Q 10 Three resistors of 4 Ω, 6 Ω and 12 Ω are connected in parallel and the combination is connected in series with a 1.5 V battery of 1 Ω internal resistance. The rate of Joule heating in the 4 Ω resistor is [Online May 12, 2012]

(a) 0.55 W (b) 0.33 W (c) 0.25 W (d) 0.86 W

(c) Resistors 4 Ω, 6 Ω and 12 Ω are connected in parallel, its equivalent resistance (R) is given by

$$\frac{1}{R}=\frac{1}{4}+\frac{1}{6}+\frac{1}{12} \Rightarrow R=\frac{12}{6}=2\Omega$$

Again R is connected to 1.5 V battery whose internal resistance $r = 1\ \Omega$.

Equivalent resistance now,

$R' = 2\Omega + 1\Omega = 3\Omega$

$$\text{Current, } I_{total}=\frac{V}{R'}=\frac{1.5}{3}=\frac{1}{2}\text{ A}$$

$$I_{total}=\frac{1}{2}=3x+2x+x=6x$$

$$\Rightarrow x=\frac{1}{12}$$

∴ Current through 4Ω resistor = $3x$

$$=3\times\frac{1}{12}=\frac{1}{4}A$$

Therefore, rate of Joule heating in the 4Ω resistor

$$=I^2R=\left(\frac{1}{4}\right)^2\times 4=\frac{1}{4}=0.25\text{W}$$