

Problem 30.33 (Y-F 15th Edition)

- 30.33** • In an L - C circuit, $L = 85.0$ mH and $C = 3.20$ μ F. During the oscillations the maximum current in the inductor is 0.850 mA. (a) What is the maximum charge on the capacitor? (b) What is the magnitude of the charge on the capacitor at an instant when the current in the inductor has magnitude 0.500 mA?

```
In[57]:= Clear["Global`*"]
```

```
In[58]:= L = 85.0 * 10-3; (* Henries *)  
c = 3.20 * 10-6; (* Farads *)  
imax = 0.850 * 10-3 (* Amperes *);
```

```
In[61]:= UL[i_] :=  $\frac{1}{2} L i^2$ 
```

```
In[62]:= Uc[q_] :=  $\frac{q^2}{2 c}$ 
```

(a)

```
In[63]:= Umax = UL[imax]
```

```
Out[63]= 3.07063  $\times 10^{-8}$ 
```

```
In[64]:= qmax = q /. Solve[Uc[q] == Umax && q > 0, q][[1]]
```

```
Out[64]= 4.43306  $\times 10^{-7}$ 
```

(b)

```
In[65]:= i = 0.500 * 10-3 (* Amperes *);
```

```
In[66]:= Clear[q]
```

```
q = q /. Solve[Umax == UL[i] + Uc[q] && q > 0, q][[1]]
```

```
Out[67]= 3.58497  $\times 10^{-7}$ 
```

Alternatively, look at how (q) and (i) vary with time:

```
In[68]:=  $\omega = \frac{1}{\text{Sqrt}[L c]}$ 
```

```
Out[68]= 1917.41
```

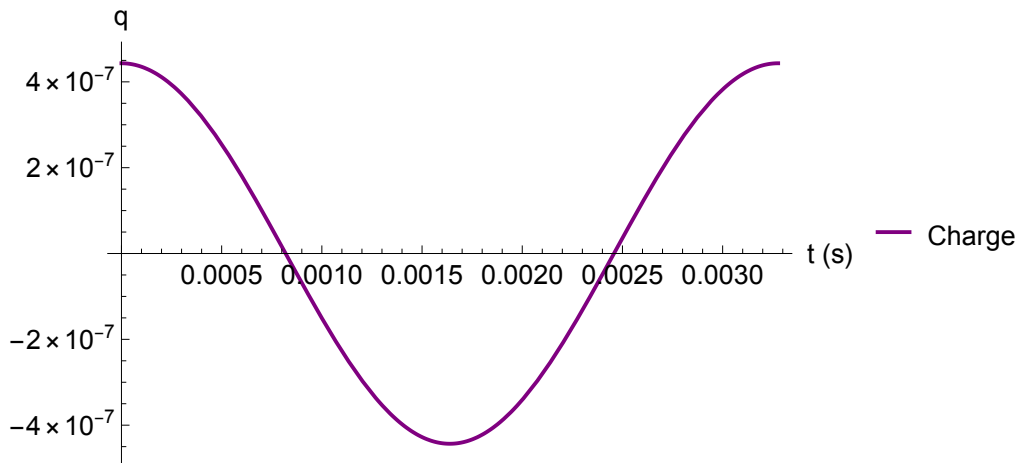
```
In[69]:= T =  $\frac{2\pi}{\omega}$ 
```

```
Out[69]= 0.00327691
```

```
In[70]:= qosc[t_] := qmax Cos[ $\omega t$ ]
iosc[t_] := imax Sin[ $\omega t$ ]
```

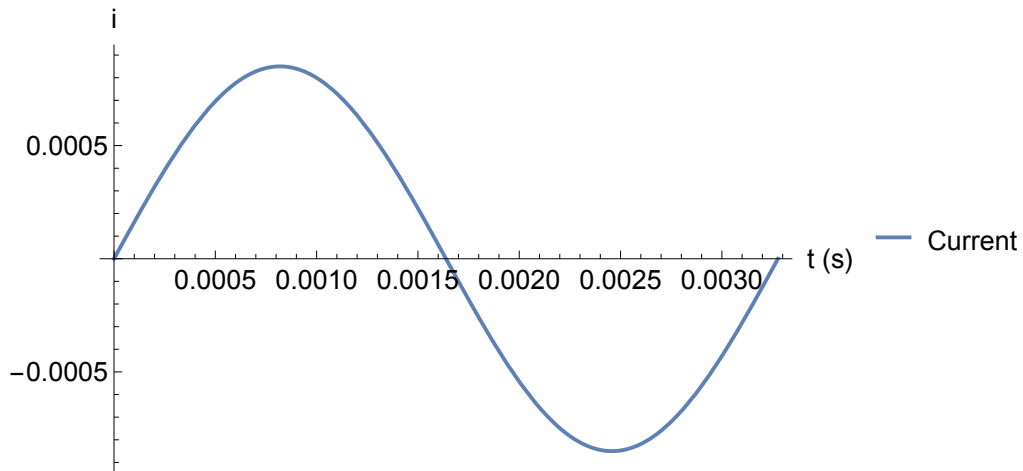
```
In[72]:= Plot[qosc[t], {t, 0, T}, PlotLegends → {"Charge"}, PlotStyle → Purple,
LabelStyle → Larger, AxesLabel → {"t (s)", "q"}, ImageSize → Scaled[0.7]]
```

```
Out[72]=
```



```
In[73]:= Plot[iosc[t], {t, 0, T}, PlotLegends → {"Current"},
LabelStyle → Larger, AxesLabel → {"t (s)", "i"}, ImageSize → Scaled[0.7]]
```

```
Out[73]=
```



When does the current = 0.500 mA?

```
In[74]:= Clear[t]
t = t /. FindRoot[iosc[t] == 0.500 * 10^-3, {t, 0}][[1]]
```

```
Out[75]= 0.000327981
```

What is the charge at that time?

```
In[76]:= qosc[t]
```

```
Out[76]= 3.58497 × 10-7
```