3

Alt solution

Profit functions

$$\Pi_1 = PQ_1 + P_x X - C_1(Q_1) \qquad Q_1 + X \le 18$$

$$\Pi_2 = PQ_2 - P_x X - C_2(Q_2) \qquad Q_2 \le 18 + X$$

Assume constraints bind

$$\Pi_1 = P(18-X) + P_x X - C_1(18-X)$$

$$\Pi_2 = P(18+X) - P_x X - C_2(18+X)$$

$$F_1: \quad -P + P_x - MC_1(18-X)(-1) = 0$$

$$F_2: \quad P - P_x - MC_2(18+X)(+1) = 0$$

$$\Rightarrow$$

$$MC_1(18-X) - MC_2(18+X) = 0$$

$$4(18-X) - 2(18+X) = 0$$

$$2(18-X) - (18+X) = 0$$

$$36 - 2X - 18 - X = 0$$

$$18 - 3X = 0$$

$$X = 6$$

Find permit price

$$60 - P_x - MC_i (18 + 6) = 0$$

$$P_x = 60 - 2(18 + 6)$$

$$= 60 - 2(24)$$

$$= 60 - 48$$

$$= 12$$