1. A barge is 20 m wide and 40 m long and has vertical sides. The bottom of the boat is 2.2 m below the water surface. What is the weight of the barge and its cargo, if it is floating in fresh water of density 1000 kg/m$^3$?

2. In outer space, a positive charge $q$ is released near a positive fixed charge $Q$, as shown in the figure. As $q$ moves away from $Q$, what is true about the motion of $q$? (There may be more than one correct choice.)

3. A piece of iron rests on top of a piece of wood floating in a bathtub. If the iron is removed from the wood, and kept out of the water, what happens to the water level in the tub?

4. If atmospheric pressure increases by an amount $\Delta p$, what happens to absolute pressure? Gauge pressure?

5. An electron and a proton are released simultaneously from rest and start moving toward each other due to their electrostatic attraction, with no other forces present. Which of the following statements are true just before they are about to collide? (There could be more than one correct choice.)

6. An air bubble underwater has the same pressure as that of the surrounding water. As the air bubble rises toward the surface (and its temperature remains constant), what happens to its volume?

7. A 340 g metal container, insulated on the outside, holds 120.0 g of water in thermal equilibrium at 23.0°C. A 21.0 g ice cube, at the melting point, is dropped into the water, and when thermal equilibrium is reached the temperature is 15.0°C. Assume there is no heat exchange with the surroundings. For water, the specific heat capacity is 4190 J/kgK and the heat of fusion is $3.34 \times 10^5$ J/kg. What is the specific heat capacity of the metal of the container?

8. Water flows out of a large reservoir through 7.0-cm diameter pipe. The pipe connects to a 4.0-cm diameter pipe that is open to the atmosphere, as shown in the figure. What is the speed of the water in the 7.0-cm pipe? Treat the water as an ideal incompressible fluid.
9. How much heat must be removed from 256 g of water at 23.0°C to change it into ice at -10.0°C? The specific heat of ice is 2090 J/kgK, the latent heat of fusion of water is $33.5 \times 10^4$ J/kg, and the specific heat of water is 4186 J/kgK.

10. Two tiny beads are 25 cm apart with no other charges or fields present. Bead A carries 10 µC of charge and bead B carries 1 µC. What is the force on B relative to the force on A?

11. A fixed container holds oxygen and helium gases at the same temperature. Which of the following statements are correct? (There could be more than one correct choice.)

12. As shown in the figure, fluid fills a container having several sections. At which of the indicated points is the pressure greatest?

![Diagram of fluid-filled container with several sections]

13. When a heavy metal block is supported by a cylindrical vertical post of radius $R$, it exerts a force $F$ on the post. If the diameter of the post is increased to $2R$, what force does the block now exert on the post?

14. Two metal rods are to be used to conduct heat from a region at 100°C to a region at 0°C as shown in the figure. The rods can be placed in parallel, as shown on the left, or in series, as on the right. When steady state flow is established, the heat conducted in the series arrangement is

![Diagram of metal rods in parallel and series configurations]

15. A spherical ball of lead (density 11.3 g/cm$^3$) is placed in a tub of mercury (density 13.6 g/cm$^3$). Where does the lead ball end up?

16. Two metal spheres are made of the same material and have the same diameter, but one is solid and the other is hollow. If their temperature is increased by the same amount, what happens to their respective densities?
17. A pressurized cylindrical tank, 5.0 m in diameter, contains water that emerges from the pipe at point C with a speed of 84 m/s, as shown in the figure. Point A is 10 m above point B and point C is 3.0 m above point B. The area of the pipe at point B is 0.080 m² and the pipe narrows to an area of 0.070 m² at point C. Assume that the water is an ideal fluid in laminar flow. The density of water is 1000 kg/m³. The rate at which the water level is falling in the tank is closest to

![Diagram of a pressurized cylindrical tank with points A, B, and C labeled.]

18. In outer space, a positive charge $q$ is released near a positive fixed charge $Q$, as shown in the figure. As $q$ moves away from $Q$, what is true about the motion of $q$?

![Diagram of positive charges $Q$ and $q$.]

19. Which one of the arrows shown in the figure best represents the direction of the electric field between the two uniformly charged metal plates?

![Diagram of metal plates with arrows indicating electric field direction.]

20. How many moles are there in 5.00 kg of iron? The atomic weight of copper is 55.845 g/mol and its density is 7870 kg/m³.
21. When a box rests on a round sheet of wood on the ground, it exerts an average pressure $p$ on the wood. If the wood is replaced by a sheet that has half the diameter of the original piece, what is the new average pressure?

23. Four tiny charged particles (two having a charge $+Q$ and two having a charge $-Q$) are distributed on the $x$- and $y$-axes as shown in the figure. Each charge is equidistant from the origin. In which direction is the net electric field at the point $P$ on the $y$-axis?

24. Originally 3.00 mol of gas are at STP. If the temperature changes to 23.0°C and the pressure decreases to a third of what it was, how many liters do the three moles now occupy?

25. In a section of horizontal pipe with a diameter of 5.0 cm, the pressure is 100 kPa and water is flowing with a speed of 1.5 m/s. The pipe narrows to 3.0 cm. What is the pressure in the narrower region? Treat the water as an ideal incompressible fluid.