liquids and gases? Grams per millilitre (g/ml) or kilograms per litre (kg/L). What are the common units for the density of solids? Grams per cubic centimetre (g/cm^3). What is the density of water at room temperature? What is the density of mercury at room temperature? Fill in the blank: Density is the mass per unit of _______. True or False: Some solids can be less dense than some liquids. What determines a substance's density? The kind of particles in the substance. What is an example of a substance that floats on water? What is the significance of Emma's results on page 42? They illustrate how the density of an object compared to a fluid determines whether it sinks or floats. What is the density of isopropyl (rubbing alcohol)? Not specified in the text. What is the density of gold? Not specified in the text. What is the density of aluminum? Not specified in the text. What is the density of iron? Not specified in the text. What is one reason a can of diet soda floats in water while a can of regular soda does not? The difference in density between the two cans. What happens to density if temperature remains constant? Density does not change as long as the temperature stays the same. What device is used to measure the density of liquids? What is the procedure to determine if the density of cold water is the same as hot water? Use a hydrometer to measure the density of both cold and hot water. True or False: Warm water has a higher density than cold water. According to the particle model, what happens to particles when energy is added? Particles move more quickly. What is the relationship between particle movement and state changes in matter? As a solid changes to a liquid and then to a gas, the particles move faster. What happens to the volume of a substance as its particles become more active? Fill in the blank: Density is the ratio of ______ to volume. How does an increase in volume affect density with a constant number of particles? What explains the phenomenon of warm water floating on cold water in a lake? Warm water has a lower density than cold water. What is the effect of temperature on the density of a substance? Density changes with temperature due to particle movement. What must be done if hot water spills on your skin? Immediately run cold water over the area. What happens to a substance as it is heated? It changes state from solid to liquid to gas. ## Footnote This process is known as phase transition. Which state of a substance typically has the greatest density? Solid state. ## Footnote This is true for most substances except water. What is the order of states for a substance as temperature increases? Solid, Liquid, Gas. ## Footnote This order reflects the typical phase changes of substances. How does the particle model explain density differences in states of matter? Particles in a solid are packed closely together, while particles in a gas have more space between them. ## Footnote This explains why solids are denser than liquids and gases. True or False: A gas has a greater density than a solid. False. ## Footnote Gases have less density than solids. Fill in the blank: A substance (except water) has a greater density in its _______ state than in its liquid and gas states. solid ## Footnote This property is common among most substances. What does Galileo's thermometer use to indicate temperature? Temperature bulbs that act like a hydrometer. ## Footnote The bulbs float based on the density of the surrounding water. When does a temperature bulb in Galileo's thermometer float to the top? When the water's density is greater than that of the bulb. ## Footnote This demonstrates the principle of buoyancy. What state of matter is least dense? Gas state. ## Footnote This is a general characteristic of gases compared to solids and liquids. In which state are particles packed closely together? Solid. ## Footnote This close packing contributes to the high density of solids. What is the density of distilled water? Why is it easier to float in salt water than in fresh water? Salt water has a higher density than fresh water What happens when salt is added to distilled water? The density of the water solution increases What effect does increasing the concentration of salt have on the density of water? It increases the density of the water solution What determines whether an object will float in a liquid? The density of the object compared to the density of the liquid Fill in the blank: Less dense objects float in _______ substances. True or False: Density is the only factor that affects whether an object floats. What is the relationship between the number of particles in a volume and density? More particles in a volume increase the density What is the role of the particle model of matter in understanding density? It explains how dissolving one substance in another increases the number of particles What body of water is mentioned as one of the saltiest on Earth? What happens to an object when its density is greater than the density of the fluid it is in? What force pulls an object downward when it is in a liquid? What is the force called that pushes an object upward when it is in a liquid? What occurs when the density of the liquid is greater than the density of the object? What happens when the density of the object is greater than that of the liquid? The tendency of an object to float when placed in a fluid. The force in fluids that acts against gravity. What allows a diver to move downward in water? The combined force of gravity and leg movement is greater than the buoyant force. What allows a diver to move upward in water? The combined buoyant force and leg movement is greater than the force of gravity. What is it called when the force of gravity equals the buoyant force? What is a practical application of buoyancy in transportation technologies? Ships are designed to float safely. Fill in the blank: When a ship moves from more dense to _______ water, its buoyancy is affected. What is the property that describes a liquid's thickness or thinness? Viscosity ## Footnote Viscosity is a key property of all fluids, including both liquids and gases. How does viscosity differ between liquids and gases? Viscosity in gases increases and decreases differently than in liquids ## Footnote Gases are often harder to visualize regarding viscosity due to their invisibility. What term is used to describe how fast a fluid 'runs'? Flow rate ## Footnote Flow rate can be measured by the time it takes for the fluid to travel from one point to another. What factors might affect the flow rate of a liquid? Properties of fluids ## Footnote Variables such as viscosity, temperature, and the nature of the fluid can influence flow rate. What is the effect of higher viscosity on the flow of a liquid? A thicker liquid flows more slowly ## Footnote Higher viscosity indicates a greater resistance to flow. Fill in the blank: A thicker liquid has a _______ viscosity. higher ## Footnote Higher viscosity means the liquid is more resistant to flow. What is an example of a liquid that flows thickly? Chocolate syrup ## Footnote Other examples include honey and caramel. True or False: Viscosity is a property of only liquids. False ## Footnote Viscosity is a property of all fluids, including gases. What might you predict about the flow of different fluids in a pan? The order of flow based on viscosity ## Footnote Thicker liquids will typically flow slower than thinner liquids. Why is it important to determine the flow rate of a liquid? The viscosity of liquids must be measured precisely in some industries ## Footnote For example, the viscosity of paints and varnishes is closely regulated for smooth application. Which industry depends on the flow properties of matter? The cosmetics industry ## Footnote Specifically, products like lipstick require careful viscosity management. What is the state of lipstick when sold? Solid ## Footnote Unlike nail polish and mascara, lipstick is a solid mixture. What processes are involved in the manufacture of lipstick? Heating, dissolving, melting, mixing, grinding, straining, pouring, and cooling ## Footnote These steps ensure proper formulation and consistency. What two mixtures are prepared in the lipstick manufacturing process? One contains oils and antioxidants, and the second contains dissolving ingredients (solvents) ## Footnote Mainly alcohol is used in the second mixture. What is the purpose of heating the two mixtures in lipstick production? To allow complete mixing ## Footnote This ensures that all ingredients blend properly. What is done to the pigment mixture in lipstick production? It is blended with colour pigments or dyes and passed through a large roller mill ## Footnote This grinds the grainy pigment to ensure a smooth product. What types of waxes are used in lipstick production? Beeswax, candelilla wax, and carnauba wax ## Footnote These waxes help the final product hold its distinctive shape. What happens to the lipsticks after cooling? They are inspected for undesirable marks ## Footnote This includes checks for mold separation lines and air holes. What is done if the lipsticks do not meet quality standards? They are removed, remelted, and remoulded ## Footnote This process ensures only acceptable products are packaged. How was furniture stripping liquid improved? The viscosity was increased to a gel-like texture ## Footnote This change made the product easier to apply and helped it stick to surfaces. True or False: The viscosity of paints and varnishes is not regulated. False ## Footnote Viscosity is closely regulated to ensure proper application. The measure of a fluid's resistance to flow. How does nail polish behave when applied? Applied as a slick fluid, it dries into a solid finish. What is the effect of solvent on products like nail polish and mascara? Controls viscosity; too little makes application difficult, too much slows drying. Why do chefs need to adjust the viscosity of gravies and sauces? To achieve the desired thickness for different culinary applications. What must mechanics consider regarding engine oil? The viscosity appropriate for the current season. Why is viscosity important for artists using oil paints or acrylics? They need to thin or thicken the paints for application. What is the role of viscosity in food manufacturing? Ensures products like ice cream toppings and sauces have the right consistency. How do food manufacturers regulate viscosity with heat? By controlling temperature to achieve the desired consistency of products. What is a specific requirement for chocolate coating in candy bars? Must be at the right consistency and temperature to cover evenly. Fill in the blank: Your mouth is highly sensitive to _______. True or False: Viscosity only matters for food products. List four occupations that require knowledge of fluid viscosity. * Candy maker * Glass blower * Baker * Mechanic What is a suggested activity to learn about viscosity in different occupations? Job shadowing someone in a related field. What should you do after job shadowing someone? Take notes on viscosity's role and write a thank-you letter. The resistance to flow in liquids ## Footnote Viscosity is influenced by internal friction and the attractive forces between particles. Why do some liquids flow more slowly than others? Because they have different viscosities ## Footnote Different internal friction levels affect how easily particles can move past each other. What creates internal friction in a liquid? Resistance to flow caused by attractive forces between particles ## Footnote Friction occurs when two surfaces or particles interact. Why is it easier to skate on ice than on pavement? The friction between skates and ice is less than that between skates and pavement ## Footnote This demonstrates how different surfaces affect motion. How do water particles compare to oil particles in terms of flow? Water particles slip past each other easily, while oil particles have more internal friction ## Footnote Oil's stronger attractive forces slow down its flow. What happens to the attractive forces between particles as temperature increases? They decrease ## Footnote Higher temperatures allow particles to move more freely. What happens to the viscosity of a liquid when it is heated? It decreases ## Footnote Warmer liquids flow more quickly due to reduced internal friction. What happens to the viscosity of a liquid when it is cooled? It increases ## Footnote Cooler liquids have stronger attractive forces, causing them to flow more slowly. Fill in the blank: The viscosity of a liquid _________ as it is heated. Fill in the blank: The viscosity of a liquid _________ as it is cooled. True or False: All fluids flow at the same rate. False ## Footnote Different viscosities result in varying flow rates. What does the particle model explain about liquids? Attractive forces exist between particles ## Footnote This model helps to understand how viscosity varies among different liquids. How does the viscosity of gases compare to that of liquids? Gases generally flow more easily than liquids. What is the primary reason gas particles flow differently than liquid particles? Gas particles are far apart, and the attractive forces are low. How do gas particles typically interact with each other? Gas particles are more likely to collide with each other than rub against each other. What happens to the viscosity of a gas when it is flowing through a constriction? It moves in one direction. What is the effect of low energy gas particles on viscosity? If gas particles have low energy and move in the same direction, viscosity is low. What occurs when gas particles gain energy? Their motion increases in all directions, increasing the number of collisions. What is the relationship between internal friction and gas flow when gas particles have high energy? Internal friction is high, and the gas does not flow as easily or quickly. How does temperature affect the viscosity of gases? Viscosity INCREASES as gases are HEATED and DECREASES as they are COOLED. What happens to gas particles when they are heated? They gain energy and move faster, increasing the number of collisions. How do cooler gases behave in terms of particle collisions? Cooler gases contain particles that are not colliding as much or as often. True or False: The viscosity of gases decreases as they are heated. Fill in the blank: The viscosity of a gas _______ when it is heated. Fill in the blank: The viscosity of a gas _______ when it is cooled. Can the solid state be less dense than the liquid state of the same substance? Yes ## Footnote Ice cubes float in water because solid ice is less dense than liquid water. What is density in scientific terms? Mass per unit volume of a substance How can density be described in everyday language? As the 'crowdedness' of the particles that make up matter What determines the unique density of each substance? The size of the particles and how close together they are What does the particle model help to explain about matter? Different substances have different-sized particles and empty space between them Fill in the blank: Density can be described as the _______ of the particles that make up matter. What happens to solid objects when they move through liquids and gases? They can move easily through them Why can dolphins leap through air and dive underwater smoothly? Fluid properties of water and air allow particles to move out of the way True or False: Solid particles tend to hold together while fluid particles tend to move apart. How does the presence of larger spaces among people affect density on an elevator? It reduces the density (crowdedness) What visual analogy is used to explain density in the context of people on an elevator? A large 'spacing box' around each person How does the density of a substance relate to its physical state? The density varies with physical state; gases are less dense than liquids, which are less dense than solids. Why does water vapour have a lower density than liquid water? Water vapour has fewer particles than liquid water due to more space between gas particles. What happens when you step onto the surface of a lake? Your foot pushes the water particles out of the way; liquids cannot support objects like solids can. What allows a solid object to pass through a liquid? The particles of a liquid move apart easily due to weak attractive forces between them. True or False: Liquid particles have a strong attraction for each other. Why is it easier to run through air than through water? Air is less dense and you move through mostly empty space, requiring less effort to move particles. How do the densities of gases compare to those of liquids? Gases are generally less dense than liquids. Fill in the blank: 'Empty space' means a separation between two objects with _______. nothing between those objects, not even air particles. What is a key difference between empty space and air? Empty space does not contain air particles, while air is a mixture of gases. Why can't astronauts venture outside their spacecraft without masks and air tanks? Because there is no oxygen in outer space. What can you determine by dropping small items into water? You can determine if the items are denser than water. What should you do to organize your observations about density in a Science Log? Create a table to organize the observations. What is the density of hydrogen at 20°C? 0.00009 g/ml ## Footnote Hydrogen is one of the lightest substances and has a very low density. What is the density of mercury? 13.55 g/ml ## Footnote Mercury is one of the densest substances known. How does the density of solid substances generally compare to their liquid state? The density of the solid state is greater than the density of the liquid state ## Footnote This is true for most pure substances, with ice being an exception. Fill in the blank: As temperature increases, a substance will change from solid, to liquid, to _______. gas ## Footnote This process is a result of particles gaining energy. Why can particles in a solid not be pushed apart? Attractive forces among the particles of a solid are stronger than those between fluid particles ## Footnote This creates a tightly packed arrangement. What happens to the density of a substance as it is heated? The density decreases ## Footnote This occurs because the particles spread out and take up more space. True or False: Ice is denser than water. False ## Footnote Ice is less dense than liquid water, which is why it floats. What is a unique property of some solid metals like copper and nickel when placed in mercury? They can float on mercury ## Footnote This is due to the high density of mercury compared to the solid metals. List three common substances with their approximate densities at 20°C from the provided table. * Air: 0.0014 g/ml * Water: 1.00 g/ml * Glycerol: 1.26 g/ml ## Footnote These densities are crucial for understanding buoyancy and fluid dynamics. How does the particle model explain the change in state from solid to gas? Particles spread out as they gain energy when heated ## Footnote This model illustrates the behavior of matter under thermal influence. Fill in the blank: The particles in a solid cannot be pushed apart because they are held together by _______. strong attractive forces ## Footnote This is a key difference between solids and fluids. Density is a way of expressing a mass-to-volume ratio ## Footnote Density can be calculated using the formula: Density = Mass/Volume. How can you measure the density of a substance? By measuring the mass and volume of the substance ## Footnote Mass is measured in grams (g) or kilograms (kg), and volume can be measured in litres or millilitres. Mass is the amount of matter in a substance ## Footnote Mass is measured using a balance. Volume is a measurement of the amount of space occupied by a substance ## Footnote Volume can be measured directly or indirectly depending on the shape of the solid. How is the volume of a solid with a regular shape calculated? Using the formula V = L x W x H ## Footnote L is length, W is width, and H is height. How can the volume of an irregularly shaped object be determined? By measuring the volume of the water that spills out of an overflow can ## Footnote This method is known as water displacement. What is the difference between mass and weight? Mass is the amount of matter, while weight is the force of gravity exerted on an object ## Footnote Weight is measured in newtons (N). What is the force of gravity on Earth for every kilogram of mass? 9.8 N ## Footnote This force is almost the same everywhere on Earth's surface. Capacity is the greatest amount of fluid that a container can hold ## Footnote Capacity is usually measured in litres or millilitres. How is the mass-to-volume ratio expressed? As a quantity of the mass divided by its volume ## Footnote This ratio is what defines density. True or False: Weight is measured in kilograms. False ## Footnote Weight is measured in newtons (N), while mass is measured in kilograms (kg). Fill in the blank: The pull of gravity on a 2.26 kg bag of sugar is _____ N on Earth. 22.1 N ## Footnote This calculation is based on the force of gravity of 9.8 N/kg. The tendency for materials to rise or float in a fluid. What is another term for buoyancy? What does buoyant force refer to? The upward force exerted on objects submerged in fluids. What role does buoyancy play in transportation? It allows matter to be transported from one place to another. What are some examples of how buoyancy is observed in nature? * Nutrients transported through the bloodstream * Pollen floating in the air * Boats and planes moving around the world. What is required for an object to float in a fluid? The ability of the fluid to support the object. What happens when an object is floating? It does not fall in air or sink in water, but remains suspended in the fluid. What force do the particles of a fluid exert? A force in a direction opposite to the force of gravity. How does gravity affect objects in fluids? Gravity pulls down, toward the center of Earth. What pushes objects up in a fluid? How is buoyant force measured? True or False: Buoyancy allows for the floating of icebergs, sailboats, and oil rigs. Fill in the blank: The buoyant force pushes objects ______ from Earth. What is the primary question addressed in the text regarding travel in air and water? How can people travel in the air and on water if the density of their bodies is greater than the density of both these fluids? What factor is suggested to not be the only explanation for why fluids can support certain substances? What is indicated as a critical aspect in determining whether an object floats or sinks? What does the Hibernia oil rig demonstrate about density and buoyancy? It can float on water despite having a mass of more than 14,000 t. What happens to a straight pin when placed in water? Fill in the blank: Water can support objects that have densities greater than water, as long as the weight of the object is spread over a _____ enough area. True or False: Density is the only factor that determines whether an object will sink or float in a fluid. What is the mass of the Hibernia oil rig? What is the mass of the straight pin mentioned in the text? What does the Dead Sea contain that affects buoyancy? Many salts ## Footnote The high salt concentration increases the density of the water, allowing people to float effortlessly. How long did it take for submersibles to free-fall to the Titanic wreck? 3 hours ## Footnote This duration is specified for a depth of 650 km. What is the density of steel? What is required for a ship to float despite being made of steel? Large, hollow hulls ## Footnote This ensures the average density of the ship is less than that of water. What does a life jacket do to a person's average density? What is the average density of a solution? An average of the densities of its components ## Footnote Solutions contain more than one pure substance. Why is average density useful for floating objects? It enables objects that would otherwise sink to float ## Footnote Examples include large ships and oil rigs. What organ in fish helps control their depth in water? How does the swim bladder function in fish? It contains a mixture of air and water ## Footnote The amount of air inside the sac determines the fish's depth. What adaptation from fish is used in submarines for depth control? Fill in the blank: The average density of a ship must be _______ than that of water to float. True or False: The density of a solution is equal to the density of the pure substances it contains. False ## Footnote The density of a solution is an average density. What is the primary function of ballast in a submarine? To control buoyancy by adjusting the amount of water and air in the tank ## Footnote Ballast tanks fill with water to sink and pump air out to rise. What happens to a submarine when it pumps air out of the ballast tank? It sinks ## Footnote Reducing the volume of air increases the density, causing it to submerge. What is the buoyant force of air compared to water? Much smaller ## Footnote This difference in buoyant forces is crucial for floating objects. What gas fills the Goodyear blimp? Helium ## Footnote Helium is the second lightest gas and contributes to the blimp's buoyancy. Its mass is relatively small compared to its volume ## Footnote The average density of the blimp is less than that of the surrounding air. Who established the relationship between the size of an object and the buoyant force exerted on it? Archimedes ## Footnote Archimedes' principle is fundamental in understanding buoyancy. Fill in the blank: Airships like blimps can float because their average density is _______ than that of the surrounding air. less ## Footnote This density difference allows them to rise. What would likely happen if you dropped a sheet of paper from a height into a small box? It would not land directly in the box ## Footnote The paper's shape and mass affect its descent. What could you do to help a sheet of paper hit its target when dropped? Fold it or crumple it ## Footnote Altering the shape increases its descent stability. True or False: A wooden block will fall straight down like a sheet of paper. False ## Footnote The wooden block has a different shape and mass distribution affecting its fall. What do ocean-going ships, hot-air balloons, and blimps have in common? They all have huge volumes ## Footnote Their volume contributes to their buoyancy in their respective mediums. Who discovered Archimedes' Principle? Archimedes ## Footnote Archimedes was a Greek scientist who lived around 212 B.C.E. What was the main task given to Archimedes by Hiero II? To determine if the crown was made entirely of gold What two values are required to calculate density? How did Archimedes measure the mass of the crown? What was the challenge Archimedes faced in measuring the crown? Measuring the volume of an irregularly shaped object What discovery did Archimedes make while at the public baths? A solid object can displace water out of a container How did Archimedes determine the volume of the crown? By submerging it in water and measuring the displaced water What conclusion did Archimedes reach after testing the crown? The crown was made of a mixture of gold and silver True or False: Archimedes concluded that the goldsmith had used pure gold for the crown. Fill in the blank: Archimedes showed that the goldsmith tried to _______ the king. Who discovered Archimedes' Principle? Archimedes ## Footnote Archimedes was a Greek scientist who lived around 212 B.C.E. What was the main task given to Archimedes by Hiero II? To determine if the crown was made entirely of gold What two values are required to calculate density? How did Archimedes measure the mass of the crown? What was the challenge Archimedes faced in measuring the crown? Measuring the volume of an irregularly shaped object What discovery did Archimedes make while at the public baths? A solid object can displace water out of a container How did Archimedes determine the volume of the crown? By submerging it in water and measuring the displaced water What conclusion did Archimedes reach after testing the crown? The crown was made of a mixture of gold and silver True or False: Archimedes concluded that the goldsmith had used pure gold for the crown. Fill in the blank: Archimedes showed that the goldsmith tried to _______ the king. What does the buoyant force of a liquid depend on? Density ## Footnote The buoyant force does not depend on the physical state of the liquid, but rather on its density. What is the density of seawater? 1.03 g/mL ## Footnote Seawater has a higher density than fresh water, which has a density of 1.00 g/mL. What is the density of fresh water? 1.00 g/mL ## Footnote Fresh water has a lower density compared to seawater. How does the density of salt water compare to that of fresh water? Salt water has a greater density than fresh water ## Footnote This means salt water can support more weight per volume. What happens to a hydrometer in a liquid with higher density? It extends farther out of the liquid ## Footnote For example, a hydrometer will float higher in water (1 g/mL) than in vegetable oil (0.9 g/mL). What is the primary use of a hydrometer? To measure liquid density ## Footnote Hydrometers are commonly used in various industries, including food and beverage. True or False: A hydrometer can determine sugar content directly. False ## Footnote Hydrometers measure density, which can be used to indirectly determine other values like sugar content. Fill in the blank: The relationship between _______ and density is the basis for the hydrometer. What observation can be made about floating in salt water compared to fresh water? Objects float more easily in salt water ## Footnote This is due to the higher density of salt water. What industries widely use hydrometers? Food and beverage industries ## Footnote Hydrometers are designed for specific uses in these industries. What does a hydrometer indicate when it sinks lower in a liquid? The liquid has a lower density ## Footnote For example, it sinks lower in vegetable oil than in water. What does the buoyant force of a liquid depend on? Density ## Footnote The buoyant force does not depend on the physical state of the liquid. How does the density of seawater compare to that of fresh water? Seawater has a density of 1.03 g/mL, while fresh water has a density of 1.00 g/mL ## Footnote This means seawater is denser than fresh water. What effect does the density of salt water have on buoyancy? Salt water can support more weight per volume than fresh water ## Footnote This is why objects float more easily in salt water. What is the purpose of a hydrometer? To measure liquid density ## Footnote Hydrometers are instruments that extend farther out of a liquid with higher density. What happens to a hydrometer in a liquid with lower density, such as vegetable oil? It will sink lower ## Footnote Vegetable oil has a density of 0.9 g/mL, which is lower than that of water. In which industries are hydrometers widely used? Food and beverage industries ## Footnote Hydrometers can determine values indirectly, such as sugar or alcohol content. Fill in the blank: The relationship between buoyancy and density is the basis for the _______. True or False: The buoyant force is the same for all liquids regardless of their density. False ## Footnote Buoyant force varies with the density of the liquid. What density does water have? How does the packing of particles in salt water compare to that in fresh water? Particles in salt water are packed together more tightly ## Footnote This increased packing contributes to its higher density. What is the effect of swimming in the ocean compared to a freshwater body in terms of buoyancy? It is easier to float in the ocean ## Footnote The higher density of seawater provides more buoyant force. What is an example of a better landing surface for a stunt double? A huge, billowy air mattress ## Footnote The air mattress absorbs the force of the fall gradually, reducing pressure on the body. What is required for the compression of a gas to occur? 1. The gas must be enclosed in a sealed container with sturdy walls. 2. There must be space between the particles. 3. An external force is applied to the gas ## Footnote Gases can be compressed because their particles can be pushed closer together. Are gases, liquids, and solids compressible? Gases are compressible; solids and liquids are almost incompressible ## Footnote Although solids and liquids have some space between particles, they cannot be squeezed into a smaller volume. What happens to liquids and solids when an external force is applied? The applied force is transmitted from one particle to the next, without changing the volume ## Footnote This transmission of force is similar to falling dominoes. Fill in the blank: Gases are _______ because their particles can be squeezed closer together. Fill in the blank: Solids and liquids are said to be almost _______ because they cannot be squeezed into a smaller volume. How do particles in a solid or liquid respond to an external force? They do not move in the direction of the force, as there is no space to move ## Footnote Only particles with space to move will move when force is applied. True or False: The spaces between particles in solids and liquids are large enough to allow for easy compression. What role does an external force play in the compression of gases? It pushes the particles closer together ## Footnote This external force is necessary to achieve the compressibility of gases. List some examples of materials that absorb force to reduce pressure felt during impact. * Mats in gymnastics * Piston-like devices in bicycles * Styrofoam packaging Pressure is a measure of the force acting perpendicular to a unit area. What happens when you press your hand against a wall? You are applying pressure on that particular area of the wall. What occurs if the force applied to a surface is increased? The pressure will increase. How does pressure change if the area is increased? Pressure will decrease if the area is increased. What is the formula for calculating pressure? Pressure (P) = Force (F) / Area (A) In which units is force measured? Force is measured in newtons (N). How is area commonly measured? Area is often measured in square metres (m^2). What is the unit for pressure? The unit for pressure is newtons per square metre (N/m^2) or pascal (Pa). What is a kilopascal (kPa) in relation to pascals? A kilopascal (kPa) is equal to 1000 pascals (Pa). Who is the pascal unit named after? The pascal unit is named after the French scientist Blaise Pascal. What was Blaise Pascal's contribution to the understanding of fluids? He discovered that the pressure exerted on a fluid in a closed container at one end could be felt undiminished at the other end. At what age did Blaise Pascal publish a geometry book? He published a geometry book at the age of 16. What did Blaise Pascal invent by the age of 19? He invented the first mechanical calculator. Fill in the blank: Pressure is calculated using the formula P = F / _______. True or False: The unit pascal is named in honor of Blaise Pascal's work with sound. What is a key property of gases when they are compressed? They exert a counterforce when compressed. ## Footnote This property is useful for cushioning shocks. How does air in a car tire function under the weight of the car? It pushes back against the force exerted by the weight of the car. ## Footnote This prevents the car from sinking to the ground. What happens to the air in tires when a car hits a bump? The extra force compresses the air further, spreading the effect over the tire. ## Footnote This prevents direct transmission of force to the car body. What occurs when the extra force on a tire is removed? The air returns to its original volume and the tire resumes its original shape. ## Footnote This demonstrates the elasticity of gases. What is the purpose of an air bag in an automobile? To cushion shocks during a collision. ## Footnote Air bags are designed to be used in addition to seat belts. What components are included in an air-bag system? Crash sensors, an ignitor, gas generator, and an inflatable nylon bag. ## Footnote The nylon bag is stored in the steering wheel or dashboard. At what speeds do impact sensors typically trigger an air bag deployment? Speeds in excess of 15-20 km/h. ## Footnote This threshold ensures activation during significant impacts. What gas is produced to inflate an air bag during a collision? Harmless nitrogen gas. ## Footnote This gas is generated through an explosive chemical reaction. How quickly does the air-bag deployment process occur? In only 0.04 seconds. ## Footnote This rapid deployment is crucial for driver safety. What is believed to be superior in some running shoes compared to plain rubber soles? Compressed air for shock absorption and bounce. ## Footnote This design enhances comfort during running. Fill in the blank: An air bag in an automobile uses _______ to protect the driver in a collision. compressed air ## Footnote This technology is vital for reducing injury risk. What is the thickness of Earth's atmosphere? What keeps the envelope of air around Earth? Why don't you feel weighed down by air? Air pressure is balanced by your body pressure How does air pressure change with altitude? Decreases as you climb higher What happens to the air pressure inside your body as you climb a mountain? It does not change quickly What is the function of the eardrum in relation to air pressure? Moves in response to differences in air pressure What occurs when there is a great difference in pressure on either side of the eardrum? You experience a 'pop' in your ear What is the most common device for measuring air pressure? What substance was used in the earliest barometers? How does a mercury barometer work? Mercury falls in a tube creating a vacuum at the top What happens when air pressure pushes down on mercury in a barometer? It forces mercury up the column What is the maximum air pressure that can support mercury at sea level? What occurs if the inside of a closed container has lower air pressure than the outside? The walls of the container will buckle What happens to a juice box when you drink from a straw? The box buckles inward due to lower air pressure inside Fill in the blank: Air pressure can support _______ mm of mercury at sea level. True or False: The air pressure inside your body changes rapidly as you ascend to higher altitudes. Upward force that opposes the weight of an object immersed in fluid For the 2019 film, see Buoyancy (film). This article has multiple issues. Please help improve it or discuss these issues on the talk page. (Learn how and when to remove these messages) This article needs additional citations for verification. Please help improve this article by adding citations to reliable sources. Unsourced material may be challenged and removed.Find sources: "Buoyancy" – news · newspapers · books · scholar · JSTOR (July 2014) (Learn how and when to remove this message) This article reads like a textbook. Please improve this article to make it neutral in tone and meet Wikipedia's quality standards. (July 2023) (Learn how and when to remove this message) The forces at work in buoyancy. The object floats at rest because the upward force of buoyancy is equal to the downward force of gravity. Part of a series onContinuum mechanics J = − D d φ d x {\displaystyle J=-D{\frac {d\varphi }{dx}}} Fick's laws of diffusion Laws Conservations Mass Momentum Energy Inequalities Clausius–Duhem (entropy) Solid mechanics Deformation Elasticity linear Plasticity Hooke's law Stress Strain Finite strain Infinitesimal strain Compatibility Bending Contact mechanics frictional Material failure theory Fracture mechanics Fluid mechanics Fluids Statics · Dynamics Archimedes' principle · Bernoulli's principle Navier–Stokes equations Poiseuille equation · Pascal's law Viscosity (Newtonian · non-Newtonian) Buoyancy · Mixing · Pressure Liquids Adhesion Capillary action Chromatography Cohesion (chemistry) Surface tension Gases Atmosphere Boyle's law Charles's law Combined gas law Fick's law Gay-Lussac's law Graham's law Plasma Rheology Viscoelasticity Rheometry Rheometer Smart fluids Electrorheological Magnetorheological Ferrofluids Scientists Bernoulli Boyle Cauchy Charles Euler Fick Gay-Lussac Graham Hooke Newton Navier Noll Pascal Stokes Truesdell vte Buoyancy (/ˈbɔɪənsi, ˈbuːjənsi/),[1][2] or upthrust, is the force exerted by a fluid opposing the weight of a partially or fully immersed object (which may be also be a parcel of fluid). In a column of fluid, pressure increases with depth as a result of the weight of the overlying fluid. Thus, the pressure at the bottom of a column of fluid is greater than at the top of the column. Similarly, the pressure at the bottom of an object submerged in a fluid is greater than at the top of the object. The pressure difference results in a net upward force on the object. The magnitude of the force is proportional to the pressure difference, and (as explained by Archimedes' principle) is equivalent to the weight of the fluid that would otherwise occupy the submerged volume of the object, i.e. the displaced fluid. For this reason, an object with average density greater than the surrounding fluid tends to sink because its weight is greater than the weight of the fluid it displaces. If the object is less dense, buoyancy can keep the object afloat. This can occur only in a non-inertial reference frame, which either has a gravitational field or is accelerating due to a force other than gravity defining a "downward" direction.[3] Buoyancy also applies to fluid mixtures, and is the most common driving force of convection currents. In these cases, the mathematical modelling is altered to apply to continua, but the principles remain the same. Examples of buoyancy driven flows include the spontaneous separation of air and water or oil and water. Buoyancy is a function of the force of gravity or other source of acceleration on objects of different densities, and for that reason is considered an apparent force, in the same way that centrifugal force is an apparent force as a function of inertia. Buoyancy can exist without gravity in the presence of an inertial reference frame, but without an apparent "downward" direction of gravity or other source of acceleration, buoyancy does not exist. The center of buoyancy of an object is the center of gravity of the displaced volume of fluid. A metallic coin (an old British pound coin) floats in mercury due to the buoyancy force upon it and appears to float higher because of the surface tension of the mercury. Main article: Archimedes' principle The Galileo's Ball experiment, showing the different buoyancy of the same object, depending on its surrounding medium. The ball has certain buoyancy in water, but once ethanol is added (which is less dense than water), it reduces the density of the medium, thus making the ball sink further down (reducing its buoyancy). Archimedes' principle is named after Archimedes of Syracuse, who first discovered this law in 212 BC.[4] For objects, floating and sunken, and in gases as well as liquids (i.e. a fluid), Archimedes' principle may be stated thus in terms of forces: Any object, wholly or partially immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object —with the clarifications that for a sunken object the volume of displaced fluid is the volume of the object, and for a floating object on a liquid, the weight of the displaced liquid is the weight of the object.[5] Mathematically we note. F B = − F g = − ρ V g {\displaystyle \mathbf {F_{B}} =-\mathbf {F_{g}} =-\rho V{\textbf {g}}} Where g {\displaystyle \mathbf {g} } is the local gravitational acceleration, ρ {\displaystyle \rho } the density of the fluid, and V {\displaystyle V} the displaced volume; the negative sign arises since the buoyant force acts in the opposite direction as the object's weight. Archimedes' principle does not consider the surface tension (capillarity) acting on the body,[6] but this additional force modifies only the amount of fluid displaced and the spatial distribution of the displacement, so the principle F B = − F g {\displaystyle \mathbf {F_{B}} =-\mathbf {F_{g}} } remains valid. It's important to note that the density of an object is defined to be its mass per unit volume. ρ = M V {\displaystyle \rho ={\frac {M}{V}}} If an object is fully submerged and we assume that the net force acting upon the object in the vertical direction is zero. If fully submerged the displaced volume is simply the volume of the object. F net = 0 = F B − F g = ρ fluid V g − ρ obj V g ⟹ ρ fluid = ρ obj {\displaystyle F_{\text{net}}=0=F_{B}-F_{g}=\rho _{\text{fluid}}Vg-\rho _{\text{obj}}Vg\implies \rho _{\text{fluid}}=\rho _{\text{obj}}} This implies that objects of greater density than the fluid will sink, and objects of lesser density will float. Example: If you drop wood into water, buoyancy will keep it afloat. A common application Archimedes' principle is of hydrostatic weighing. Suppose we can measure the tension of a hanging mass by a force probe. Assuming Archimedes' principle, when the mass is submerged in the fluid and the net force is zero. F net = 0 = F B + F T − F g = ρ fluid V g + F T − m g {\displaystyle F_{\text{net}}=0=F_{B}+F_{T}-F_{g}=\rho _{\text{fluid}}Vg+F_{T}-mg} ⟹ V = m g − F T ρ fluid g {\displaystyle \implies V={\frac {mg-F_{T}}{\rho _{\text{fluid}}g}}} Recall that the definition of density states. ρ obj = m V = m g ρ fluid m g − F T {\displaystyle \rho _{\text{obj}}={\frac {m}{V}}={\frac {mg\rho _{\text{fluid}}}{mg-F_{T}}}} Thus, the density of the immersed object relative to the density of the fluid can easily be calculated without measuring any volumes. Below we can denote the ratio of densities. ρ obj ρ fluid = F g F g − F app {\displaystyle {\frac {\rho _{\text{obj}}}{\rho _{\text{fluid}}}}={\frac {F_{g}}{F_{g}-F_{\text{app}}}}\,} This formula is also used for example in describing the measuring principle of a dasymeter. This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (January 2016) (Learn how and when to remove this message) A duck has difficulties to get under water due to its buoyancy. When no swimming forces are implied, the natural equilibrium of forces keeps about half of the duck above water. The equation to calculate the pressure inside a fluid in equilibrium is: f + div σ = 0 {\displaystyle \mathbf {f} +\operatorname {div} \,\sigma =0} where f is the force density exerted by some outer field on the fluid, and σ is the Cauchy stress tensor. In this case the stress tensor is proportional to the identity tensor: σ i j = − p δ i j . {\displaystyle \sigma _{ij}=-p\delta _{ij}.\,} Here δij is the Kronecker delta. Using this the above equation becomes: f = ∇ p . {\displaystyle \mathbf {f} =abla p.\,} Assuming the outer force field is conservative, that is it can be written as the negative gradient of some scalar valued function: f = − ∇ Φ . {\displaystyle \mathbf {f} =-abla \Phi .\,} Then: ∇ (p + Φ) = 0 ⟹ p + Φ = constant . {\displaystyle abla (p+\Phi)=0\Longrightarrow p+\Phi ={\text{constant}}.\,} Therefore, the shape of the open surface of a fluid equals the equipotential plane of the applied outer conservative force field. Let the z-axis point downward. In this case the field is gravity, so Φ = −ρfgz where g is the gravitational acceleration, ρf is the mass density of the fluid. Taking the pressure as zero at the surface, where z is zero, the constant will be zero, so the pressure inside the fluid, when it is subject to gravity, is p = ρ f g z . {\displaystyle p=\rho _{f}gz.\,} So pressure increases with depth below the surface of a liquid, as z denotes the distance from the surface of the liquid into it. Any object with a non-zero vertical depth will have different pressures on its top and bottom, with the pressure on the bottom being greater. This difference in pressure causes the upward buoyancy force. The buoyancy force exerted on a body can now be calculated easily, since the internal pressure of the fluid is known. The force exerted on the body can be calculated by integrating the stress tensor over the surface of the body which is in contact with the fluid: B = ∮ σ d A . {\displaystyle \mathbf {B} =\oint \sigma \,d\mathbf {A} .} The surface integral can be transformed into a volume integral with the help of the Gauss theorem: B = ∫ div σ d V = − ∫ f d V = − ρ f g ∫ d V = − ρ f g V {\displaystyle \mathbf {B} =\int \operatorname {div} \sigma \,dV=-\int \mathbf {f} \,dV=-\rho _{f}\mathbf {g} \int \,dV=-\rho _{f}\mathbf {g} V} where V is the measure of the volume in contact with the fluid, that is the volume of the submerged part of the body, since the fluid does not exert force on the part of the body which is outside of it. The magnitude of buoyancy force may be appreciated a bit more from the following argument. Consider any object of arbitrary shape and volume V surrounded by a liquid. The force the liquid exerts on an object within the liquid is equal to the weight of the liquid with a volume equal to that of the object. This force is applied in a direction opposite to gravitational force, that is of magnitude: B = ρ f V disp g , {\displaystyle B=\rho _{f}V_{\text{disp}}\,g,\,} where ρf is the density of the fluid, Vdisp is the volume of the displaced body of liquid, and g is the gravitational acceleration at the location in question. If this volume of liquid is replaced by a solid body of exactly the same shape, the force the liquid exerts on it must be exactly the same as above. In other words, the "buoyancy force" on a submerged body is directed in the opposite direction to gravity and is equal in magnitude to B = ρ f V g . {\displaystyle B=\rho _{f}Vg.\,} Though the above derivation of Archimedes principle is correct, a recent paper by the Brazilian physicist Fabio M. S. Lima brings a more general approach for the evaluation of the buoyant force exerted by any fluid (even non-homogeneous) on a body with arbitrary shape.[7] Interestingly, this method leads to the prediction that the buoyant force exerted on a rectangular block touching the bottom of a container points downward! Indeed, this downward buoyant force has been confirmed experimentally.[8] The net force on the object must be zero if it is to be a situation of fluid statics such that Archimedes principle is applicable, and is thus the sum of the buoyancy force and the object's weight F net = 0 = m g − ρ f V disp g {\displaystyle F_{\text{net}}=0=mg-\rho _{f}V_{\text{disp}}g\,} If the buoyancy of an (unrestrained and unpowered) object exceeds its weight, it tends to rise. An object whose weight exceeds its buoyancy tends to sink. Calculation of the upwards force on a submerged object during its accelerating period cannot be done by the Archimedes principle alone; it is necessary to consider dynamics of an object involving buoyancy. Once it fully sinks to the floor of the fluid or rises to the surface and settles, Archimedes principle can be applied alone. For a floating object, only the submerged volume displaces water. For a sunken object, the entire volume displaces water, and there will be an additional force of reaction from the solid floor. In order for Archimedes' principle to be used alone, the object in question must be in equilibrium (the sum of the forces on the object must be zero), therefore; m g = ρ f V disp g , {\displaystyle mg=\rho _{f}V_{\text{disp}}g,\,} and therefore m = ρ f V disp . {\displaystyle m=\rho _{f}V_{\text{disp}}.\,} showing that the depth to which a floating object will sink, and the volume of fluid it will displace, is independent of the gravitational field regardless of geographic location. (Note: If the fluid in question is seawater, it will not have the same density (ρ) at every location, since the density depends on temperature and salinity. For this reason, a ship may display a Plimsoll line.) It can be the case that forces other than just buoyancy and gravity come into play. This is the case if the object is restrained or if the object sinks to the solid floor. An object which tends to float requires a tension restraint force T in order to remain fully submerged. An object which tends to sink will eventually have a normal force of constraint N exerted upon it by the solid floor. The constraint force can be tension in a spring scale measuring its weight in the fluid, and is how apparent weight is defined. If the object would otherwise float, the tension to restrain it fully submerged is: T = ρ f V g − m g . {\displaystyle T=\rho _{f}Vg-mg.\,} When a sinking object settles on the solid floor, it experiences a normal force of: N = m g − ρ f V g . {\displaystyle N=mg-\rho _{f}Vg.\,} Another possible formula for calculating buoyancy of an object is by finding the apparent weight of that particular object in the air (calculated in Newtons), and apparent weight of that object in the water (in Newtons). To find the force of buoyancy acting on the object when in air, using this particular information, this formula applies: Buoyancy force = weight of object in empty space − weight of object immersed in fluid The final result would be measured in Newtons. Air's density is very small compared to most solids and liquids. For this reason, the weight of an object in air is approximately the same as its true weight in a vacuum. The buoyancy of air is neglected for most objects during a measurement in air because the error is usually insignificant (typically less than 0.1% except for objects of very low average density such as a balloon or light foam). Pressure distribution on an immersed cube Forces on an immersed cube Approximation of an arbitrary volume as a group of cubes A simplified explanation for the integration of the pressure over the contact area may be stated as follows: Consider a cube immersed in a fluid with the upper surface horizontal. The sides are identical in area, and have the same depth distribution, therefore they also have the same pressure distribution, and consequently the same total force resulting from hydrostatic pressure, exerted perpendicular to the plane of the surface of each side. There are two pairs of opposing sides, therefore the resultant horizontal forces balance in both orthogonal directions, and the resultant force is zero. The upward force on the cube is the pressure on the bottom surface integrated over its area. The surface is at constant depth, so the pressure is constant. Therefore, the integral of the pressure over the area of the horizontal bottom surface of the cube is the hydrostatic pressure at that depth multiplied by the area of the bottom surface. Similarly, the downward force on the cube is the pressure on the top surface integrated over its area. The surface is at constant depth, so the pressure is constant. Therefore, the integral of the pressure over the area of the horizontal top surface of the cube is the hydrostatic pressure at that depth multiplied by the area of the top surface. As this is a cube, the top and bottom surfaces are identical in shape and area, and the pressure difference between the top and bottom of the cube is directly proportional to the depth difference, and the resultant force difference is exactly equal to the weight of the fluid that would occupy the volume of the cube in its absence. This means that the resultant upward force on the cube is equal to the weight of the fluid that would fit into the volume of the cube, and the downward force on the cube is its weight, in the absence of external forces. This analogy is valid for variations in the size of the cube. If two cubes are placed alongside each other with a face of each in contact, the pressures and resultant forces on the sides or parts thereof in contact are balanced and may be disregarded, as the contact surfaces are equal in shape, size and pressure distribution, therefore the buoyancy of two cubes in contact is the sum of the buoyancies of each cube. This analogy can be extended to an arbitrary number of cubes. An object of any shape can be approximated as a group of cubes in contact with each other, and as the size of the cube is decreased, the precision of the approximation increases. The limiting case for infinitely small cubes is the exact equivalence. Angled surfaces do not nullify the analogy as the resultant force can be split into orthogonal components and each dealt with in the same way. Main article: Ship stability Illustration of the stability of bottom-heavy (left) and top-heavy (right) ships with respect to the positions of their centres of buoyancy (CB) and gravity (CG) A floating object is stable if it tends to restore itself to an equilibrium position after a small displacement. For example, floating objects will generally have vertical stability, as if the object is pushed down slightly, this will create a greater buoyancy force, which, unbalanced by the weight force, will push the object back up. Rotational stability is of great importance to floating vessels. Given a small angular displacement, the vessel may return to its original position (stable), move away from its original position (unstable), or remain where it is (neutral). Rotational stability depends on the relative lines of action of forces on an object. The upward buoyancy force on an object acts through the center of buoyancy, being the centroid of the displaced volume of fluid. The weight force on the object acts through its center of gravity. A buoyant object will be

stable if the center of gravity is beneath the center of buoyancy because any angular displacement will then produce a 'righting moment'. The stability of a buoyant object at the surface is more complex, and it may remain stable even if the center of gravity is above the center of buoyancy, provided that when disturbed from the equilibrium position, the center of buoyancy moves further to the same side that the center of gravity moves, thus providing a positive righting moment. If this occurs, the floating object is said to have a positive metacentric height. This situation is typically valid for a range of heel angles, beyond which the center of buoyancy does not move enough to provide a positive righting moment, and the object becomes unstable. It is possible to shift from positive to negative or vice versa more than once during a heeling disturbance, and many shapes are stable in more than one position. This section does not cite any sources. Please help improve this section by adding citations to reliable sources. Unsourced material may be challenged and removed. (January 2016) (Learn how and when to remove this message) As a submarine expels water from its buoyancy tanks, it rises because its volume is constant (the volume of water it displaces if it is fully submerged) while its mass is decreased. As a floating object rises or falls, the forces external to it change and, as all objects are compressible to some extent or another, so does the object's volume. Buoyancy depends on volume and so an object's buoyancy reduces if it is compressed and increases if it expands. If an object at equilibrium has a compressibility less than that of the surrounding fluid, the object's equilibrium is stable and it remains at rest. If, however, its compressibility is greater, its equilibrium is then unstable, and it rises and expands on the slightest upward perturbation, or falls and compresses on the slightest downward perturbation. See also: Submarine § Submersion and trimming Submarines rise and dive by filling large ballast tanks with seawater. To dive, the tanks are opened to allow air to exhaust out the top of the tanks, while the water flows in from the bottom. Once the weight has been balanced so the overall density of the submarine is equal to the water around it, it has neutral buoyancy and will remain at that depth. Most military submarines operate with a slightly negative buoyancy and maintain depth by using the "lift" of the stabilizers with forward motion.[citation needed] The height to which a balloon rises tends to be stable. As a balloon rises it tends to increase in volume with reducing atmospheric pressure, but the balloon itself does not expand as much as the air on which it rides. The average density of the balloon decreases less than that of the surrounding air. The weight of the displaced air is reduced. A rising balloon stops rising when it and the displaced air are equal in weight. Similarly, a sinking balloon tends to stop sinking. Underwater divers are a common example of the problem of unstable buoyancy due to compressibility. The diver typically wears an exposure suit which relies on gas-filled spaces for insulation, and may also wear a buoyancy compensator, which is a variable volume buoyancy bag which is inflated to increase buoyancy and deflated to decrease buoyancy. The desired condition is usually neutral buoyancy when the diver is swimming in mid-water, and this condition is unstable, so the diver is constantly making fine adjustments by control of lung volume, and has to adjust the contents of the buoyancy compensator if the depth varies. Density column of liquids and solids: baby oil, rubbing alcohol (with red food colouring), vegetable oil, wax, water (with blue food colouring) and aluminium. If the weight of an object is less than the weight of the displaced fluid when fully submerged, then the object has an average density that is less than the fluid and when fully submerged will experience a buoyancy force greater than its own weight.[9] If the fluid has a surface, such as water in a lake or the sea, the object will float and settle at a level where it displaces the same weight of fluid as the weight of the object. If the object is immersed in the fluid, such as a submerged submarine or air in a balloon, it will tend to rise. If the object has exactly the same density as the fluid, then its buoyancy equals its weight. It will remain submerged in the fluid, but it will neither sink nor float, although a disturbance in either direction will cause it to drift away from its position. An object with a higher average density than the fluid will never experience more buoyancy than weight and it will sink. A ship will float even though it may be made of steel (which is much denser than water), because it encloses a volume of air (which is much less dense than water), and the resulting shape has an average density less than that of the water.[10] Atmosphere of Earth, also known as Air Archimedes paradox – Variation in pressure as a function of elevationPages displaying short descriptions of redirect targets Buoy – Floating structure or device Brunt–Väisälä frequency – Measure of fluid stability against vertical displacement Buoyancy compensator (diving) – Equipment for controlling the buoyancy of a diver Buoyancy compensator (aviation) – Equipment to regulate buoyancy of airships Cartesian diver – Classic science experiment demonstrating the Archimedes' principle and the ideal gas law Dasymeter Diving weighting system – Ballast carried to counteract buoyancy Hydrostatics – Branch of fluid mechanics that studies fluids at rest Galileo thermometer – Thermometer containing several glass vessels of varying density Hull (watercraft) – Watertight buoyant body of a ship or boat Hydrometer – Device used to measure density of liquids Hydrostatic weighing – Technique for measuring the density of a living person's body Lighter than air – Property necessary for a gas to be considered a lifting gas Naval architecture – Engineering discipline of marine vessels Plimsoll line – Legal limit to which a merchant ship may be loaded Pontoon – Float used to support a boat Quicksand – Colloid consisting of granular material and water Salt fingering – Mixing process of warm, salty water with colder, fresher water Submarine – Watercraft capable of independent underwater operation Swim bladder – Gas-filled organ that contributes to the ability of a fish to control its buoyancy Thrust – Reaction force ^ Wells, John C. (2008), Longman Pronunciation Dictionary (3rd ed.), Longman, ISBN 978-1-4058-8118-0 ^ Roach, Peter (2011), Cambridge English Pronouncing Dictionary (18th ed.), Cambridge: Cambridge University Press, ISBN 978-0-521-15253-2 ^ Note: In the absence of surface tension, the mass of fluid displaced is equal to the submerged volume multiplied by the fluid density. High repulsive surface tension will cause the body to float higher than expected, though the same total volume will be displaced, but at a greater distance from the object. Where there is doubt about the meaning of "volume of fluid displaced", this should be interpreted as the overflow from a full container when the object is floated in it, or as the volume of the object below the average level of the fluid. ^ Acott, Chris (1999). "The diving "Lawers": A brief resume of their lives". South Pacific Underwater Medicine Society Journal. 29 (1). ISSN 0813-1988. OCLC 16986801. Archived from the original on 2 April 2011. Retrieved 13 June 2009.. ^ Pickover, Clifford A. (2008). Archimedes to Hawking. Oxford University Press US. p. 41. ISBN 978-0-19-533611-5. ^ "Floater clustering in a standing wave: Capillarity effects drive hydrophilic or hydrophobic particles to congregate at specific points on a wave" (PDF). 23 June 2005. Archived (PDF) from the original on 21 July 2011. ^ Lima, Fábio M. S. (22 January 2012). "Using surface integrals for checking Archimedes' law of buoyancy". European Journal of Physics. 33 (1): 101–113. arXiv:1110.5264. Bibcode:2012EJPh...33..101L. doi:10.1088/0143-0807/33/1/009. S2CID 54556860. Retrieved 8 April 2021. ^ Lima, Fábio M. S. (11 May 2014). "A downward buoyant force experiment". Revista Brasileira de Ensino de Fisica. 36 (2): 2309. doi:10.1590/S1806-11172014000200009. ^ Pickover, Clifford A. (2008). Archimedes to Hawking. Oxford University Press US. p. 42. ISBN 978-0-19-533611-5. ^ Stewart, Ken (15 October 2024). "Buoyancy". Look up buoyancy in Wiktionary, the free dictionary. Wikimedia Commons has media related to Buoyancy. Falling in Water W. H. Besant (1889) Elementary Hydrostatics from Google Books. NASA's definition of buoyancy Retrieved from " Buoyancy and density are closely related concepts in physics. Here's how they connect: Density is the mass of an object per unit volume. It's usually expressed in grams per cubic centimeter (g/cm³) or kilograms per cubic meter (kg/m³). Buoyancy is the upward force that a fluid (like water or air) exerts on an object placed in it. This force makes objects feel lighter in the fluid. The relationship between them is: An object will float if its density is less than the density of the fluid it's placed in. An object will sink if its density is greater than the density of the fluid. For example, a piece of wood floats on water because its density is less than that of water. A rock sinks because its density is greater than that of water. Share — copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt — remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution — You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike — If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions — You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. 0 ratings0% found this document useful (0 votes)0 views35 pagesThe document discusses the equilibrium of bodies in liquids, focusing on concepts such as upthrust (buoyant force), Archimedes' Principle, and the principle of floatation. It includes lesson…SaveSave Equilibrium of Bodies in Liquids (1) For Later0%0% found this document useful, undefined0 ratings0% found this document useful (0 votes)0 views35 pagesThe document discusses the equilibrium of bodies in liquids, focusing on concepts such as upthrust (buoyant force), Archimedes' Principle, and the principle of floatation. It includes lesson objectives, experimental verification, applications, and solved examples related to density and relative density. Additionally, it introduces the hydrometer as a tool for measuring liquid density based on these principles.0 ratings0% found this document useful (0 votes)0 views35 pagesThe document discusses the equilibrium of bodies in liquids, focusing on concepts such as upthrust (buoyant force), Archimedes' Principle, and the principle of floatation. It includes lesson… Author: PiDate: 2025.07.04 Equilibrium of Bodies in Liquids 8. Principle of Floatation12. Relative Density (Floating Bodies)1. Lesson Objectives2. Introduction9. Density and Relative Density13. Relative Density of Powder or Liquid7. Solved Example 1: Fraction of Submerged Volume10. Solved Example 2: Tension in a String 11. Density of Irregular Solids14. The Hydrometer3. Upthrust (Buoyant Force)5. Experimental Verication (Real-life illustration)6. Applications of Archimedes' Principle4. Archimedes’ Principle Negative buoyancy is when the gravitational pull on a diver is greater than the buoyant force. This means that the diver is being pulled downward, and that the buoyant force is doing negative work (work that is in the opposite direction of the displacement). Positive buoyancy is the opposite situation in which the buoyant force of the diver is greater than the gravitational pull, which makes the diver move upwards. Usually, a person's weight is slightly more than the weight of the displaced amount of water. For example, a person who weighs 80kg displaces 79dm2 of water, which weighs 79kg, that is, he has about 1kg of negative buoyancy. As for your question whether this negative buoancy is a unique feature for black people, the answer is no. it is related to the person's density. Study and Practice for FreeTrusted by 100,000+ Students WorldwideAchieve Top Grades in your Exams with our Free Resources.Practice Questions, Study Notes, and Past Exam Papers for all Subjects!