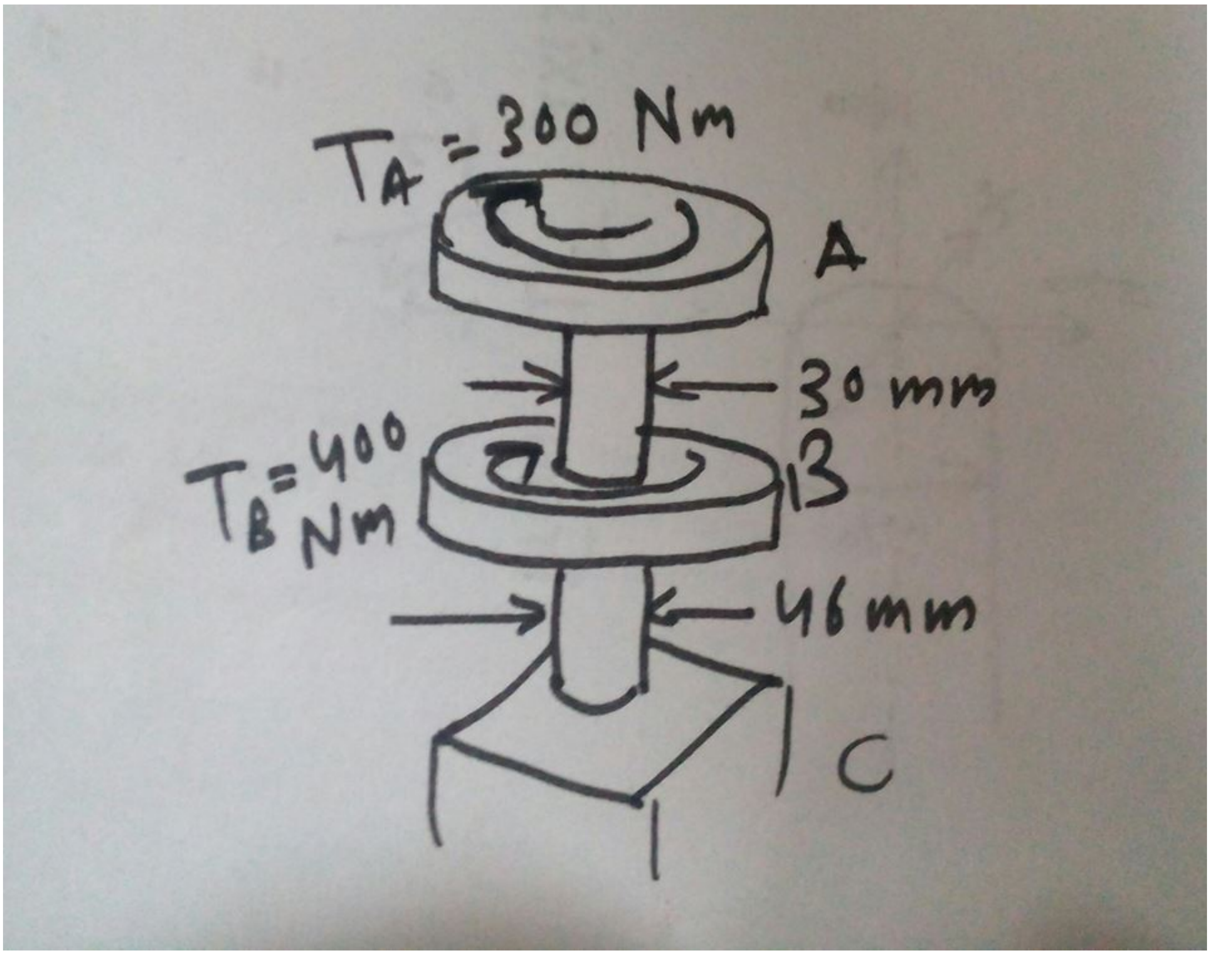
NUMERICAL 1

The torques T(A) and T(B) as shown, are exerted on pulleys A and B which are attached to solid circular shafts AB and BC. In order to reduce the total mass of the assembly, which of the following is the smallest diameter of shaft BC for which the largest shearing stress in the assembly is not increased?



T(AB) = ? and T(BC)=?

38.35 mm

Look. The question says that due to the applied torques, some shear stresses will get generated in the shafts.
You have to reduce the mass of the assembly.

That can be done by reducing the dia of the shaft in which the stress is less (since reducing dia increases stress).
You can reduce the diameter of that shaft in which the stress in less upto the extent till stress in that becomes equal to the stress in the shaft in which stress was high. This is the question.

Sir why do we need to take T(AB)

We need to find out stress in each shaft using tau=Tr/J

so T(AB) and T(BC) both are required to calculate tau

T (AB) means Torque in AB. It is not multiplication

Shaft AB: $T_{AB} = 300$ N.m, $d = 0.030$ m, $r = 0.015$ m

$$\tau_{max} = \frac{16T}{\pi d^3} = 56.6\text{MPa}$$

Shaft BC: $T_{BC} = 300 + 400 = 700$ N.m.

$d = 0.046$

$$\tau_{max} = \frac{16T}{\pi d^3} = 36.6\text{MPa}$$

The largest stress occurs in AB.

Reduce the diameter of BC to provide the same stress.

$T_{BC} = 700$ Nm

Take $\tau_{BC} = \tau_{max} = 56.6$ MPa

Put in $\tau_{BC} = \frac{16 . T_{BC}}{\pi d^3}$

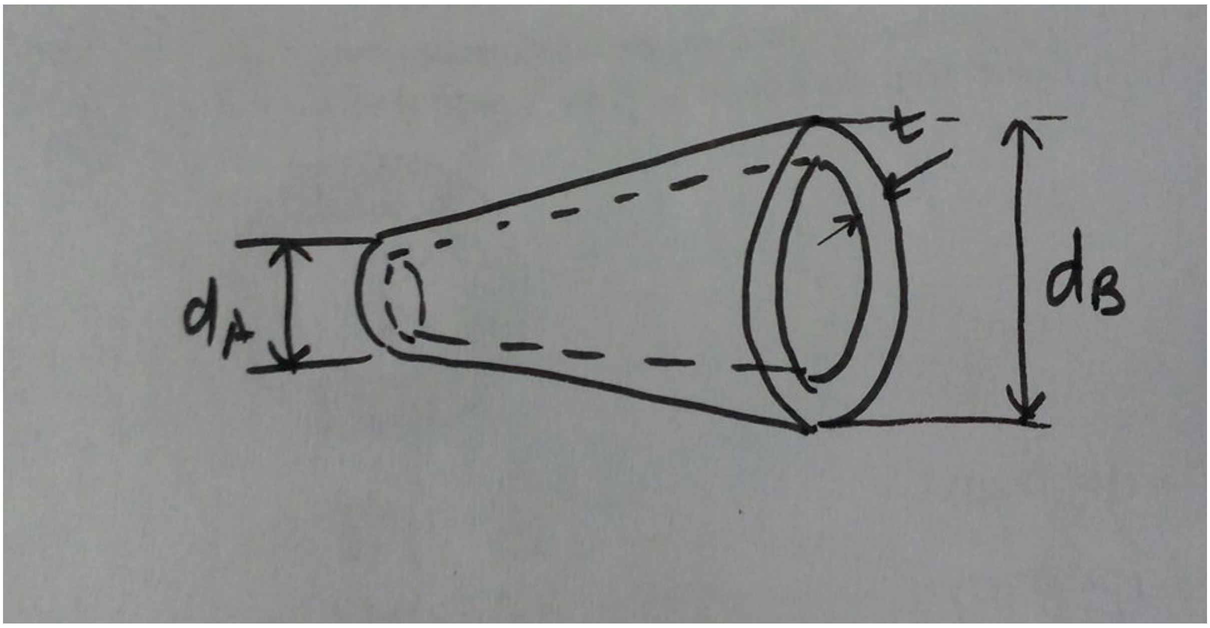
$\Rightarrow d = 39.8$ mm

$\therefore$ we can reduce the dia of BC upto 39.8 mm

NUMERICAL 2

A uniformly tapered tube AB of hollow circular cross section is shown in the figure. The tube has constant wall thickness t and Length L. The average diameters at the ends are d(A) and d(B) = 2 . d(A). The polar moment of inertia is represented by the approximate formula J = pie*(d^3)*t/4.

What will be the angle of twist of the tube when it is subjected to torques T acting at the ends?



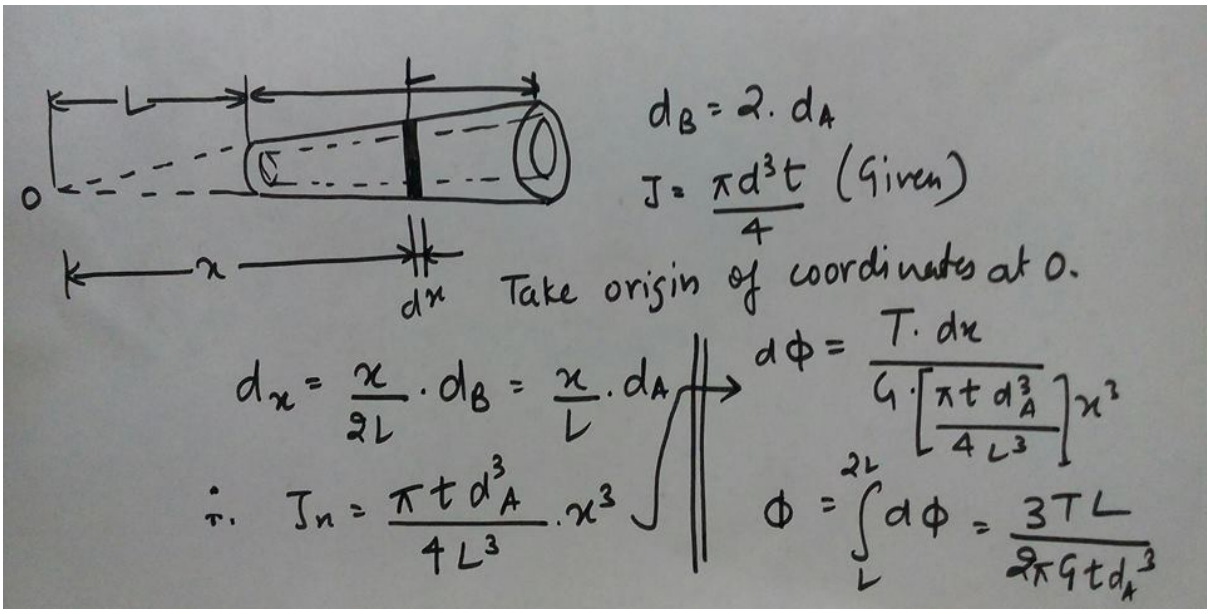
Try solving by integration.

It is a question where J is varying. Right? What do we do in such cases? We integrate.

Take an element of very small thickness and then integrate

how to know when to integrate... when not to..

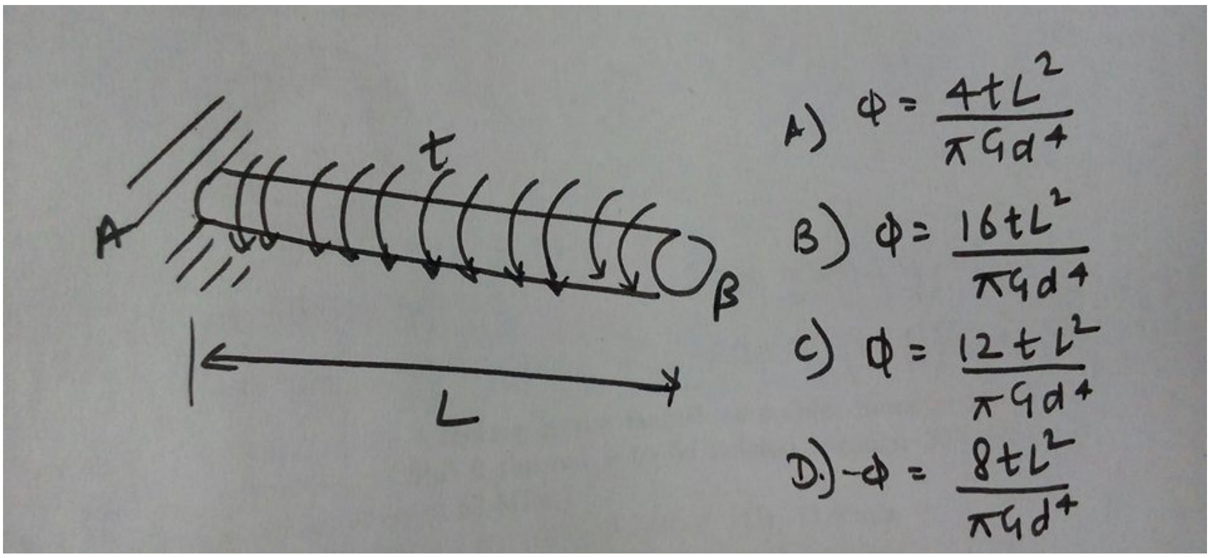
Whenever a parameter which was supposed to remain constant is varying. You can take a small limiting case and then integrate. We have been solving such questions since physics.



You do not have to integrate it from zero since it is a frustrum of a cone, not a cone.

NUMERICAL 3

A prismatic bar AB of length L and solid circular cross section of diameter d is loaded by a distributed torque of constant intensity t per unit distance as shown in figure. What will be the angle of twist between the ends of the bar?



One more application of intergration but in a different way

For others: As we will move from left to right, net torque will keep on increasing. Given torque is uniformly distributed. So the equation of torque will be, T = t.x (as x increases, T increases linearly).

$$T_{(x)} = t \cdot x$$

$$J = \frac{\pi d^4}{32}$$

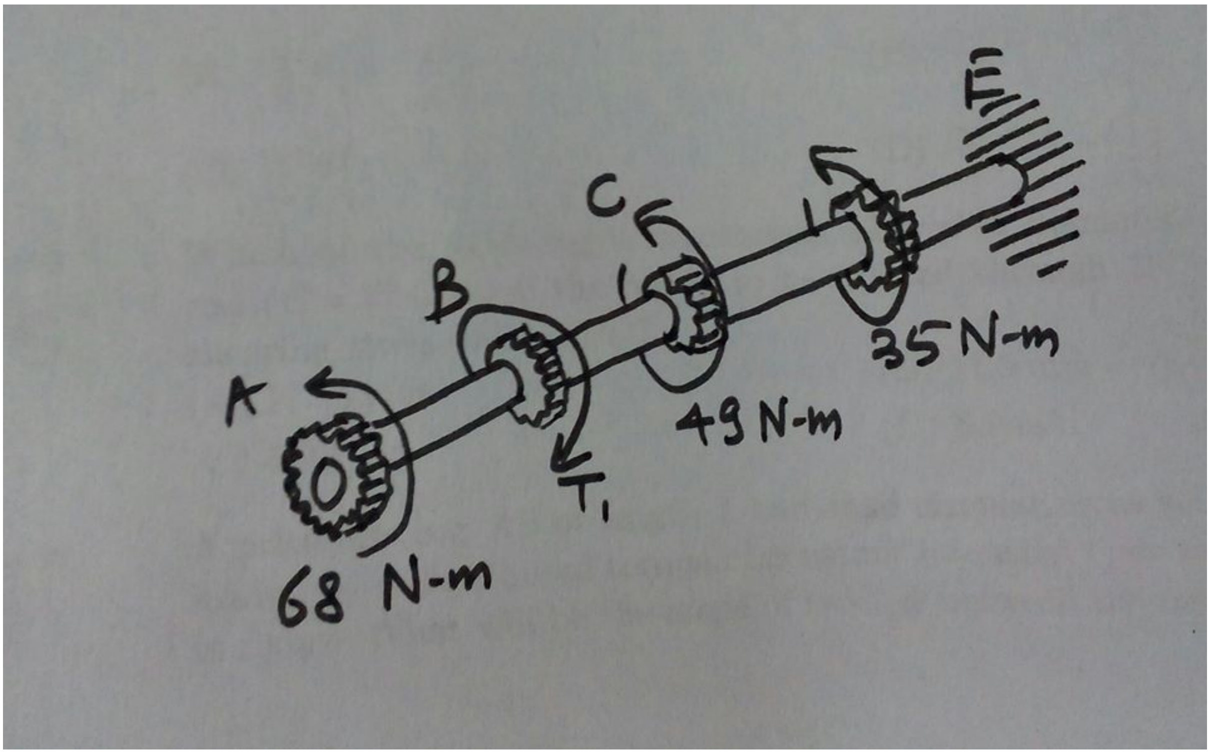
$$d\phi = \frac{T_x . dx}{GJ}$$

$$\phi = \int_0^L d\phi = \int \frac{T(x) dx}{GJ} = \int \frac{x . t . dx}{G \cdot \frac{\pi d^4}{32}} = \frac{16 t L^2}{\pi G d^4}$$

NUMERICAL 4

The solid aluminum shaft has a diameter of 50 mm and an allowable shear stress of allowable shear = 6 MPa. The largest torque T1 is applied to the shaft and it is also subjected to the other torsional loadings. It is required that T1 act in the direction shown.

What will be the largest torque T1?



215.26Nm

You need to find T. Here, all the shafts have same d and same J. right? So first you need to locate the critical member

how to find critical member?

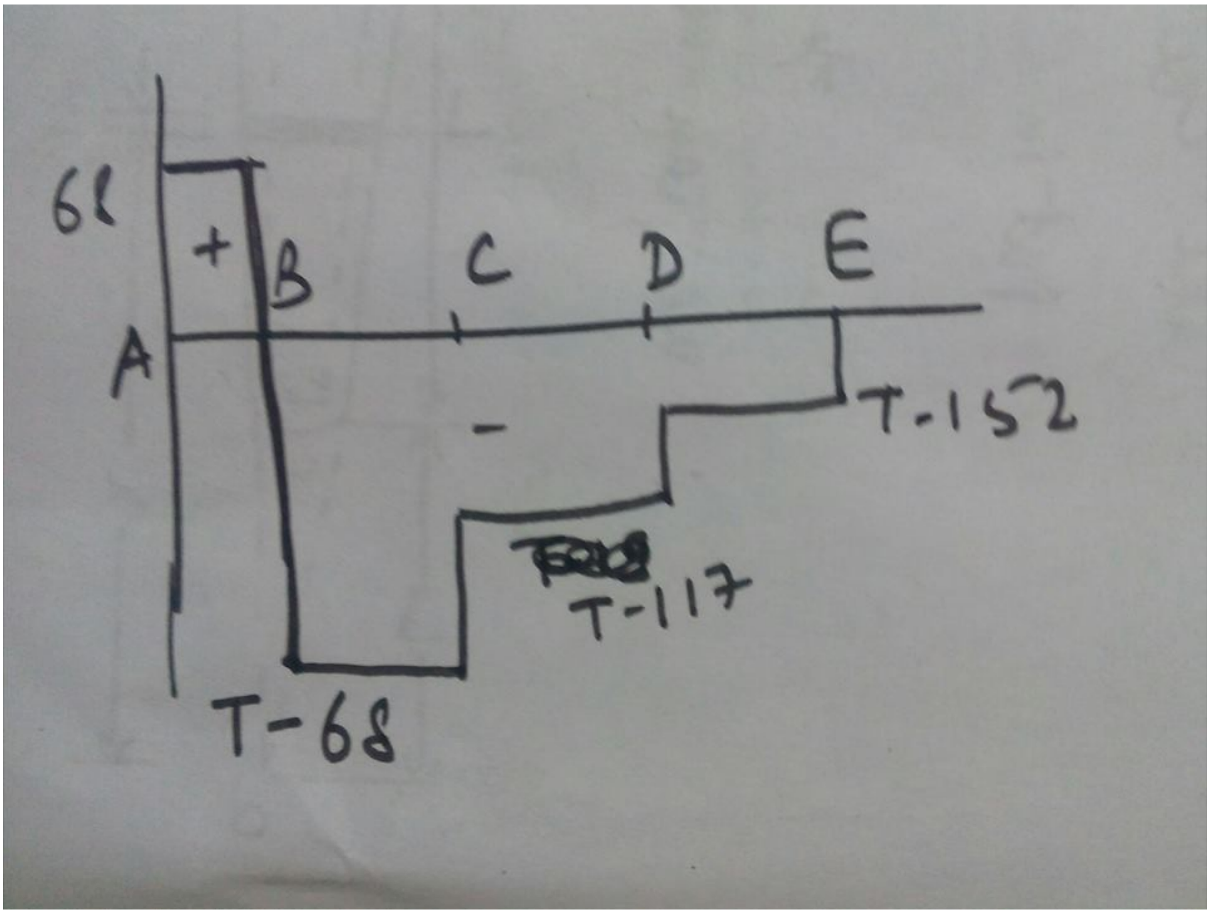
since tau allowable is given and d and J are known, you can easilty find T

Yes we have to do it by superposition only

In the question, it is written than what is the LARGEST torque T1. It means that you HAVE TO find a value of T as high as possible

It means that value of T will be so high that every section further to T will have a resultant twist in the direction of T.

Now let us draw the torque diagram



as per sign convention 68 NM should be negative na ?

Yes. I have drawn the curve magnitude wise

you can do the same by taking CCW -ve and CW +ve

becoz of influence of larger magn of T the entire torque dia after T is negative

We have to take as high value of T is possible within permissible limit of tau

Since (T-68) has to more more than 152-68 (since upto E all should be -ve). so T-68 is max of all

T has to maximum, it is written in the question

critical member ? BC.

BC is critical?

Sometimes easy looking questions can also get tricky. This was one such question.

Why BC is critical ??

The section having max value of torsion is known as critical.