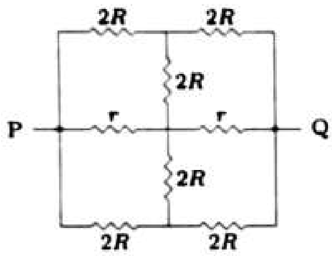
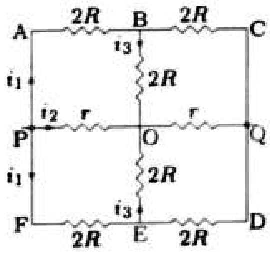
Q 11

The effective resistance between points P and Q of the electrical circuit shown in the figure is (2002)



(A) $\frac{2Rr}{R+r}$ (B) $\frac{8R(R+r)}{3R+r}$ (C) $2r+4R$ (D) $\frac{5R}{2}+2r$

Sol. The given circuit is a good example of symmetry. When looking from P, branch PAB looks same as the branch PFE and hence the same current i_1 should flow through these branches.



Similarly, when looking from O, branches OB and OE look identical and same current i_3 should flow through them. Branches through P and Q are also identical. Apply Kirchhoff's law in loop ABOPA and BCQOB to get

$$2Ri_1 + 2Ri_3 - i_2 r = 0, \quad (1)$$

$$2R(i_1 - i_3) - r(i_2 + 2i_3) - 2Ri_3 = 0. \quad (2)$$

Solve equations (1) and (2) to get $i_3 = 0$ i.e., no current flows in the branch OB and OE. Hence, branch OB and OE can be removed from the circuit without affecting the effective resistance.

Thus, effective resistance of the circuit is $R_e = (4R \parallel 4R) \parallel 2r = \frac{2Rr}{R+r}$. We encourage you to exploit the symmetry to check that $i_3 = 0$.

Ans. A