2.31

$S + 2.60 = 0.001(D - 240)^2$

(a) S_f ; OCCURS AT D = 0:

$$S = 0.001(0-240)^2 - 2.60$$
$$S = 55 \text{ mph}$$

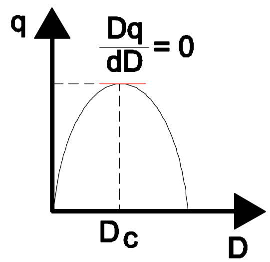
(b) D_j; OCCURS AT S = 0:

$$0 = 0.001(D - 240)^2 - 2.6$$
$$2.6 = 0.001\,(D^2 - 480D + 57600)$$
$$2.6 = 0.001D^2 - 0.48D + 57.6$$
$$0.001D^2 - 0.48D + 55 = 0$$

SOLVING VIA QUADRATIC FORMULA: $\frac{-b \pm \sqrt{b - 4ac}}{2a}$

$$D_j = \frac{-(-0.48) \pm \sqrt{(-0.48)^2 - 4(0.001)(55)}}{2(0.001)}$$

$$D_j = \frac{0.48 \pm 0.10}{0.002} = \begin{cases} 290 \\ \underline{\underline{190}} \end{cases}$$



(c)

$$S + 2.60 = 0.001(D - 240)^2$$
$$S = 0.001(D-240)^2 - 2.60$$
$$q = S * D$$
$$q = D[0.001(D - 240)^2 - 2.60]$$
$$q = D[0.001(D^2 - 480D + 57600) - 2.60]$$
$$q = D[0.001D^2 - 0.48D + 57.6 - 2.60]$$
$$q = 0.001D^3 - 0.48D^2 + 55.0D$$

TO FIND CAPACITY (MAXIMUM FLOW) $\frac{dq}{dD} = 0$: $0.003D^2 - 0.96D + 55.0 = 0$

SOLVING VIA QUADRATIC FORMULA: $\frac{-b \pm \sqrt{b - 4ac}}{2a}$

$$D_c = \frac{-(-0.96) \pm \sqrt{(-0.96)^2 - 4(0.003)(55)}}{2(0.003)} = \frac{0.96 \pm 0.51}{0.006}$$

$$D_c = \begin{cases} +75 \\ +245 \end{cases}$$

CHECK :

$$0.003(+245)^2 - 0.96(+245) + 55 = 0$$
$$180 - 235 + 55 = 0 \checkmark$$

$$0.003(+75)^2 - 0.96(+75) + 55 = 0$$
$$17 - 72 + 55 = 0 \checkmark$$

FOR $D_c = 75$:

$$q = 75[0.001(75 - 240)^2 - 2.60]$$

(c.) SOLUTION → $q_{max} = \underline{\underline{1846.9}}$ ✓

FOR $D_c = 245$:

$$q = 75[0.001(245-240)^2 - 2.60]$$

$q_{max} = -193.1$ ← NEGATIVE IS NOT A FEASIBLE SOLUTION

(d) $S_c = \frac{q_{max}}{D_c} = \frac{1846.9}{75} = \underline{\underline{24.6}}$