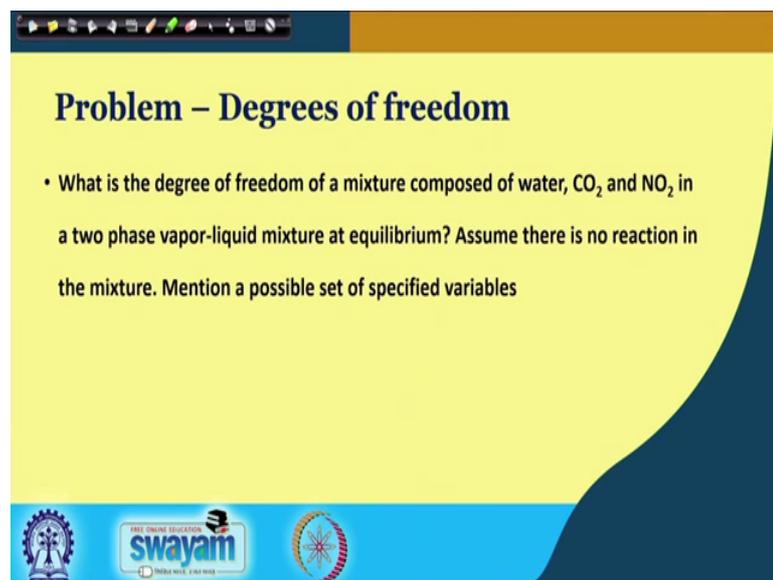


**Mass, Momentum and Energy Balances in Engineering Analysis**  
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**Cryogenics Engineering Center**  
**Indian Institute of Technology, Kharagpur**

**Lecture – 04**  
**Balance Equations Preliminaries – I (Contd.)**

Hello, today in this particular lecture, we shall be doing some problem solving based on whatever physical concepts or we have learned so far. And also we shall be going back to some very basics, which we learned in our school ok. So, some of these things you might find that you know, and some of these things with the kind of revision for you, but these are important for the balance equations.

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**Problem – Degrees of freedom**

- What is the degree of freedom of a mixture composed of water, CO<sub>2</sub> and NO<sub>2</sub> in a two phase vapor-liquid mixture at equilibrium? Assume there is no reaction in the mixture. Mention a possible set of specified variables

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So, the first problem: here we see that how to find out the degrees of freedom, and how to specify it. So, here it says that we have to determine the degrees of freedom of a mixture composed of water, carbon dioxide, and nitrogen dioxide. And these three components are in a two phase vapor-liquid mixture at equilibrium ok. And as we learned earlier that degrees of freedom applies only for the system that equilibrium ok. And it is also mentioned that there is no reaction in the mixture.

The second part of the question is that: we have to mention a possible set of specified variables, as we learned that degrees of freedom gives us the minimum number of

intensive variables needed to be specified to describe the system completely at equilibrium.

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**Solution**

Component:  $\text{H}_2\text{O}, \text{CO}_2, \text{NO}_2$   
Number of components,  $C = 3$   
Number of phases:  $\pi = 2$  (liquid and gas)  
Number of independent reactions,  $\nu = 0$

Gibbs phase rule,  $F = 2 + C - \pi - \nu$   
 $F = 2 + 3 - 2 - 0$   
 $F = 3$

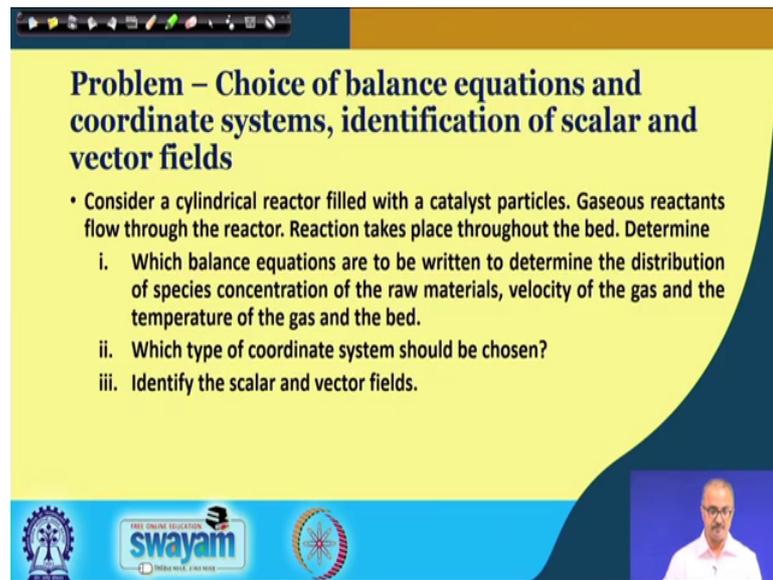
Possible specification:  $T, P$ , liquid phase mole fraction of  $\text{CO}_2$

So, let us go to the solution. Here first we write the components we have, there we have water, carbon dioxide, and nitrogen dioxide. So, we have three components, so  $C$  is equal to 3. Now, since we have two phases, liquid and gas. So, we write the  $\pi$  equal to 2. And since there are no reactions happening, so  $\nu$  is equal to 0.

So, now let us go to the Gibbs phase rule, we write that  $F$  equal to 2 plus  $C$  minus  $\pi$  minus  $\nu$ .  $\nu$  is 0,  $\pi$  is 2,  $C$  is 3 plugging these values, we find the  $F$  equal to 3, that means, we have to figure out three intensive variables, which can describe the system completely. And you can see that a one possible set is that temperature, pressure, and liquid phase mole fraction of CO say CO 2, only one mole fraction is good enough ok.

These three are good enough to describe the system. That means, we can find out the mole fractions of the water and nitrogen dioxide in the liquid phase and in the vapor phase with only these three things. So, we can also describe the system completely ok. And how to do this; we shall learn later on.

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**Problem – Choice of balance equations and coordinate systems, identification of scalar and vector fields**

- Consider a cylindrical reactor filled with a catalyst particles. Gaseous reactants flow through the reactor. Reaction takes place throughout the bed. Determine
  - i. Which balance equations are to be written to determine the distribution of species concentration of the raw materials, velocity of the gas and the temperature of the gas and the bed.
  - ii. Which type of coordinate system should be chosen?
  - iii. Identify the scalar and vector fields.

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Next problem is based on the balance equations, and the coordinate systems, and identification of scalar and vector fields. So, you have to given the problem, you have to identify what kind of balance equations you would need, what kind of coordinate system you would go for, and you have to identify that which are the scalar field, and which are the vector fields.

So, here we are saying that consider a cylindrical reactor filled with a catalyst some particles. So, catalyst particles are there and you know that reactors are often having the catalyst, because they help in lowering the extremity of the conditions, for example temperature or pressure to do some reaction ok. So, gaseous reactants flow through the reactor. Reaction takes place throughout the bed. And we have been asked to determine, which balance equations should be written to determine the distribution of species concentration of the raw materials, velocity of the gas and the temperature of the gas and the bed.

So, you see that as the raw materials are moving through the bed because of reaction the concentrations are changing. So, if we need to know what kind of concentration distribution and profiles are getting generated inside the bed, what kind of equations we need to write? Similarly, if the reactions are having some kind of heat effect, they may be exothermic or endothermic depending on that the temperature may either rise or temperature may either or fall ok. So, how the temperature is varying in the reactor?

Similarly, due to these reactions the properties like density may also getting changed. And due to these what happens, the flow rate is getting changed, and due to that the velocities are also getting changed. So, all these how to find a distribution of the velocities; so all these things, we need to determine. So, what kind of equations we need to write? 2nd part is this, which kind of coordinate system we choose? We should choose to do this kind of the study. And thirdly, we have to identify which are the scalar fields and which are the vector fields.

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**Solution**

i. The following table shows which equations are to be used

Variable to be determined	Type of equations
Concentration profile	Mass balance (overall and species)
Temperature profile	Energy balance
Velocity distribution	Momentum equation

ii. Since the reactor is cylindrical, the choice is generally cylindrical coordinate system. However, simplifications may be done to simplify the equation and adopt rectangular coordinate system.

iii. Concentration and temperature – Scalar field, Velocity – Vector field

So, here we have the first we write that to find out this these things that concentration profile. We have to go for the mass balance equation, because in the mass balance only we find, we have the concentrations come into picture. Now, here we have both mass balance. One is overall mass balance, another is the species mass balance. Species, because each species is changing it is identity ok. So, the mass total mass of the mixture, we will be having some kind of composition at the inlet. And some other composition at the outlet, because many species have lost their identity, and they have given rise to some new species; so, we have to go by species by species balance.

Next is the temperature profile, and for that temperature comes only from the energy exchange. So, we need to write the energy balance equation. And thirdly, we have the velocity distribution for that we can have it from the momentum balance equation. So,

we find that all these momentum balance, energy balance, and mass balance have to be written to find out all these profiles.

Next is which kind of coordinate system, we should choose. Now, the reactor is cylindrical. So, generally for cylindrical geometry, we go for cylindrical coordinate, but you will find that this is a general statement. But, many a times we do some simplifications, because cylindrical coordinate system equations are a bit more difficult to solve than for the Cartesian coordinate system ok.

So, even though obvious choice is cylindrical, but many a times depending on the particular situation by some making some assumptions. We can also choose a rectangular coordinate system to analyze such kind of problem, so that I am not telling you now. But, in general we say that, we can choose a cylindrical coordinate based on the geometry of the system.

And thirdly to find out the concentration and the temperature, we find that. Concentration and temperature are both scalar field. On the other hand velocity is a vector field, because velocity you know that it goes in three directions. So, we can identify now that for the concentration and temperature. That means, concentration means it is coming for the mass balance. So, those mass balances are scalar field mass balance, temperature energy balance that is also a scalar field balance. Similar, but for the velocities momentum equation, this will be a vector field that means, the momentum equation will be written in the three directions separately.

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**Problem – Conversion from Cartesian to cylindrical coordinates**

- Convert the points  $(-2,1,4)$  to cylindrical coordinates

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Next problem is about conversion from a Cartesian coordinate to cylindrical coordinate. So, here we have been given this particular coordinate values minus 2, 1, 4. And we have to make this thing into the a cylindrical coordinate.

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**Solution**

- Given:  $x = -2, y = 1$  and  $z = 4$
- To Find:  $r, \theta, z$
- Method:

$$r = \sqrt{x^2 + y^2}$$
$$\Rightarrow r = \sqrt{-2^2 + 1^2} = \sqrt{5}$$
$$\theta = \tan^{-1}\left(\frac{y}{x}\right)$$
$$\Rightarrow \theta = \tan^{-1}\left(\frac{1}{-2}\right) \cong -0.46 \text{ rad} \cong -26.35^\circ$$
$$z = z = 4$$

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So, first let us see, what is given to us that we know the x value, y value, and z value. And we have to find out the corresponding r, theta, and z. So, we know that this is the particular expression given to convert this x and y to r. And we find this r is under root 5 that is the point is located, under root 5 units from the origin.

Then the rotation and this rotation is also called azimuthal ok, the azimuthal direction is theta. So, what is rotation? This we can find from tan inverse y by x. And here you find it is minus 0.46 radian or minus 26.35 degrees, and the elevation remains the same. So, r theta z, x, y, z; z is remaining the same. So, why this a radial distance, the rotation, and the elevation. We have now located the same point in the cylindrical coordinate system.

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**Problem – Conversion from Cartesian to spherical coordinates**

- Given:  $x = -2, y = 1$  and  $z = 4$
- To Find:  $r, \theta, \phi$

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Next is to convert the Cartesian coordinate to spherical coordinate. Again here we have these points minus 2, 1, 4, we have to find out r, theta, phi.

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**Solution**

- Given:  $x = -2, y = 1$  and  $z = 4$
- To Find:  $r, \theta, \phi$
- Method:

$$r = \sqrt{x^2 + y^2 + z^2} \quad \theta = \tan^{-1} \left( \frac{\sqrt{x^2 + y^2}}{z} \right) \quad \phi = \tan^{-1} \left( \frac{y}{x} \right)$$

$$\Rightarrow r = \sqrt{-2^2 + 1^2 + 4^2} \quad \theta = \tan^{-1} \left( \frac{\sqrt{-2^2 + 1^2}}{4} \right) \quad \phi = \tan^{-1} \left( \frac{1}{-2} \right)$$

$$r = \sqrt{13} \quad \theta \cong 0.51 \text{ rad} \cong 29.20^\circ \quad \phi \cong -0.46 \text{ rad} \cong -26.56^\circ$$

The slide includes a Swamyam logo and a small video inset of a man in a white shirt.

So, here to find  $r$ ,  $\theta$ ,  $\phi$ : we apply these equations for  $r$  we write this,  $\theta$  this, and  $\phi$  this. And we find the value of  $r$  is  $\sqrt{13}$ , and  $\theta$  is  $-\text{0.52}$  radian and  $\phi$  is  $0.46$ . So, what you find that in the two problems. Even though the coordinates is remaining same in the Cartesian system, but they are having different values of the radial distance, the  $\theta$ , and the  $\phi$  in the two systems ok.

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**Problem – Dimensions and units**

- Mass flow rate through a nozzle is given by the following equation as a function of temperature ( $T$ ) and pressure ( $P$ ) :

$$m = 0.06P/\sqrt{T}$$

Where  $m$  is in kg/s,  $P$  is in Pa, and  $T$  is in K.  
Determine the units of the constant 0.06.

Now, we come to a very important concept and aspect, because here we find we are prone to make many mistakes, and because of which we land up with wrong answers and wrong analysis. So, this is about dimensions and units. And whenever you are about to solve any kind of equation, you must check for the dimensions and the units that means, the dimensions and the units must be consistent in the reaction particular equation.

So, here we are given that the mass flow rate through a nozzle is given by the following equation ok. And this equation, we have the pressure and the temperature. And here we are also given this mass flow rate is given in kg per second; pressure is given in terms of Pascal, and temperature in terms of the Kelvin. So, we have to determine, what is the unit of this particular constant 0.06? Please understand depending on the unit used in the equation, the value of the constant will change ok. So, we have to first find out what is the dimension of this particular constant.

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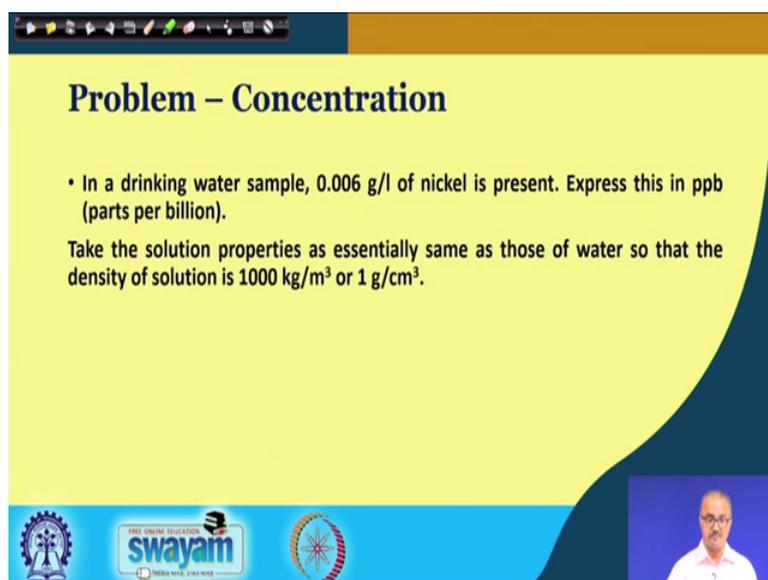
**Solution**

- Write the units of various variables:
$$\frac{\text{kg}}{\text{s}} = 0.06 \frac{\text{Pa}}{\text{K}^{0.5}}$$
- Pa is a derived unit and can be given in terms of the fundamental units as  $\text{kg m}^{-1} \text{s}^{-2}$ .
- Thus the dimensional equation can be rewritten as
$$\frac{\text{kg}}{\text{s}} = 0.06 \frac{\text{kg}}{\text{m s}^2 \text{K}^{0.5}}$$
- Whence the unit of 0.06 is  $\text{m s K}^{0.5}$

So, what we do without writing any kind of numbers, we simply put this kg per second on the left hand side, because mass plate is in the kg per second. The Pascal is for the pressure and Kelvin for the temperature. Now, what we do that we write now that all these things in there, because there are we know that this pressure is a derived quantity ok. So, we put everything in terms of fundamental variables. So, kg is second there all fundamental, this Kelvin is fundamental, now we pressure is kg per meter per second square.

So, we put this kg per meter per second square here. And then after some cancellations, we find that this 0.06 has a dimension of meter second Kelvin to the power 0.5. So, this particular value is not dimensionless, it has a dimension. And this value will certainly change, if we change the dimension. So that is how we are applying the concept of dimensional consistency, unit consistency in determining the particular unit of a particular constant.

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**Problem – Concentration**

- In a drinking water sample, 0.006 g/l of nickel is present. Express this in ppb (parts per billion).

Take the solution properties as essentially same as those of water so that the density of solution is  $1000 \text{ kg/m}^3$  or  $1 \text{ g/cm}^3$ .

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Next we come to the concentration. Now, concentration we learned can be represented in various manners. One common thing is to find out in terms of the ppb that is part per billion, ppm-parts per million. This we encounter a lot many times in our day-to-day life. Because, whenever we are reporting the environmental condition the pollution content in the environment, you will find that in the newspapers, in other literature people are talking in terms of ppm, ppb of the various kinds of pollutants, whether in air or whether in the land ok.

So, let us see that how we can convert, we can understand what is ppb, and what is ppm. Now, as such ppb means part per billion that means, part per billion means  $10$  to the power  $9$ , parts per million means parts per  $10$  to the power  $6$  ok. So, let us see that how we convert this particular given a thing in water, drinking water it has  $0.006$  gram per liter of nickel ok. And we have to express this in terms of part per billion.

Here we do to do this kind of problem we assume that because it is such a small amount is there. So, we assume the water sample is having properties of water, and its density is same as that of water that is  $1000 \text{ kg per meter cube}$  or  $1 \text{ gram per cubic centimeter}$ . This information we would need for the conversion ok.

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**Solution**

$$\frac{0.006 \text{ mg Ni}}{1 \text{ l of soln}} \times \frac{1 \text{ l soln}}{1000 \text{ cm}^3} \times \frac{1 \text{ cm}^3}{1.00 \text{ g water}} \times \frac{1 \text{ g}}{1000 \text{ mg}} = \frac{6 \text{ g}}{10^9 \text{ g soln}} = 6 \text{ ppb}$$

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So, here I have shown you that we are given this is 0.006 oh it should be milligram it should be milligram, there is a mistake here milligram it should be milligram ok. So, we go there.

So, we simply make this kind of thing that one this many milligrams per liter of solution this is liter 1 ok. So, 1 liter solution is 1000 cubic centimeter. And then that means, we have converted into cubic centimeter. And then what we are doing, we are just dividing by the density of water to get that how much gram, it is coming to per gram of water. And then 1 gram is 1000 milligram. So, we find that this 6 gram is coming in 10 to the power 9 gram that means, it is 6 ppb; that means, 6 parts per billion, so that 0.006 milligram per liter of solution is 6 ppb of the nickel in water.

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**Problem – Conversion of mass to moles**

- How many moles of Nitrogen are there in 2 kg of Nitrogen?

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Next we are coming to conversion of mass to moles. So, here we had been given that two kg of nitrogen is there. So, how many moles does it make?

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**Solution**

- Given: mass of nitrogen,  $m_{N_2} = 2 \text{ kg}$
- To Find: moles of nitrogen,  $n_{N_2}$
- Method:  
Molecular weight of nitrogen,  $MW_{N_2} = 28 \text{ g/mol}$   
$$n_{N_2} = \frac{m_{N_2}}{MW_{N_2}} = \frac{2 \text{ kg}}{28 \text{ g/mol}}$$
  
$$= \frac{2 \text{ kg} \cdot \text{kmol}}{28 \text{ kg}} = 0.0714 \text{ kmol}$$

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So, for this what we need, we need to know the molecular weight of nitrogen, which is 28 gram per mole. So, to know the number of moles of nitrogen, what we do? We simply divide the mass of the nitrogen with the molecular weight of nitrogen, and by putting these values. We find it is coming about 0.0714 kilo mole.

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**Problem – Conversion of mole to mass**

- How much does 10 kmoles of oxygen weigh?

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Next is the conversion of mole to mass ok. So, it is the inverse of whatever we did in the last problem, here we are given the number of moles that is 10 kilo moles of oxygen, and we have to give the mass of this oxygen.

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**Solution**

- Given: moles of oxygen,  $n_{O_2} = 10 \text{ kmol} = 10000 \text{ mole}$
- To Find: mass of oxygen,  $m_{O_2}$
- Method:

Molecular weight of oxygen,  $MW_{O_2} = 32 \text{ g/mol}$

$$m_{O_2} = n_{O_2} \times MW_{O_2} = 10000 \text{ mol} \times 32 \text{ g/mol}$$
$$m_{O_2} = 320000 \text{ g} = 320 \text{ kg}$$

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So, what we do here again, we need the molecular weight of oxygen that is 32 gram per mole. And these many kilo moles are given that means, 10,000 moles are there. And we just simply multiply this with the gram, and we get these 320 kg ok. So, we see that in terms of mole, it is a very small number. But, this small number represents a very huge

mass of the particular component. And this mass will be depending on the molecular weight the lower the molecular weight, the lower the mass for a given a number of moles.

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**Problem – Determination of mass fraction**

- 10 kg of a gas contains 20% by mole of component A (Molecular Weight = 12 g/mol), 30% by mass of component B (Molecular Weight = 14 g/mol) and the rest component C (Molecular Weight = 16 g/mol). Determine the mass fraction of component C.

Now, let us go to another representation of the concentration that is the mass fraction. So, here we have been given that 10 kg of a gas contains 20 percent by mole of component A, and the molecular weight is 12 gram per mole, 30 percent of mass of component B, molecular weight is 14 gram per mole, and the rest component is C, molecular weight is 16 gram per mole. So, we have to determine the mass fraction of component C. So that means, here that we have been given the mole fraction of one component, mass fraction of another component ok; and we have to determine the mass fraction of a 3rd component.

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**Solution**

Given: Basis: 1 mole of gas

Molecular weight of A,  $MW_A = 12$  g/mol, Mole fraction of A =  $\frac{n_A}{n_{total}} = 0.2$

Molecular weight of B,  $MW_B = 14$  g/mol, Mass fraction of B =  $w_B = 0.3$

Molecular weight of C,  $MW_C = 16$  g/mol

To Find:

Mass fraction of C =  $w_C$

So, for this it is quite easy problem that we know that we take a basis of 1 mole of gas. So, we find that molecular weight of these three things we write here. And we know that mole fraction of A is given like number of moles of a divided by total number of moles, and that is 0.2. And similarly, mass fraction of B is given that is the mass of B divided by and the total mass of the system that is 0.3 ok.

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**Solution (contd..)**

Solution:

Mass fraction of B =  $w_B = \frac{m_B}{m_{total}} = \frac{m_B}{m_A + m_B + m_C} = \frac{m_B}{10} = 0.3$

$\Rightarrow$  Mass of B =  $m_B = 0.3 \times 10 = 3$  kg

Mole fraction of A =  $n_A = \frac{n_A}{n_{total}} = \frac{n_A}{n_A + n_B + n_C}$

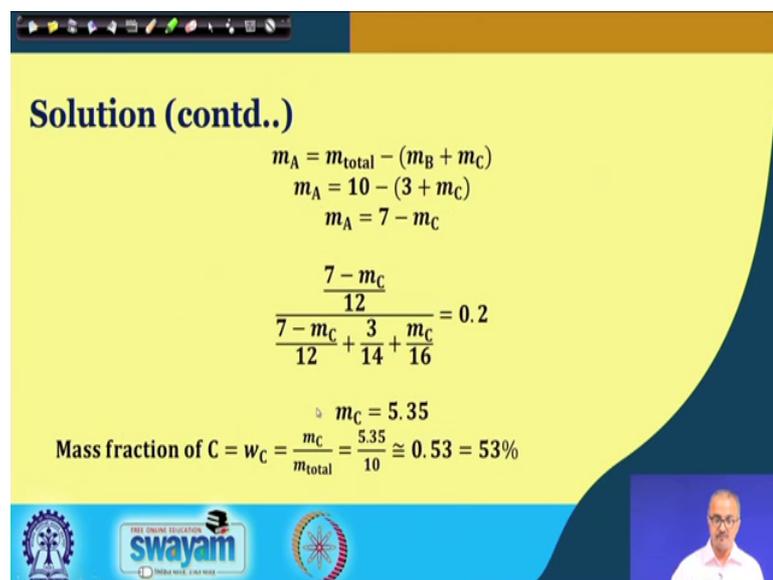
$= \frac{\frac{m_A}{MW_A}}{\frac{m_A}{MW_A} + \frac{m_B}{MW_B} + \frac{m_C}{MW_C}} = 0.2$

Now, we have to find the mass fraction of component C. So, what we do, we first see the mass fraction of these things. So, we write the mass fraction of B is mass of B divided by

the total mass of the system, and that is given as 10 kg. And here it is 0.3 that means, the mass of B is 3 kgs.

And now, mole fraction of A is given as this number of moles by total number of moles, and total number is n A plus, n B plus, n C. Now, we are converting this number of moles in mass. So, number of moles of A is mass of A divided by the molecular weight of A. Number of moles of the other two components is the mass of each of the components divided by their respective molecular weight. And this value has been given to be 0.2.

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**Solution (contd..)**

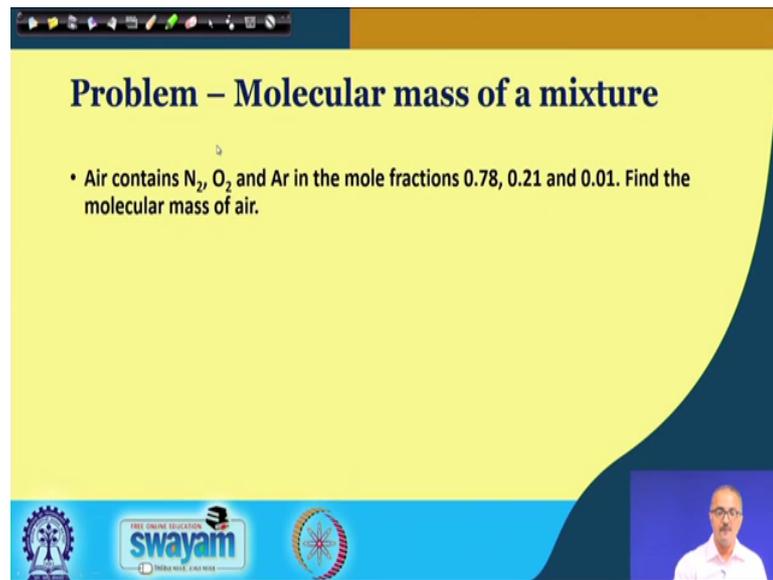
$$m_A = m_{\text{total}} - (m_B + m_C)$$
$$m_A = 10 - (3 + m_C)$$
$$m_A = 7 - m_C$$
$$\frac{7 - m_C}{12} = 0.2$$
$$\frac{7 - m_C}{12} + \frac{3}{14} + \frac{m_C}{16} = 0.2$$
$$m_C = 5.35$$
$$\text{Mass fraction of C} = w_C = \frac{m_C}{m_{\text{total}}} = \frac{5.35}{10} \cong 0.53 = 53\%$$

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So, what we do, we do this rearrange the equation. After rearranging, we find that the mass of A is coming out to be like this that from the total; we are subtracting the mass of B and C. And we are putting the mass of B here, and we are getting m equal to 7 minus m C.

So, this value we are putting in this particular equation. So, what we find that, when we put there this whole equation is now converted in terms of C. Now, we can solve for this equation to get the value of C as one 5.35 kgs ok. And from this, we can also find out that; what is the mass fraction of the particular component C.

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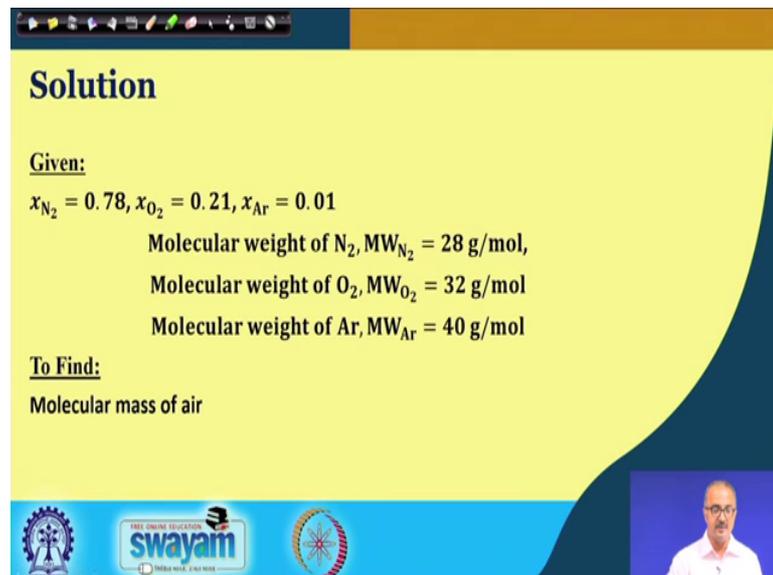
**Problem – Molecular mass of a mixture**

- Air contains  $N_2$ ,  $O_2$  and Ar in the mole fractions 0.78, 0.21 and 0.01. Find the molecular mass of air.

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Now, coming to the next problem; we have here a problem to determine the molecular mass of a mixture. So, here we are given air that contains nitrogen, oxygen, and argon, and the mole fractions are 0.78, 0.21, and 0.01. And we have to find out the molecular mass of air.

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**Solution**

Given:

$x_{N_2} = 0.78, x_{O_2} = 0.21, x_{Ar} = 0.01$

Molecular weight of  $N_2, MW_{N_2} = 28 \text{ g/mol}$ ,  
Molecular weight of  $O_2, MW_{O_2} = 32 \text{ g/mol}$   
Molecular weight of Ar,  $MW_{Ar} = 40 \text{ g/mol}$

To Find:

Molecular mass of air

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So, what we do here, we take the first we have to understand know the molecular weight of each of the components nitrogen is 28, oxygen is 32, and argon is 40 ok.

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**Solution**

Average molecular mass,

$$M = \sum_{i=1}^c x_i MW_i = 0.78 \times 28 + 0.21 \times 32 + 0.01 \times 40 = 28.96 \text{ g/mol}$$

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So, now after knowing these molecular weight and the mole fractions, what we do? We go with this particular formula; we learned earlier that we take a summation of the product of the mole fraction, and the molecular weight of each of the components of 0.78 into 28 plus 0.21 into 32 plus 0.01 into 40.

And when we do this addition, we get 28.96 that means, about 29. And this is a value, which we often use to know or to represent the molecular weight of air as 29 gram per mole ok. So, these are the things you have learned that how to find the mole fraction, how to convert the coordinate system, how to find out the mass molecular mass of a mixture in this particular lecture.

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**Problem**

- A storage tank is filled with a liquid (sp. Gr. 0.909). A pressure gauge is connected at the bottom of the tank. Find the gauge pressure exerted at the bottom by 15 m high liquid column in the tank.

1 atm = 101.3 kPa

15 m

Pressure gauge

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Now, we come to another very common problem about the gauge pressure. Now, you see that the problems, I have shown in these lectures are not correlated. There are some just kind of going back to our basics ok. So, here we have a problem, in this we have a vessel in which we have a liquid ok. And there is a certain pressure gauge at the bottom of the liquid, and the liquid specific gravity is mentioned here ok. And we have to find out that what is the gauge pressure exerted at the bottom, if we have a 15 meter of the liquid column.

Now, you know the gauge pressure is the excess pressure over the atmospheric pressure. So, whenever we are having the gauge here or the surface of the liquid, we have the atmospheric pressure. But, as we move down the liquid we find, the hydrostatic head of the liquid comes into picture. And at this bottom we find if the pressure is the summation of the pressure of the atmosphere plus the pressure by this liquid column. So, the excess pressure is excess pressure means excess to the atmospheric pressure is the basically the pressure exerted by this liquid column.

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**Solution**

- Gauge pressure (pressure in excess of atmospheric pressure) at the bottom of the storage tank = hydrostatic pressure of the liquid =  $h\rho g$

$$h\rho g = 15[\text{m}] \times (0.909 \times 1000) \left[ \frac{\text{kg}}{\text{m}^3} \right] \times 9.81 \left[ \frac{\text{m}}{\text{s}^2} \right] \approx 133759 \text{ Pa} \approx 134 \text{ kPa}$$

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And this we also know that these can be found easily, if we know the height  $h$ ,  $\rho$ ,  $g$  ok; height of the liquid, the density of the liquid, and the gravitational acceleration. So, here we have the height of the liquid and a gravitational this density is the specific gravity into the density of water, and this is the value of the  $g$ .

And if we multiply these three, we get this value in Pascal, and this can be converted to 134 kilo Pascal that is the gauge pressure is 134 Kilo Pascal. And we know that the atmospheric pressure in Kilo Pascal is about 101.3 Kilo Pascal. So, the absolute pressure at the bottom of the column is 101 plus 134 that makes about 235 Kilo Pascal. So, this is the absolute pressure at the bottom of the tank.

So, be careful, whenever you are reading the pressure, be careful that whether the pressure has been given in terms of absolute pressure or the gauge pressure. Many a times, we commit mistakes by not converting the gauge pressure into the absolute pressure ok.

Thank you.