1 Two substances mercury with a density 13600 kg/m³ and alcohol with a density 800 kg/m³ are selected for an experiment. If the experiment requires equal masses of each liquid, what is the ratio of alcohol volume to the mercury volume?

- A 1/15
- B 1/17
- C 1/13
- D 17/1
2. A perpendicular force $F$ is applied to a certain area $A$ and produces a pressure $P$. If the same force is applied to an area two times in size, the new pressure on the surface is:

- A. $2P$
- B. $4P$
- C. $P$
- D. $P/2$
3 There are two round tables in the physics classroom: one with the radius of 50 cm the other with a radius of 150 cm. What is the relationship between the two forces applied on the table tops by the atmospheric pressure?

☐ A 1/3
☐ B 1/9
☐ C 3/1
☐ D 9/1
4. Three containers are used in a chemistry lab. All containers have the same bottom area and the same height. A chemistry student fills each of the containers with the same liquid to the maximum volume. Which of the following is true about the pressure on the bottom in each container?

- A. \( P_1 > P_2 > P_3 \)
- B. \( P_1 < P_2 < P_3 \)
- C. \( P_1 < P_2 > P_3 \)
- D. \( P_1 = P_2 = P_3 \)
5. What is the difference between the pressure on the bottom of a pool and the pressure on the water surface?

- A $\rho gh$
- B $\rho g/h$
- C $\rho/gh$
- D $gh/\rho$
6  A boy swims a lake and initially dives 0.5 m beneath the surface. When he dives 1 m beneath the surface, how does the absolute pressure change?

- A  It doubles
- B  It quadruples
- C  It cut to a half
- D  It slightly increases
7. Which of the following scientists invented a mercury barometer?

- A. Blaise Pascal
- B. Evangelist Torricelli
- C. Amedeo Avogadro
- D. Robert Brown
8 A car driver measures a tire pressure of 220 kPa. What is the absolute pressure in the tire?

- A 321 kPa
- B 119 kPa
- C 0 kPa
- D 101 kPa
9 In a hydraulic lift the small piston has an area of 2 cm\(^2\) and large piston has an area of 80 cm\(^2\). What is the mechanical advantage of the hydraulic lift?

- A 40
- B 4
- C 2
- D 1
10. A hydraulic lift is used to lift a car. The small piston has a radius of 5 cm and the large piston has a radius of 50 cm. If a driver applies a force of 88 N to the small piston, what is the weight of the car the large piston can support?

A. 880 N  
B. 88 N  
C. 8800 N  
D. 8.8 N
11 Three blocks of equal volume are completely submerged into water. The blocks made of different materials: aluminum, iron and lead. Which of the following is the correct statement about the buoyant force on each block? ($\rho_{\text{aluminum}} = 2700 \text{ kg/m}^3$, $\rho_{\text{iron}} = 7800 \text{ kg/m}^3$, $\rho_{\text{lead}} = 11300 \text{ kg/m}^3$)

- A $F_{\text{aluminum}} > F_{\text{iron}} > F_{\text{lead}}$
- B $F_{\text{aluminum}} < F_{\text{iron}} < F_{\text{lead}}$
- C $F_{\text{aluminum}} < F_{\text{iron}} > F_{\text{lead}}$
- D $F_{\text{aluminum}} = F_{\text{iron}} = F_{\text{lead}}$
12 A piece of iron has a weight of 3.5 N when it is in air and 2.0 N when it is submerged into water. What is the buoyant force on the piece of iron?

- A 3.5 N
- B 2.0 N
- C 1.5 N
- D 1.0 N
13 Physics students use a spring scale to measure the weight of a piece of lead. The experiment was performed two times: once in the air and once in water. If the volume of lead is 50 cm$^3$, what is the difference between the two readings on the scale?

- A 0.5 N
- B 5.0 N
- C 50 N
- D 500 N
A solid cylinder of mass 5 kg is completely submerged into water. What is the tension force in the string supporting the piece of aluminum if the specific gravity of the cylinder’s material is 10?

- A 5 N
- B 0.5 N
- C 50 N
- D 45 N
15 An object has a weight of 9 N when it is in air and 7.2 N when it is submerged into water. What is the specific gravity of the object’s material?

- A 5
- B 6
- C 7
- D 8
16 A wooden block with a weight of 7.5 N is placed on water. When the block floats on the surface of water it is partially submerged in water. What is the weight of the displaced water?

A 5.0 N  
B 5.5 N  
C 6.0 N  
D 7.5 N
17. A wooden block with a weight of 9 N is placed on water. When the block floats on the surface of water it is partially submerged in water. What is the volume of the displaced water?

A 500 cm³
B 400 cm³
C 300 cm³
D 900 cm³
18 Water flows at a constant speed of 16 m/s through narrow section of the pipe. What is the speed of water in the section of the pipe where its radius is twice of the initial radius?

- A 16 m/s
- B 12 m/s
- C 8 m/s
- D 4 m/s
19 Venturi tubes have three sections with different radii. Which of the following is true about manometer readings?

- A $P_1 > P_2 > P_3$
- B $P_1 < P_2 < P_3$
- C $P_2 > P_1 > P_3$
- D $P_3 = P_2 = P_1$
20 An open bottle is filled with a liquid which is flowing out through a spigot located at the distance $h$ below the surface of the liquid. What is the velocity of the liquid leaving the bottle?

- A $\sqrt{2}gh$
- B $2gh$
- C $4gh$
- D $\rho gh$
21 A table surface of area $A$ is placed underwater in a tank at a depth $H$ relative to the surface of the water. A toy submarine is placed into the water and it sinks onto the table. If the submarine has a mass that cannot be ignored, and the amount of water displaced from the tank is $M_w$, what is the pressure on the table surface?

- A: $\frac{g(\rho H - M_w)}{A}$
- B: $\frac{g(\rho H + M_w)}{A}$
- C: $\frac{g[H - (M_s + M_w)]}{A}$
- D: $\frac{g[H + (M_s - M_w)]}{A}$
22 A student wishes to test which things will float on olive oil. Olive oil has a specific gravity of 0.70. The following are specific gravities of various substances. Which will float on olive oil? Select two answers.

- A Oak - 0.78
- B Balsa wood - 0.16
- C Beeswax – 0.95
- D Charcoal – 0.40
Two boxes lie on a table top: a 2 N box with a volume of 5 x 6 x 4 cm$^3$ and a 3 N box with a volume of 4 x 5 x 9 cm$^3$. Which two arrangements will exert the same pressure? Select two answers.

- [ ] A  The 2N box on the 6 cm x 5 cm side.
- [ ] B  The 2N box on the 4 cm x 5 cm side.
- [ ] C  The 3N box on the 4 cm x 5 cm side.
- [ ] D  The 3N box on the 5 cm x 9 cm side.
24 A partially evacuated vertical cylindrical container is covered by a circular lid that makes an airtight seal. The pressure in the room is 1.01 x 105 Pa and the pressure inside the container is 0.41 x 105 Pa. What other two quantities would you need to know in order to calculate the minimum upward applied force required to lift the lid? Select two answers.

☐ A The volume of the container.
☐ B The density of the air in the container.
☐ C The mass of the lid.
☐ D The radius of the lid.
25 Four objects are thrown into water. Two objects, with volumes $0.02\text{cm}^3$ and $0.04\text{cm}^3$, float and two objects, also with volumes $0.02\text{cm}^3$ and $0.04\text{cm}^3$, sink. Which two objects could have the same buoyant force exerted on them? Select two answers.

- [ ] A The object with a volume of $0.02\text{m}^3$ that floats.
- [ ] B The object with a volume of $0.04\text{m}^3$ that floats.
- [ ] C The object with a volume of $0.02\text{m}^3$ that sinks.
- [ ] D The object with a volume of $0.04\text{m}^3$ that sinks.
1. A small sphere of mass m and density D is suspended from an elastic spring. The spring is stretched by a distance $X_1$.
   
a. Determine the spring constant.
1. A small sphere of mass $m$ and density $D$ is suspended from an elastic spring. The spring is stretched by a distance $X_1$. The sphere is submerged into liquid of unknown density $\rho < D$. The new displacement of the spring is $X_2$.

b. On the diagram below show all the applied forces on the sphere when it is submerged.
1. A small sphere of mass \( m \) and density \( D \) is suspended from an elastic spring. The spring is stretched by a distance \( X_1 \). The sphere is submerged into liquid of unknown density \( \rho < D \). The new displacement of the spring is \( X_2 \).

c. Determine the weight of the displaced liquid by the sphere.
1. A small sphere of mass $m$ and density $D$ is suspended from an elastic spring. The spring is stretched by a distance $X_1$. The sphere is submerged into liquid of unknown density $\rho < D$. The new displacement of the spring is $X_2$.

d. Determine the density of liquid. Express your result in terms of $D, X_1, X_2$. 
2. A pool has an area $A = 50 \text{ m}^2$ and depth $h = 2.5 \text{ m}$. The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water and has a radius $r_1 = 4 \text{ cm}$ while the other has a radius $r_2 = 2.5 \text{ cm}$. Answer the following questions ignoring friction, viscosity, and turbulence.

a. Calculate the net force on the bottom of the pool.
2. A pool has an area \( A = 50 \text{ m}^2 \) and depth \( h = 2.5 \text{ m} \). The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water and has a radius \( r_1 = 4 \text{ cm} \) while the other has a radius \( r_2 = 2.5 \text{ cm} \). Answer the following questions ignoring friction, viscosity, and turbulence.

b. Calculate work done by the pump required to empty the pool in 5 h.
2. A pool has an area $A = 50 \text{ m}^2$ and depth $h = 2.5 \text{ m}$. The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water and has a radius $r_1 = 4 \text{ cm}$ while the other has a radius $r_2 = 2.5 \text{ cm}$. Answer the following questions ignoring friction, viscosity, and turbulence.

c. Calculate the speed of the water flow in the submerged pipe.
2. A pool has an area $A = 50 \text{ m}^2$ and depth $h = 2.5 \text{ m}$. The pool is filled with water to the maximum height. An electrical pump is used to empty the pool. There are two pipes coming out the pump: one is submerged into water and has a radius $r_1 = 4 \text{ cm}$ while the other has a radius $r_2 = 2.5 \text{ cm}$. Answer the following questions ignoring friction, viscosity, and turbulence.

The pump produces a pressure $P_1 = 9 \times 10^5 \text{ Pa}$ in the submerged pipe.

d. Calculate speed of the water flow in the second section of the pipe placed on the ground.
3. A submarine dives from rest a 100-m distance beneath the surface of the Pacific Ocean. Initially the submarine accelerates down at a constant rate $0.3 \text{ m/s}^2$ until it reaches a speed of $4 \text{ m/s}$ and then continues its journey down at a constant speed. The density of salt water is $1030 \text{ kg/m}^3$. The submarine has a hatch with an area of $2 \text{ m}^2$ located on the top of the submarine’s body.

a. How much time does it take for the submarine to move down 100 m?
3. A submarine dives from rest a 100-m distance beneath the surface of the Pacific Ocean. Initially the submarine accelerates down at a constant rate $0.3 \, \text{m/s}^2$ until it reaches a speed of $4 \, \text{m/s}$ and then continues its journey down at a constant speed. The density of salt water is $1030 \, \text{kg/m}^3$. The submarine has a hatch with an area of $2 \, \text{m}^2$ located on the top of the submarine’s body.

b. Calculate the gauge pressure applied on the submarine at the depth of 100 m.
3. A submarine dives from rest a 100-m distance beneath the surface of the Pacific Ocean. Initially the submarine accelerates down at a constant rate 0.3 m/s$^2$ until it reaches a speed of 4 m/s and then continues its journey down at a constant speed. The density of salt water is 1030 kg/m$^3$. The submarine has a hatch with an area of 2 m$^2$ located on the top of the submarine’s body.

c. Calculate the absolute pressure applied on the submarine at the depth of 100.
3. A submarine dives from rest a 100-m distance beneath the surface of the Pacific Ocean. Initially the submarine accelerates down at a constant rate 0.3 m/s\(^2\) until it reaches a speed of 4 m/s and then continues its journey down at a constant speed. The density of salt water is 1030 kg/m\(^3\). The submarine has a hatch with an area of 2 m\(^2\) located on the top of the submarine’s body.

d. How much force is required in order to open the hatch from the inside of submarine?
4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m\(^3\) and the surface area of the top is 14 m\(^2\). The density of ice is 900 kg/m\(^3\) and sea water is 1030 kg/m\(^3\).

a. On the diagram below show all the applied forces on the slab.
4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m$^3$ and the surface area of the top is 14 m$^2$. The density of ice is 900 kg/m$^3$ and sea water is 1030 kg/m$^3$.

b. Calculate the buoyant force on the slab.
4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m³ and the surface area of the top is 14 m². The density of ice is 900 kg/m³ and sea water is 1030 kg/m³.

c. Calculate the height $h$ of the portion of the slab that is above the water surface.
4. A rectangular slab of ice floats on water with a large portion submerged beneath the water surface. The volume of the slab is 20 m$^3$ and the surface area of the top is 14 m$^2$. The density of ice is 900 kg/m$^3$ and sea water is 1030 kg/m$^3$.

A polar bear climbs to the top of the slab and sits on the slab for a long time.

d. On the diagram below show all the applied forces on the slab.
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A polar bear climbs to the top of the slab and sits on the slab for a long time.

e. If the average mass of a polar bear is 500 kg, calculate the maximum number of bears that can sit on the slab without sinking.
5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m$^3$.

   a. The circle below represents the sphere. Draw and label each of the applied forces that act on the sphere.
5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m$^3$.

b. Calculate the density of the sphere.
5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m$^3$.

   c. The string is cut and the sphere begins to move. Calculate the initial acceleration of the sphere immediately after the string is cut.
5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m³.

d. Does the buoyant force change as the sphere rises to the surface? Justify your answer.
5. A sphere with a radius of 5 cm is completely submerged in a tank of water and it is attached to the bottom of the tank by a string as shown in the picture above. The tension in the string is 0.75 times the weight of the sphere. The density of water is 1000 kg/m$^3$.

e. Does the buoyant force change as the sphere reaches the surface and rises out of the water? Justify your answer.