Unit 3: Fluids Chapter 9 Questions

Reading Check Answers, p. 336

1. a push or a pull
2. Two forces are balanced if they are equal, and opposite, and acting upon the same object.

    Balanced forces add up to zero net force.
    An **unbalanced force** is a force that is not opposed.
    Unbalanced forces cause a change in the speed or direction of a moving object

3. **Mass**: the amount of matter in an object.
Weight: the force of gravity that acts on an object.
4. The amount of matter in a body will be the same, wherever that body may be.
The force of gravity on the same object will change, depending on the object's location.

Reading Check Answers, p. 339

1. **Buoyancy** is the upward force on objects that are submerged in, or floating on, a fluid.
2. **Gravity** pulls downward on an object.
The buoyant force pushes upward on the same object.
3. **Neutral buoyancy** is a state in which the force of gravity is exactly balanced by the buoyant force, so the object neither rises nor sinks.
4. The buoyant force on an object is **equal to the mass of the fluid that was displaced by the object.**
5**. You will sink in the water until your body has displaced the same mass of water as your body mass.**
(If you exhale and hold your breath, you will sink until only the top of your head sticks out above the water.)

Reading Check Answers, p. 343

1. **Average density** is the total mass of an object divided by the total volume of that object.
2. The metal of the ship is distributed over a large volume.
The average density of the ship, including air spaces, is less than that of water. After it sinks just enough into the water to displace a mass of water equal to its own total mass, the ship reaches neutral buoyancy.

3. The greater the density of the fluid, the smaller the volume of fluid a ship has to displace in order to float. Dense fluids provide a greater buoyant force.
4. The hydrometer has a certain mass. The hydrometer sinks in the fluid until it has displaced a mass of water equal to its own mass.
A scale shows how far it has sunk in the fluid.
The greater the fluid's density, the less the hydrometer has to sink.

What Did You Find Out? Answers

1. The egg floats because the dissolved salt increases the density of the tap water. When enough salt has been added, the density of the solution becomes greater than the density of the egg, and the egg floats.

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2. Students' sketches and explanations should show that when more water is carefully added to the solution, the egg floats in the middle of the glass. The dense salt water sinks to the bottom, the egg floats on that, and the tap water is the least dense so it floats above all.

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What Did You Find Out? Answers

1. When the bottle is squeezed, the amount of water in the "diver" increases.
2. When the bottle is suddenly released, the amount of water in the "diver" decreases.

Extension Answers

3. Squeezing the bottle both decreases the amount of low density air, and increases the volume of high density water, inside the diver. The diver's average density increases, and the diver sinks. Releasing the bottle causes the volume of air to increase and the volume of water

Analyze Answers

1. Students' answers will vary, depending on what items were placed in the density tower. A sample table is shown below.

Object Ranking

cork 1
oil 2
superball 3
water 4
penny 5

2. Substances that are denser than water will sink (e.g., paper clip, penny). Substances that are less dense will float (e.g., cork, toothpick, pencil).

Conclude and Apply Answers

3. A solid can be less dense than a liquid. Cork is a solid that is less dense than many liquids.
The particles that make up cork are held together as a solid but they have spaces between them. Many liquids have particles that are closer together than the particles in cork, but the liquids' particles move more freely. The liquid is thus more dense than cork and can support it.
4. Volume does not determine the density of the object. As long as the temperature and pressure stay the same, the density of a substance remains constant. The density of an object is its mass-to-volume ratio. The mass of an object increases proportionally as the volume of the object is increased; therefore, the density of the object remains the same.

Extend Your Skills Answer

5. Students will choose very different kinds of materials, so variation should be expected.

What to Do Answers

1. Listed in order from greatest to least, the buoyant force in the three cases are:

Green: 0.30 N; Red: 0.15 N;Blue: 0.10 N

2. Listed in order from greatest to least, the densities of the three liquids are: Green 2.0 g/mL;
Red 1.0 g/mL; Blue 0.67 g/mL. Both lists are in the same order.

Analyze Answers

1. The weight of the 100 g mass submerged in the liquids decreases as the density of the liquid increases. When the 100 g mass is submerged,it displaces its volume of the fluid.
The force of gravity on the displaced fluid provides a force that pushes upward on the mass, called the buoyancy force.
The greater the density of the surrounding fluid is, the greater the mass of the fluid displaced is. The
greater the mass of fluid is, the greater the force of gravity on that fluid is, and the greater the buoyancy force is.
2. The hydrometer in set 2 shows a different reading for each liquid. In liquid 3, the hydrometer extends halfway out of the liquid.
In liquid 2, the hydrometer is almost entirely submerged.
In liquid 1, the top of the hydrometer's scale is slightly below the surface of theliquid.
The greater the density of the liquid is, the less the hydrometer has to sink to displace a mass of liquid equal to its own mass.
3. Archimedes' principle states that the mass of the displaced volume of liquid equals the buoyant force.
The 100 g mass displaces the same volume of liquid every time. However,the density of the fluid is different. The greater the density of the fluid is, the greater the mass of the displaced fluid is, and the greater the force of gravity upon the displaced fluid is.
Therefore the buoyant force exerted by each liquid must be different.
The greater the density of the liquid is, the greater the buoyant force is that it exerts.

Section 9.1 A ssessment, p. 347
Check Your Understanding A nswers

Checking Concepts

1. The motion of the soccer ball was changed. The goalie must have applied a force to stopthe ball.
2. Peter's mass would still be 84 kg. The amount of matter in Peter does not change.
3. A bathroom scale measures the force that gravity exerts upon your body. On the moon, the force of gravity is one sixth as much, so your weight would also be one sixth as much.

Bathroom scales are built to operate on Earth only, so they will incorrectly translate your weight into a mass, and display a mass that is only one sixth of your real mass, which has remained unchanged.
4. The boat would sink. Its volume is so small that it only displaces 260 g of water. It would have to displace at least 320 g of water to float.
5. If you change the shape of the substance, you could change the average density of the material.
(a) Compressing foam plastic beads can increase their density by squeezing out air to cause them to sink.
(b) Shaping foil into a boat with a much larger volume will make the average density of the metal object much less, making it able to float.

Understanding Key Ideas

6. Students' answers will vary, but should contain the following points:
(a) The diagram must show a car with equal forces pushing in opposite directions.
These forces should be labelled as balanced.
The answer should explain that the car remains at its current speed, zero.
(b) The diagram should show the force of both people pushing in the same direction. There should be a third force, friction, pointing in the opposite direction. The forces are unbalanced, then the car is accelerating. If the forces are balanced, then the car must be travelling at a constant speed.
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7. Students' answers will vary. One sophisticated student answer can be seen in this diagram.
Weight, as measured by the spring Newton force scale
Fs
FB
Fg
Buoyant force exerted by the displaced water
Force of gravity on the submerged metal mass
8. The blimp is filled with helium. Together with the tonnes of fabric, frame, motor, TV cameras, batteries, gondola, and people, the helium and the other objects have an average density very close to the density of air.
The blimp's neutral buoyancy allows it to float without rising or sinking.
9. Submarines have ballast tanks which can be filled with sea water, or with air. If the ballast tanks are filled with water, the average density of the submarine is greater than sea water and the submarine sinks.
If the water is pumped out of the ballast tanks, and air is allowed in, then the average density of the submarine is less, and the ship rises.

10. (a) The wooden boat has a smaller average density. It will float, and the waterlogged stick will sink.
(b) The metal block has a greater average density. It will sink. The metal boat has a smaller average density. It will float.
(c) The sealed, empty plastic bottle has a lower average density. It will float, while the water-filled bottle might sink.

What Did You Find Out? Answers before p350

1. It took less force and less time to pop the balloon with the pin.
2. The straight pin had the smaller surface area.
3. The same amount of pressure is needed to pop the balloon either way. Because the force is applied to such a small area with the pin, less force creates the same amount of pressure.
(This concept should become clearer to students as they work through this section.)
4. The greater the area is, the more force that is required to provide the same pressure.

Practice Problem Answers p. 351

Students should provide a complete solution, as described in the text.

1. $P = \frac{F}{A}$

$= \frac{(0.80\ \text{N})}{(0.016\ \text{m}^2)}$

$= 50\ \text{N/m}^2$ The pressure on your hand is 50 Pa.

2. $P = \frac{F}{A}$

$= \frac{(14\ \text{N})}{(0.60\ \text{m}^2)}$

$= 23.333\ \text{N/m}^2$ The book exerts 23 Pa pressure.

3. $P = \frac{F}{A}$

$= \frac{(185\ \text{N})}{(0.12\ \text{m}^2)}$

$= 1541.667\ \text{N/m}^2$ The pressure at the bottom of the tub is 1542 Pa.

Practice Problem Answers p. 352

1. $F = P \times A$
= (2500 Pa) × (0.15 m2)
= 375 N
Water exerts 380 N. (Round to the nearest 10.)
2. $F = P \times A$
= (517 000 Pa) × (0.0005 m2)
= 258.5 N
The force on the piston is 260 N.
3. $F = P \times A$
= (241 000 Pa) × (1 m2)
= 241 000 N
Force on 1m2 of tire is 241 kN.
(240 000 Newtons).

Practice Problem Answers p. 353

1. $A = \frac{F}{P}$
$= \frac{(102\ 000\ \text{N})}{(153\ 000\ \text{Pa})}$
= 0.67 m2
The area must be 0.67 m^2.
2. $A = \frac{F}{P}$
$= \frac{(24\ 525\ 000\ \text{N})}{(19\ 620\ \text{Pa})}$
= 1250 m2.
The area must be 1250 m^2.

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3. $A = \frac{F}{P}$
$= \frac{(50\ 662.5\ \text{N})}{(101\ 325\ \text{Pa})}$
= 0.5 m2
The area must be 0.500000 m^2.

Reading Check Answers, p. 353

1. Pressure is the force acting on a certain area of a surface.
2. The greater the force is (on the same area), the greater the pressure is.
The smaller the area is (if the force stays the same), the greater the pressure is.
3. $P = \frac{F}{A}$
4. The Pascal. One Pascal is the pressure exerted by one Newton force distributed over one square metre. 1 Pa = 1 N/m^2
5. For large pressures, we often use the kiloPascal, kPa.

Reading Check Answers, p. 355

1. The deeper you swim, the greater the weight is of the water above you.
2. Compressibility is the ability to be squeezed into a smaller volume or space.
3. The space between particles in a gas is very large.
The particles can be squeezed into a smaller volume.
4. The particles in both the solid state and the liquid state are touching each other. It is not possible to squeeze them together much closer than they are already.
5. The atmospheric pressure is less at higher altitudes.
As students saw on page 276, as you go up farther and farther in the atmosphere, the pressure gets less and less.
Air trapped inside your ears is released in little "burps" from the inside of your eardrum to the outside. You experience your ears popping.

Reading Check Answers, p. 359

1. **Pascal's law:** The pressure applied to an enclosed fluid is transmitted equally throughout the container.
2. **A hydraulic system** transmits forces through **a liquid**.
3. A **pneumatic system** transmits forces through a **gas.**
4. **The brake system in a car is hydraulic.**
The shock absorbers on a bicycle are pneumatic.
5. A small force acting on a small area in one part of an enclosed fluid can become a large force acting on a large area in the same system.

What Did You Find Out? Answers before p359

1. When a force is applied to the "main cylinder" in the hydraulic system, the plunger in the "reacting cylinder" moves out.

2. The setup is an example of a **hydraulic system** since the transmission of the applied force is done through the **liquid**. (The force is exerted on an enclosed liquid.)

What Did You Find Out? Answers p 359

1. The force at B varies, depending on the relative sizes of the syringes.
2. This system can be used to make work easier.
The syringes can be arranged so that a small inward force on piston A results in a larger outward force at piston B.
Piston A must move a greater distance than piston B in order for piston B to move.

Analyze Answers p359

1. (a) As the amount of water in the bottle increased, it became more difficult to compress the bottle.
(b) As the amount of sand in the bottle increased, it became more difficult to compress the bottle.

Conclude and Apply Answers

2. (a) A **gas is more compressible than a solid.**
(b) A **gas is more compressible than a liquid.**
3. A liquid is slightly more compressible than a solid.
4. Answers will vary. The water would probably compress a bit, then the bottle would burst.
Liquids can only compress a little bit. Most of the force of the car's weight would be transferred to the bottle itself.

Extend Your Knowledge Answers

5. Students' answers may vary. Some students may recall that solids are compressed deep within the Earth. Others may believe that water can be compressed, but only under higher pressure.
Ideally, a controlled force would be applied equally to all parts of the bottle.
Students might construct a lever or a press that could provide greater pressure.
Caution:
have students stand clear of the bottle cap as it might pop off with considerable force.

Section 9.2 Assessment, p. 363
Check Your Understanding Answers

Checking Concepts

1. $P = F \div A$ ^{2} cm = 0.02 m
$A = \pi r^2$
$= 3.14 \times 0.02 \text{ m} \times 0.02 \text{ m}$
$= 0.001 \text{ m}^2$
$P = (500 \text{ N}) \div (0.001 \text{ m2})$
$P = 500\,000 \text{ N/m}^2$
The pressure of her head on the floor is 500 kPa, or 500 000 Pa.
2. As they rise, they encounter lower and lower atmospheric pressure outside the balloon. The helium in the balloon expands as the pressure decreases, eventually bursting the balloon.
3. The heart is like the pump, and the blood is like the hydraulic fluid. The blood circulates inside the closed system.
4. The pressure is greater at the bottom of the barrel, because there is a greater weight of water above it. The water squirts farther if it leaks from the bottom, as long as the holes are the same size.
5. The air inside the plane is at higher pressure than the air outside the plane. If the door opens, air will move rapidly out of the plane, taking people with it if they are not belted in.

Understanding Key Ideas

6. The space between gas particles is large, so gases can be compressed. Liquids cannot be compressed because there is little space between the particles.
7. In the atmosphere, the air inside and outside your body can equalize pressure as you breathe and move. When you are holding your breath, the extra 30 kPa of water pressure cannot be equalized, so you feel it. The air is still up there over the pool, so the pressure underwater is actually 130 kPa.
8. (a) Pneumatic systems are based on the compressibility of gases. Compressed gas stores energy that can be released quickly. (For example, a paint ball gun stores a measured amount of compressed gas. When you pull the trigger, the expanding gas propels the paintball out at high speed.)
(b) This property helps pneumatic systems work by storing energy. You can exert a force on the system, and the system will store the energy as compressed gas, then it can be released at a time, or in a place where work is to be done.

9. Pumps move the fluid around and provide pressure. The valves control the flow of the fluid, and the movement of the pistons

Section 9.2 Assessment, p. 363
Check Your Understanding Answers

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$A = \pi r^2$
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(b) This property helps pneumatic systems do work by storing energy. You can exert a force on the system, and the system will store the energy as compressed gas, then it can be released at a time, or in a place where work is to be done.
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Page 364-365 What Did You Find Out? Answers

1. Students should observe a small balloon partially inflating.
2. Students should write about the balloon collapsing, perhaps being pushed into the bottle by the atmosphere.
3. When the gas was heated, the air particles in the balloon moved more quickly. They collided with each other both more often and more vigorously. This process caused the particles to move apart, and the gas occupied more space. Cooling the balloon slowed down the particles, they moved together, and occupied less volume. Then the balloon collapsed.

Reading Check Answers, p. 367

1. If you want to find out how pressure and volume are related, you must not allow any other factor to influence pressure or volume. In other words, control for temperature.
2. If the volume of a gas is forcibly reduced, the pressure of the gas increases.
3. If you hit a bump while riding a bike, the gas in the shock absorbers is squeezed into a smaller volume.
   The pressure of the gas increases gradually, reducing the amount of shock.
   If you are holding a straw in your mouth as you increase the volume of air inside your mouth, you can reduce the pressure there. Water can be forced up into your mouth by the greater outside atmospheric pressure.

Reading Check Answers, p. 370

1. Gas will expand if it is heated, as long as the pressure remains constant.

2. You must hold the volume constant.

3. The pressure of a gas will increase as you heat the gas, as long as the volume is held constant.

What Did You Find Out? Answers - 369

1. The large bulgy part of the balloon inflated first. When the books were on the balloon, the balloon inflated to the sides first.
2. Each additional book applies additional force to the balloon.
The force of the books, divided by the area of contact, is the pressure.
As the force increases, so does the pressure, so it takes more lung pressure to inflate the balloon.
4. Some students can lift six or more books without bursting the seal.

What Did You Find Out? Answers 371

1. When the temperature is increased, the pressure increases as well. Since it is a straight line graph, the pressure is proportional to the temperature.

2. Students' answers will vary considerably. NOTE: BOTH the volume and the number of particles in the container are fixed. As the particles are heated, they speed up. Because they are travelling faster, they collide with the walls of the container with a greater force. This additional force exerts a greater pressure on the walls of the container.

Analyze Answers

1. Independent: the mass used to apply the force; the identity of the fluid
Dependent: the volume of the fluid
Controlled: the temperature, and the number of particles of the substance trapped in the syringe

2. Results should support hypotheses such as the following:
More force causes a decrease in the volume of air;
air will compress more than water or oil.

Conclude and Apply Answers

1. (a) The volume of the liquids will not change.
The volume of the gas will become smaller as greater force is applied.
(b) The volume of the liquids certainly cannot be reduced to zero.
The volume of the gas can be reduced, but the pressure that the gas exerts becomes very large at small volumes, and it becomes extremely hard to compress further.
The volume will never become exactly zero.

Section 9.3 A ssessment, p. 373
Check Your Understanding A nswers

Checking Concepts

1. Apply a force to the container to reduce the volume.
   The pressure of the gas will increase.

2. Boyle poured mercury into a J-shaped glass tube, sealed at the low end and open at the high end. The mercury trapped a small volume of gas in the low, sealed end of the Jshaped tube. As Boyle poured more mercury into the tube, the height of the mercury column increased. He found that if he doubled the height of the mercury column, the volume of the trapped gas was reduced by half. If he tripled the height of mercury, the volume of the gas became one third its original volume.
3. If the pressure is held constant, the volume of a gas can be reduced by cooling.
4. A typical Volume vs. Temperature graph will be a straight line, like the graph below.

Volume increases directly with temperature.

5. When the volume of a gas is fixed, as in an aerosol can, the pressure of the gas inside increases with increasing temperature. Eventually, the increasing pressure will cause the can to burst, which could easily cause injury.

6. A rigid container will keep the volume of gas constant while temperature and pressure are measured.

Understanding Key Ideas

7. Submerge the entire syringe in a large bucket of water at 50°C.

8. As the temperature falls, the particles of gas move more slowly.
The volume of the gas in the tires decreases, so the tires look flat.
The weight of the car does not change, so the pressure on the gas in the tires remains relatively constant.

9. Several possibilities exist. Perhaps some of the gas leaked out, so that the number of particles in the syringe is not constant. Perhaps the container changes volume a little, in response to changes in pressure.

10. At the top of the mountain, atmospheric pressure can be quite low. When you seal the bottle, you seal in air at the lower pressure.
As you descend, atmospheric pressure increases.
The high pressure outside the bottle causes the bottle to collapse.
The bottle will collapse until the pressure of the gas inside the bottle more closely matches the pressure outside.

Chapter review: Checking Concepts

1. When the same pressure is exerted on both air and water, the volume of air is reduced, but the volume of water remains the same.

2. The pressure at the shallow end of the pool less, because there is less water above. At the deep end, there is more water above, so the pressure is greater.

3. (a) Hydraulics deals with pressure on liquids;
pneumatics deals with pressure on gases.
(b) Both topics consider pressure on fluids.

4. Hydraulic multiplication is used in life-saving rescue tools.
A small force, exerted by a person, is applied to a small area to create a large hydraulic pressure. That pressure is applied to a large area, resulting in a force much larger than the original human force.
Forces can be developed that can easily cut steel.

5. Pumps are used to force water into water mains against high pressure.

6. The volume would increase.

7. The number of particles in the system would have to be controlled, as well as the pressure.

8. An increase in temperature would cause an increase in volume, all else being constant. Increasing the pressure would be accompanied by a decrease in volume, all else being constant.

Understanding Key Ideas

9. (a) A piston inside the bicycle pump can be forced downward, reducing the volume of the air and causing an increase in pressure.

(b) The hole in the basketball needle is so small that the viscosity of air can reduce the flow through the needle.

10. The small force on the small pump acts upon a small area, resulting in a large pressure. The large pressure is transmitted equally throughout the oil. The large pressure acting upon the large area of the big piston provides a large force, capable of lifting the house.

11. (a) You could decrease the pressure on the container, allowing the gas inside to expand.

(b) To increase the pressure in the altered system, increase the temperature without changing the volume.

12. Energy from the sun could heat the balloon's thin skin, thus heating the air inside. If the balloon is very tight, it cannot increase in volume, so the heated air will increase in pressure. The balloon could burst!