Answer on Question 59051, Physics, Electric Circuits

Question:

The current I in a conductor as a function of time t is given as $I(t) = 5t^2 - 3t + 10$, where current is in ampres (A) and t is in seconds (s). What quantity of charge moves across a section through the conductor during the interval $t = 2\ s$ to $t = 5\ s$?

a) $154.4\ C$

b) $193.5\ C$

c) $225.5\ C$

d) $300.0\ C$

Solution:

Let's recall the definition of the current. The electric current is the rate at which the electric charge flows through the cross-sectional area of a conductor:

$$I = \frac{\Delta Q}{\Delta t},$$

here, ΔQ is the amount of charge that passes through the cross-sectional area of the conductor in a time interval Δt. Let's write the definition of the electric current in the differential form:

$$I = \frac{dQ}{dt}.$$

From this formula, we can find the quantity of charge moves across a section through the conductor during the interval from $t = 2\ s$ to $t = 5\ s$: $dQ = Idt$,

$$Q = \int_2^5 Idt = \int_2^5 (5t^2 - 3t + 10)dt =$$
$$= \left(\frac{5}{3}t^3 - \frac{3}{2}t^2 + 10t\right)\Big|_2^5 = \frac{5}{3}(5)^3 - \frac{3}{2}(5)^2 + 10 \cdot 5 - \frac{5}{3}(2)^3 + \frac{3}{2}(2)^2$$
$$- 10 \cdot 2 = 193.5\ C.$$

Answer: b) $193.5\ C$