Week 2

1.2 Determine the current following through an element if the charge flow is given by

(a) $q(t) = (3t+8)\,mC$

$(3t+8)\frac{d}{dt} = 3$ **Answer : 3mA**

(b) $q(t) = (8t^2+4t-2)\,C$

$(8t^2+4t-2)\frac{d}{dt} = 16t+4$ **Answer : $(16t+4)\,A$**

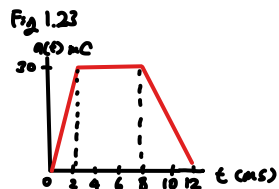**1.3** Find the charge $q(t)$ flowing through a device if the current is:

(a) $i(t) = 3A$, $q(0) = 1C$

$\int 3\,dt + 1 = 3t+1$ **Answer: $(3t+1)\,C$**

(b) $i(t) = (2t+5)\,mA$, $q(0) = 0$

$\int 2t+5\,dt + 0 = t^2+5t$ **Answer: $(t^2+5t)\,mC$**

1.6 The charge entering a certain element is shown in Fig.1.23. Find the current at:

Fig 1.23

(a) $t = 1ms$

$\frac{dq}{dt} = \frac{15}{7} = 15$

(b) $t = 6ms$

$\frac{dq}{dt} = \frac{0}{4} = 0$

(c) $t = 10ms$

$\frac{dq}{dt} = \frac{-30}{4} = -7.5$

Answer
a)   15A
b)   0A
c)   -7.5A

1.10 A lightning bolt with 10kA strikes an object for 15μs.
How much charge is deposited on the object?

$i = 10kA = 10 \times 10^3\,A$

$t = 15\mu s = 15 \times 10^{-6}\,s$

$q = i \cdot t = (10 \times 10^3) \times (15 \times 10^{-6})$

$= 150 \times 10^{-3}$

Answer : $150\,mC$

1.12 If the current following through an element is given by

$$i(t) = \begin{cases} 3A, & 0 \le t < 6s \\ 18A, & 6 \le t < 10s \\ -12A, & 10 \le t < 15s \\ 0, & 15 \le t \end{cases}$$

Plot the charge stored in the element over $0 < t < 20s$

$0 \le t < 6s$,

$q(t) = \int_0^t 3\,dt + q(0) = \left[\frac{3}{2}t\right]_0^t + 0$

$= 1.5\,t^2$

$q(6) = 54$

$6 \le t < 10s$

$q(t) = \int_6^t 18\,dt + q(6) = \left[18t\right]_6^t + 54$

$= 18t - 108 + 54$

$= 18t - 54$

$q(10) = 126$

$10 \le t < 15s$

$q(t) = \int_{10}^t (-12)\,dt + q(10) = \left[-12t\right]_{10}^t + 126$

$= -12t + 120 + 126$

$= -12t + 246$

$q(15) = -12 \times 15 + 246$

$= 66$

$15 \le t$,

$q(t) = \int_{15}^t 0\,dt + q(15) = 66$

Answer

$$q(t) = \begin{cases} 1.5\,t^2 & C, & 0 \le t < 6s \\ 18t-54 & C, & 6 \le t < 10s \\ -12t+246 & C, & 10 \le t < 15s \\ 66 & C, & 15 \le t < 20s \end{cases}$$