Q1 b)

Jump equations for perpendicular shock:

In[31]:=
```
eqs = {ρ1 v1^2 + p1 + B1^2 / (2 μ0) == ρ2 v2^2 + p2 + B2^2 / (2 μ0),
  1 / 2 ρ1 v1^3 + γ / (γ - 1) p1 v1 + B1^2 v1 / μ0 ==
   1 / 2 ρ2 v2^3 + γ / (γ - 1) p2 v2 + B2^2 v2 / μ0}; eqs // Column
```

Out[31]=

$$p1 + \frac{B1^2}{2\,\mu0} + v1^2\,\rho1 == p2 + \frac{B2^2}{2\,\mu0} + v2^2\,\rho2$$

$$\frac{p1\,v1\,\gamma}{-1+\gamma} + \frac{B1^2\,v1}{\mu0} + \frac{v1^3\,\rho1}{2} == \frac{p2\,v2\,\gamma}{-1+\gamma} + \frac{B2^2\,v2}{\mu0} + \frac{v2^3\,\rho2}{2}$$

Substituting for variables with r, R, M1 and β

```
eqs2 = eqs //. {B2 → r B1, v2 → v1 / r, ρ2 → r ρ1,
    p2 → R p1, B1 → Sqrt[2 μ0 p1 / β], v1 → M1 Sqrt[γ p1 / ρ1]};
```

Solving for R

In[68]:=
```
Solve[eqs2, {R, ρ1}][[1]] // Column
```

Solve::svars : Equations may not give solutions for all "solve" variables. >>

Out[68]=

$$R \to \frac{r - r^3 + r\,\beta - \beta\,\gamma\,M1^2 + r\,\beta\,\gamma\,M1^2}{r\,\beta}$$

Solving for r

In[64]:=
```
Solve[eqs2, {r, R}][[All, 1]] // Column
```

Out[64]=

$$r \to 1$$

$$r \to \frac{2\,\gamma + 2\,\beta\,\gamma - \beta\,\gamma\,M1^2 + \beta\,\gamma^2\,M1^2 - \sqrt{\left(-2\,\gamma - 2\,\beta\,\gamma + \beta\,\gamma\,M1^2 - \beta\,\gamma^2\,M1^2\right)^2 - 4\,(-4+2\,\gamma)\,\left(\beta\,\gamma\,M1^2 + \beta\,\gamma^2\,M1^2\right)}}{2\,(-4+2\,\gamma)}$$

$$r \to \frac{2\,\gamma + 2\,\beta\,\gamma - \beta\,\gamma\,M1^2 + \beta\,\gamma^2\,M1^2 + \sqrt{\left(-2\,\gamma - 2\,\beta\,\gamma + \beta\,\gamma\,M1^2 - \beta\,\gamma^2\,M1^2\right)^2 - 4\,(-4+2\,\gamma)\,\left(\beta\,\gamma\,M1^2 + \beta\,\gamma^2\,M1^2\right)}}{2\,(-4+2\,\gamma)}$$