```
(*problem:solve x''[t]+w^2*x[t]=0 by using series apprimation and compare
   with teh exact solution.The initial conditions are x[0]=1,x'[0]=0*)

deq = x''[t] + w^2 * x[t] == 0;
initial = {x[0] == 1, x'[0] == 0};
s = 100;
ser = x[t] + O[t]^s

sereq = deq /. {x[t] → ser, x''[t] → D[ser, {t, 2}]}

? Join
```

Join[$list_1$, $list_2$, …] concatenates lists or other expressions that share the same head.
Join[$list_1$, $list_2$, …, n] joins the objects at level n in each of the $list_i$. ≫

```
eqs = Join[{sereq}, initial]

unknowns = Table[Derivative[n][x][0], {n, 0, s - 1}]

knowns = Solve[eqs, unknowns]

ser = ser /. knowns[[1]] /. w → 1


"series aprximation"

sersol = Normal[ser]

(*Exact solution*)

sol1 = DSolve[{deq, x[0] == 1, x'[0] == 0}, x[t], t]

"Exact solution"

sol1 = sol1 /. w → 1;
exsol = x[t] /. sol1[[1]]

"compare exact sol with series approximation"

Plot[{exsol, sersol}, {t, 0, 10}, PlotRange → 1,
 PlotStyle → {{Red, Dotted}, {Yellow, Dotted}}]

g1 = Plot[exsol, {t, 0, 10}]


g2 = Plot[sersol, {t, 0, 10}, PlotRange → 1]

Show[g1, g2]
```