What is a "force"?

In physics, a force is any interaction which tends to change the motion of an object. In other words, a force can cause an object with mass to change its velocity (which includes to begin moving from a state of rest), i.e., to accelerate. Force can also be described by intuitive concepts such as a push or a pull. A force has both magnitude and direction, making it a vector quantity. It is measured in the SI unit of newtons and represented by the symbol F.

The original form of Newton's second law states that the net force acting upon an object is equal to the rate at which its momentum changes with time. If the mass of the object is constant, this law implies that the acceleration of an object is directly proportional to the net force acting on the object, is in the direction of the net force, and is inversely proportional to the mass of the object. As a formula, this is expressed as:

$$\sum \vec{F} = m\vec{a}_{\text{net}}$$

where the arrows imply a vector quantity possessing both magnitude and direction. There may be many forces acting on an object, and each of them will contribute to the net acceleration of that object.

Taken singly, each force contributes to an acceleration, leading to Newton’s Second Law of Motion:

$$\vec{F} = m\vec{a}$$

One such force we have discussed is the force proportional to the weight of the atmosphere. We called that the pressure force, and if you are laying flat on the earth, it is
indeed proportional to the weight of the atmosphere pressing down on you, in which the acceleration of gravity produces what we call “weight”, mass X gravity.

Sometimes, to prevent confusion, we separate the forces and accelerations that occur on each of the three coordinate axes. We can indicate that by putting a subscript x, or y, or z, to indicate that we are considering the forces act on that axis alone. However, there may be forces that also act on the other axes as well.

Both the vertical pressure force itself and the acceleration of gravity act in the negative z direction, since they point downward. Pressure is itself the result of a force applied over a unit area, such as dynes/cm² or pounds/in². In reality, the pressure force is distributed in all three directions of the rectangular coordinate system. Unequal distribution of pressure forces can be associated with what meteorologists and oceanographers call the “pressure gradient acceleration” that will be discussed in an upcoming class session.