Welcome students, I'm FatimaFernandes from Carmel College of Arts, Science and Commerce for Women , Nuvem,Goa. Today I will be discussing the carbon dioxide system from the chapter phase rule. This is module #13.Outline we have the phase rule. Carbon dioxide system and differences between water system and the carbon dioxide system . Learning outcomes: It explains the phase rule and it applies the phase rule to the carbon dioxide system. Now the mathematical expression for the phase rule is given by F isequal to C - P + 2, where F is the degree of freedom, C is the number of components and P is the number of phases.

In the carbon dioxide system,there are three phases, hence P is equal to three and these phases are solid carbon dioxide, liquid carbon dioxide, and gaseous carbon dioxide. In the carbon dioxide system, the number of components is one that

is the composition of everyphase can be expressed in terms

of 1 chemical constituent, that is carbon dioxide. There

are three types of equilibrium in the carbon dioxide system. Equilibrium between solid carbon dioxide and liquid carbon dioxide, liquid carbon dioxide,and gaseous carbon dioxide, gaseous carbon dioxide, and solid carbon dioxide. We can see each equilibrium involves two phases.

This is a phase diagram of the carbon dioxide system.It is a graphical representation of the physical states of carbon dioxide under different conditions of temperature and pressure.
We will see the curves first. Now curve OA is the sublimation curve.
Curve OC is called as the Fusion curve. Curve OB is called as the vaporization curve.
Along this curve AO there is solid carbon dioxide in equilibrium with gaseous carbon dioxide.
Along curve OB liquid carbon dioxide in equilibrium with gaseous carbon dioxide. Along curve OC solid carbon dioxide is in equilibrium with liquid carbon dioxide.
We can see the areas marked here. We have solid carbon dioxide in this area. AOC, liquid carbon dioxide in the area COB and gaseous carbon dioxide in the area AOB.
The two important points in this particular phase diagram is O
which is the triple point and point B which is called as the
critical point.
Now in the phase diagram, we have already seen
the curves, we have curve OA, curve OC and curve OB.
Now along any of these curves there are always two phases which are in equilibrium. Hence on any curve, P will be equal to two. In any area AOC

COB or AOB, the number of phases is one, that is there is just one phase in that given area.
The important points which are shown by the red arrow is the triple Point O which has coordinates of minus 56.6 degrees centigrade, and 5.11 atmosphere and the critical point B which has coordinates of 31.1 degrees centigrade and 73 atmospheres.

Application of the phase rule to the carbon dioxide system. Carbon dioxide system is a one component system. So if you substitute, C as equal to 1 in the phase rule equation we have,F is equal to C - P + 2
Along any curve, number of phases is always 2, so substitute P as equal to two and we get degree of freedom F as one.
Degree of freedom is 1 means it is a univariant system along any curve, and one variable has to be specified to define the system,either temperature or pressure has to be specified, the other is automatically fixed
In any area,the number of phases P is equal to , when you substitute in the phase rule equation we get the degree of freedom as equal to two, hence it is a bi variant system. So in any area it is always a bivariant system.
Hence both temperature and pressure has to be specified to describe a state in an area
At the triple O, all the three phases. Solid carbon dioxide,Liquid carbon dioxide, and gaseous carbon dioxide, coexist. The number of phases here will be 3.
So P is equal to three and if you apply this to the Phase rule equation, we get the degree of freedom F as equal to zero. Hence at the triple point, It is a non variant or invariant system,which means the triple point has got a rigid conditions.
The temperature and pressure at the triple point are fixed and they cannot be changed.The pressure is 5.11 atmosphere and the temperature is minus 56.6 degrees centigrade.

Now at the critical point B, which I've highlighted, liquid and the gas phases have exactly the same density and only a single phase will exist. This single phase is called super critical fluid.
The meniscus here, which separates the liquid and the gas will disappear. The critical temperature is 31 degrees centigrade and the critical pressure is 73atmospheres.
Why carbon dioxide is called dry ice?
Carbon dioxide is called as dry ice because liquid carbon dioxide cannot exist at any pressure below 5.11 atmospheres, so below this pressure, solid carbon dioxide when heated will directly pass into gaseous state without melting or liquid being formed. This is the process of sublimation and hence carbon dioxide is called dry Ice.
What are the differences between water system and the carbon dioxide system?

First difference, solid liquid boundary for Water System has a negative slope. It is inclined more towards the Y axis, whereas for carbon dioxide it has a positive slope.
Second difference, the coordinates of the triple point in the water system is 0.0098 degrees centigrade, and 4.58 milli meters of Mercury, whereas in the carbon dioxide system the coordinates are minus 56.6 degrees centigrade and 5.11 atmospheres, which is comparatively very higher than the water system.
Third difference is at one atmospheric pressure water can exist in all three phases, whereas carbon dioxide can exist in only two phases and does not exist in the liquid state. Solid carbon dioxide sublimes directly to a gas.
This is Glossary. You can go through the terms involved.

References.
Thank you.