PSI Algebra Based Physics

Fluids

Practice Problems

Density and Specific Gravity

Classwork

1. What is the density of an aluminum block with a mass of 4050 kg and volume of 1.5 m^3?
2. What is the mass of a rectangular shaped ice block with dimensions of 0.04m × 0.05m× 0.03 m if the density of ice is 917 kg/m^3?
3. What is the volume of a wooden board with a mass of 0.6 kg and density of 900kg/m^3?
4. An iron block has a mass of 175.5 kg and volume of 0.0225 m^3. What is its density?
5. The density of copper is 8900 kg/m^3. What is the specific gravity of copper?

Homework

6. A concrete brick with dimensions of 0.8×0.3×0.2 m^3 has a density of 2300 kg/m^3. What is its mass?
7. The density of mercury is 13600 kg/m^3. What must the volume of a container be in order to store 4 kg of mercury?
8. A 500-mL (0.0005m^3) beaker has a mass of 250 g when empty and 645 g when filled with an unknown liquid. What is the density of the liquid?
9. What is the approximate mass of air in the physics classroom with dimensions 6.5×4.2×3.0 m^3 if the density of air is 1.29 kg/m^3?
10. A liquid has a specific gravity of 0.68. What is the density of the liquid?

Pressure

Classwork

11. A 150 N force is applied to an area of 0.2 m^2. What is the pressure due to this force?
12. An aluminum cylinder with a cross-sectional area 0.07 m^2 is placed vertically on a table-top. What is the weight of the cylinder if it exerts a 1400 Pa of pressure on the table-top?
13. What is the covered area by a 49 N object that exerts a pressure of 1200 Pa?
14. A 100 N wooden block has dimensions of 0.5 m ×0.4 m ×0.1 m. What is the maximum pressure the block can exert on a floor?
15. A 750 N boy stands on snowshoes. Each snowshoe has an area of 0.125 m^2. What is the pressure on the snow?

Homework

16. A 600 N force is applied to an area of 0.15 m^2. What is the pressure due to this force?
17. A copper cylinder with a cross-sectional area 0.034 m^2 is placed vertically on a table-top. What is the weight of the cylinder if it exerts an 800 Pa of pressure on the table-top?
18. What is the covered area by a 168 N object that exerts a pressure of 8200 Pa?
19. A 600 N metal block has dimensions of 0.3 m ×0.25 m ×0.1 m. What is the minimum pressure the block can exert on a floor?
20. A contact surface between a wagon wheel and railroad rails is 0.0025 m^2. What pressure does the wagon exert on rails if its mass is 30,000 kg?

Pressure and Pascal's Principle

Classwork

21. A 10-cm tall glass is filled with water (density 1000 kg/m^3). What is the water pressure at the bottom of the glass?
22. A diver can withstand a maximum pressure of 3×10^5 Pa. What maximum depth he can reach in seawater (density 1025 kg/m^3)?
23. A graduated cylinder is filled with mercury (density 13,600 kg/m^3). The distance between the surface of the mercury and the bottom of the cylinder is 25 cm. What is the mercury pressure at the bottom of the cylinder?
24. A diving bell can withstand a maximum pressure of 2.5×10^6 Pa. What maximum depth can the bell reach in seawater (density 1025 kg/m^3)?
25. A circular window in a submarine has a diameter of 40 cm. The window can withstand a maximum force of 5.6×10^5 N. What is the maximum depth in the sea (density 1025 kg/m^3) to which the submarine can submerge without breaking the window?
26. What is the absolute pressure if the gauge pressure is 100 kPa?
27. What is the gauge pressure if the absolute pressure is 400 kPa?
28. What is the absolute pressure 2.5 m below sea surface (density 1025 kg/m^3)?
29. A 400 N force is applied to the small piston of a hydraulic machine. The area of the small piston is 4 cm^2 and the area of the large piston is 36 cm^2? What maximum force can be supported by the large piston?
30. The large piston of a hydraulic machine with an area of 120 cm^2 supports an object with a weight of 10,000 N. What is the force applied to the small piston with the area 30 cm^2?

Homework

31. What is the gauge pressure at the bottom of a pool 1.9 m deep? (water density 1000 kg/m^3)
32. The gauge pressure at the bottom of “Marinas Trench” is 1.2×10^8 Pa. What is the distance between the surface of the ocean and the bottom of the Trench? (assuming the seawater density stays unchanged 1025 kg/m^3)
33. What gauge pressure must a pump produce to pump water from the ground level to the top of Empire State Building 381 m tall? (density 1000 kg/m^3)
34. What is the depth of a lake if the gauge pressure at the bottom is 1×10^5 Pa? (density 1000 kg/m^3)
35. A pool has a bottom area of 20 m^2 and is filled with water (density 1000 kg/m^3)to a height of 2 m. What is the force on the bottom of the pool applied by water?
36. A hatch of a diving bell has a circular shape with a diameter of 1.6 m. The hatch can withstand a maximum force of 4.8×10^5 N. What is the maximum depth in a lake (density 1000 kg/m^3) the bell can reach without destroying the hatch?
37. What is the absolute pressure if the gauge pressure is 3.2 atm?
38. What is the gauge pressure if the absolute pressure is 321 atm?
39. What is the absolute pressure 1.8 m below the surface of a lake (density 1000 kg/m^3)?
40. The small piston of a hydraulic lift has an area of 6 cm^2 and its large piston has an area of 54 cm^2. A 50 N force is applied to the small piston. What is the weight of the load can be lifted by the large piston?
41. The small piston of a hydraulic lift has an area of 25 cm^2 and the large piston has an area of 625 cm^2. What force must be applied to the small piston in order to lift a car weighing 14,000 N?

Buoyancy and Archimedes Principle

Classwork

42. A metallic object weighs 50 N in air and 40 N in water. What is the buoyant force of the water?
43. An object has a volume of 1.8 m^3. What is the buoyant force on the object when it is completely submerged into water (density 1000 kg/m^3)?
44. An object has a volume of 4.5 m^3 and a weight of 50,000 N. What will its weight be in water (density 1000 kg/m^3)?
45. If the density of iron is 7800 $kg/^3$, what is the buoyant force on the 234 kg iron block in water (density 1000 kg/m^3)?
46. A 1500 N object floats in water. What is the weight of displaced water?
47. A 30,000 N ice foe floats in sea water (density 1025 kg/m^3). What is the submerged volume of the floe?
48. A wooden block floats in water with a half of its volume beneath the surface. What is the density of wood?
49. An ice floe has a rectangular shape with a surface area of 40 m^2 and 0.1 m thick. What is the maximum mass of a polar bear can sit on the floe before sinking? (ice density 900 kg/m^3, sea water density 1025 kg/m^3)

Homework

50. A 650 N diver weighs 500 N in sea. What is the buoyant force of the sea water?
51. An object has a volume of 3.2 m^3. What is the buoyant force on the object when it is completely submerged into sea (density 1025 kg/m^3)?
52. An object has a volume of 3.4 m^3 and a weight of 45,000 N. What will its weight be in water (density 1000 kg/m^3)?
53. If the density of copper is 8900 $kg/^3$, what is the buoyant force on the 356 kg copper block in water (density 1000 kg/m^3)?
54. A 2400 N object floats in water. What is the weight of displaced water?
55. A 50 N wooden block floats in water (density 1000 kg/m^3). What is the submerged volume of the block?
56. A wooden block floats in water with three-quarter of its volume beneath the surface. What is the density of wood?
57. An ice floe has a rectangular shape with a surface area of 3 m^2 and 1 m thick. What is the maximum mass of a polar bear can sit on the floe before sinking? (ice density 900 kg/m^3, sea water density 1025 kg/m^3)
58. A wooden raft has a rectangular shape with a surface area of 36 m^2 and 0.5 m thick. What is the maximum number of a rescue team with an average mass of each person 75 kg can cross a river by using the raft? (wood density 600 kg/m^3, water density 1000 kg/m^3)

Fluid Dynamics

Classwork

59. Water flows through a pipe of cross-sectional area 2 cm^2 at a rate of 2.5 m/s. The cross-sectional area of the pipe is increased to 10 cm^2. What is the water rate in the wider section of the pipe?
60. Water flows through a pipe of cross-sectional area 16 cm^2 at a rate of 12 m/s. The cross-sectional area of the pipe is decreased to 4 cm^2. What is the water rate in the narrow section of the pipe?
61. Water flows through a horizontal pipe at a speed of 15 m/s and pressure 4×10^5 Pa. The pipe widens and the water speed drops to a 5 m/s. What is the pressure in the wider section of the pipe?
62. Water flows through a horizontal pipe at a speed of 8 m/s and pressure 3.4×10^5 Pa. The pipe narrows and the water speed goes up to a 16 m/s. What is the pressure in the narrow section of the pipe?
63. A container holds water at a depth of 12 m. There is a hole in the bottom of the container. At what speed will water flow out of the hole?

Homework

64. Water flows through a pipe of cross-sectional area 3 cm^2 at a rate of 36 m/s. The cross-sectional area of the pipe is increased to 27 cm^2. What is the water rate in the wider section of the pipe?
65. Water flows through a pipe of cross-sectional area 48 cm^2 at a rate of 6 m/s. The cross-sectional area of the pipe is decreased to 12 cm^2. What is the water rate in the wider section of the pipe?
66. Water flows through a horizontal pipe at a speed of 24 m/s and pressure 4.2×10^5 Pa. The pipe widens and the water speed drops to a 6 m/s. What is the pressure in the wider section of the pipe?
67. Water flows through a horizontal pipe at a speed of 14 m/s and pressure 8.4×10^5 Pa. The pipe narrows and the water speed goes up to a 42 m/s. What is the pressure in the narrow section of the pipe?
68. A water tank is filled with water. There is a faucet on the side wall of the container 6 m below the surface of water. What will the speed of water flow be when the faucet is opened?

Fluids Answer Key

1. 2700 kg/m^3
2. 0.055 kg
3. $6.7x10^{-4}$ m^3
4. 7800 kg/m^3
5. 8.9
6. 110.4 kg
7. $2.9x10^{-4}m^3$
8. 790 kg/m^3
9. 1057 kg
10. 680 kg/m^3
11. 750 Pa
12. 98 N
13. 0.041 m^3
14. 2500 Pa
15. 3000 Pa
16. 4000 Pa
17. 27.2 N
18. 0.02 m^3
19. 8000 Pa
20. $1.18x10^8$Pa
21. 980 Pa
22. 29.9 m
23. 33320 Pa
24. 248.9 m
25. 443.6 m
26. 201 kPa
27. 299 kPa
28. $1.26x10^5$ Pa
29. 3600 N
30. 2500 N
31. 18620 Pa
32. 11946 m
33. 3.7×10^6 Pa
34. 10.2 m
35. 392000 N
36. 24.4 m
37. 4.2 atm
38. 320 atm
39. $1.18x10^5$ Pa
40. 450 N
41. 560 N
42. 10 N
43. 17640 N
44. 5900 N
45. 294 N
46. 1500 N
47. 2.99 m^3
48. 500 kg/m^3
49. 500 kg
50. 150 N
51. 23144 N
52. 11680 N
53. 356 N
54. 2400 N
55. 0.005 m^3
56. 750 kg/m^3
57. 375 kg
58. 96 people
59. 0.5 m/s
60. 48 m/s
61. $5x10^5$ Pa
62. $2.44x10^5$ Pa
63. 15.3 m/s
64. 4 m/s
65. 24 m/s
66. $6.9x10^5$ Pa
67. $5.6x10^4$ Pa
68. 10.8 m/s