Problem 1: Constant force and direction:

(a) Calculate the amount of work done pushing a box with constant force of 5 N a distance of 16 m.

(b) Calculate the amount of work done pushing a metal sphere 100 m across a field if you push consistently using 10 N of force.

(c) If you pull a large sleigh with 6 N of force diagonally across a snowy field a distance of 37 m, what is the total work done?

(d) Find the work done lifting a 3 kg box up to the top of a set of stairs 8 m above the ground.

(e) If you pull a storage container weighing 80,000 g up a skyscraper 0.2 km, what is the work done?

Problem 2: Lifting problems:

(a) A bucket weighing 2.3 kg and filled with 7.3 kg of water is attached to a nylon wire with linear density of 7.1 g/m. If the bucket is at the bottom of a 15 m hole, find the work done pulling the bucket from the bottom of the hole to the top.

(b) A load of construction materials weighing 181.4 N sits at the base of a constructions site. The materials need to be lifted to the top of the parking garage being built—a distance of 18.3 m above the ground. The workers use an aluminum cable weighing 0.02 kg per meter. Find the work done lifting these materials.

(c) A 6 m cable 'weighing' 18 kg hangs from a building with none of the cable touching the ground. Find the work done pulling in all the cable to the top of the building. How would the situation change if 1 m of the cable was lying on the ground? Can you calculate the work in this case? If so, calculate it. If not, explain why.

(d) A 45 kg chain is 15 m long and is hanging completely suspended in the air from a wooden beam at the top of a barn. How much work is required to pull in the first 10 m of the chain?

(e) A 3.6 kg bucket containing 2.5 kg of water is hanging at the end of a 16 m chain weighing 4500 g/m. The end of the chain is attached to a pulley. The chain is pulled across the pulley at a rate of 0.2 m/s, lifting the bucket up. However, the bottom of the bucket has sprung a leak and water begins to leak out of the bucket at a rate of 1 kg/min. Find the work done reeling in the bucket of water entirely. How would the situation chance if the water were leaking out at 1.5 kg/min? Can you calculate the work done in this case?

Problem 3: Pumping Problems:

(a) A rectangular tank 10 m long and 2 m wide is filled 1.5 m deep with water. Find the work required to pump all the water to the top of the tank. What if only 1 m of water is to be removed?

(b) A cylindrical tank of height 3 m and width 1 m is filled with caster oil (density 956.1 kg/m^3). Find the work done pumping all of the oil out of the container.

(c) A holding tank has the shape of an inverted cone. The tank has height 6 m and the width at the hold of the tank is 2 m. If the tank is filled three-quarters of the way to the top of the tank with beer (density 1010 kg/m^3), find the work done pumping the beer to a pre-bottling holding cell 10 m above the top of the tank.

(d) A trough has the shape of a half-drum (half a cylinder) and is lying on its side. If the trough has length 10 m and is 1 m wide and assuming the trough is full of water, find the work done pumping all the water to the top of the trough.

(e) A spherical tank has radius 2 m and is filled with water (density 1000 kg/m^3). Connected at the top of the tank is a 0.5 m spout. If the tank is half full and the water in the tank has to be pumped out the spout at the top of the tank, what is the total work done?

(f) A cylindrical storage tank having length 10 m and a width of 4 m is lying on its side and is buried 8 m below the ground. If the tank is filled with butane (density 599 kg/m^3) and is to be pumped to the surface through a outlet pipe at the top of the tank, what is the total work done? What if the outlet pipe were at the bottom of the tank?

(g) Determine the amount of work done in pumping water out of a trapezoidal tank filled with water if the tank has a rectangular bottom with length 10 m and width 8 m and the rectangular top has width of 15 m and width of 10 m. The tank is 10 m tall.

(h) A underground storage tank is filled with castor oil (density 956 kg/m^3). If the tank has the shape of a semisphere with the circular base on top and parallel to the ground, what is the work done pumping the oil out of the tank if the tank is full and buried 6 m below the surface?

(i) Determine the work required to pump a liquid with density ρ out of a tanked shaped like the frustum of a right circular cone with height h meters, lower radius R meters, and upper radius r meters ($r < R$) if the liquid is to be pumped out the top of the frustum. Use this to find the work done if the tank had the shape of a right circular cone with base radius R and height h.

Problem 4: Pressure Problems:

(a) A equilateral triangular plate of width 4 meters is submerged in the water so that the base of the plate is touching the surface of the water and parallel to it. Find the hydrostatic force on the plate.

(b) A equilateral triangular plate of width 4 meters is submerged in the water so that the base of the plate is 1 m above the surface of the water and is parallel to the waters surface. Find the hydrostatic force on the plate.

(c) A equilateral triangular plate of width 4 meters is submerged in the water so that the base of the plate is parallel to the waters surface and is 5 m below the surface. Find the hydrostatic force on the plate.

(d) Find the hydrostatic force on a circular plate of radius 2 m that is submerged 30 m below the surface of the water.

(e) A water trough has the shape of a vertical triangular plate with width 1 m and is 1 m deep. What is the fluid force against the ends of the trough?

(f) A truck with a large cylindrical storage tank, 12 m in length and 2 m across, filled with oxolane (density 888 kg/m^3). If the tank is filled up to a half a meter below the top of the tank, what is the force on the end of the tank?

(g) Determine the hydrostatic force on the side of a trapezoidal tank filled with water if the tank has a rectangular bottom with length 10 m and width 8 m and the rectangular top has width of 15 m and width of 10 m. The tank is 10 m tall. Assume the tank is completely filled. What if the tank were filled to a depth of 8 m? What is the tank were half full (in terms of volume).