**70** An ideal gas, at initial temperature *T*1 and initial volume 2.0 m3, is expanded adiabatically to a volume of 4.0 m3, then expanded isothermally to a volume of 10 m3, and then compressed adiabatically back to *T*1.What is its final volume?

For adiabatic processes

Adiabatic

P

$PV^{γ}=constant$

2 4 6 8 10

3

2

`

1 T1

$⟹ P\_{1}V\_{1}^{γ}=P\_{2}V\_{2}^{γ} (1) $

4 T1

Isothermal

$and P\_{3}V\_{3}^{γ}=P\_{4}V\_{4}^{γ} (2) $

For isothermal processes

$PV=constant$

V(m3)

$$⟹ P\_{1}V\_{1}=P\_{4}V\_{4} (3) $$

$$and P\_{3}V\_{3}=P\_{2}V\_{2} (4) $$

Dividing eqn (1) by eqn (3) and eqn (2) by eqn (4) we get:

$ \frac{P\_{1}V\_{1}^{γ}}{ P\_{1}V\_{1}}=\frac{P\_{2}V\_{2}^{γ}}{P\_{4}V\_{4}} ⟹ V\_{1}^{γ-1}= \frac{P\_{2}V\_{2}^{γ}}{P\_{4}V\_{4}} $

$and \frac{P\_{3}V\_{3}^{γ}}{ P\_{3}V\_{3}}=\frac{P\_{4}V\_{4}^{γ}}{P\_{2}V\_{2}} ⟹ V\_{3}^{γ-1}= \frac{P\_{4}V\_{4}^{γ}}{P\_{2}V\_{2}} $

Multiplying the last two eqns we get

$ V\_{3}^{γ-1}×V\_{1}^{γ-1}= \frac{P\_{4}V\_{4}^{γ}}{P\_{2}V\_{2}}×\frac{P\_{2}V\_{2}^{γ}}{P\_{4}V\_{4}} $

$ \left(V\_{3}V\_{1} \right)^{γ-1}= \left(V\_{4}V\_{2} \right)^{γ-1} $

$⟹ V\_{3}V\_{1}= V\_{4}V\_{2} and V\_{4}=\frac{V\_{3}V\_{1}}{V\_{2}}=\frac{10×2}{4}=5 m^{3}$