

Problem Set 2 Solution 1/4

1a.

$$Q = CV = 5V \cdot 100\mu F$$

$$= 5V \cdot 100 \times 10^{-6} \frac{1C}{1V}$$

$$= 500 \times 10^{-6} C$$

$$\text{or } 500\mu C$$

$$\text{or } 0.5mC$$

the unit of Farad is

$$1F \equiv \frac{1C}{1V}$$

1b. 0 total charge because the opposite charge is on the other plate

2a. We studied discharge of a capacitor through a resistor in class. The result was

$$Q(t) = Q(0)e^{-t/RC} \quad Q(0) = 0.5mC$$

In this case $RC = 10k\Omega \times 100\mu F$

$$= 10000 \times 10^3 \times 10^{-6} F\Omega$$

$$= 1s$$

Because

$$\frac{1C}{1A} = 1s$$

$$\frac{1C}{1A} \quad \frac{1V}{1A}$$

Table and Graph for Problem 2

Obviously I did not intend you to use Mathematica to solve this problem. That said, it is a nice way of making accurate tables of data.

The point of this problem was to give you a flavor of how rapidly exponential functions decline. The charge on a capacitor that is discharging through a resistor follows an exponential decline.

Defining the Function to Graph

```
In[10] = q[t_] := q0 * E-t/(r c) /. {q0 -> 5 × 10-3, r -> 10 000, c -> 100 × 10-6}
```

Making the Table

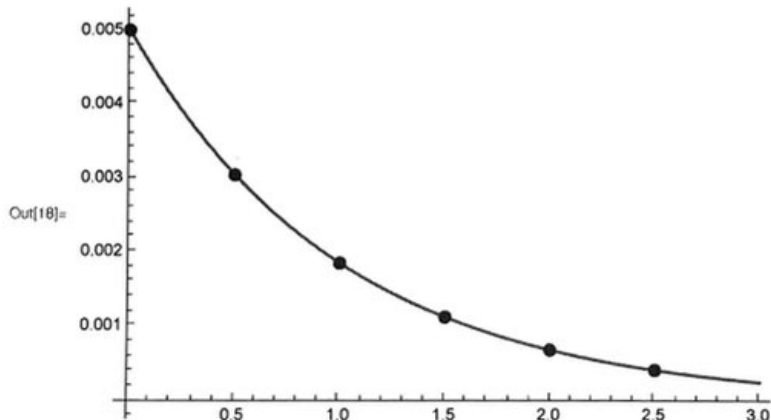
```
In[17] = pointList = Table[{t, q[t]}, {t, 0.0, 2.5, 0.5}];
TableForm[Prepend[N[Table[{t, q[t]}, {t, 0.0, 2.5, 0.5}]],
{"time(in seconds)", "charge(in Coulombs)"}]]
```

Out[17]/TableForm=

time(in seconds)	charge(in Coulombs)
0.	0.005
0.5	0.00303265
1.	0.0018394
1.5	0.00111565
2.	0.000676676
2.5	0.000410425

Making the Graph

```
In[18] = Plot[q[t], {t, 0, 3.0},
Epilog -> {Blue, PointSize@Large, Point[pointList], PlotRange -> {0, 3}}]
```

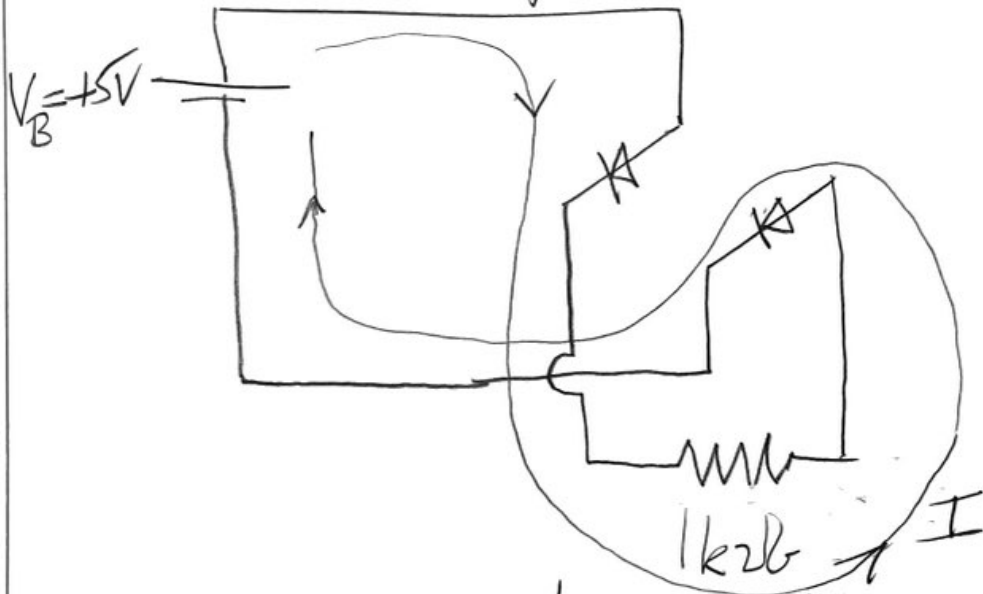


3. The two diodes going in
this direction

are "reverse-biased"

They pass no current.

So they can be removed from the
circuit, leaving

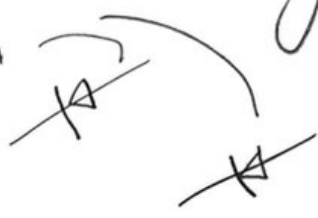


The remaining two diodes are forward
biased. We are treating them as
ideal, so they freely pass current.

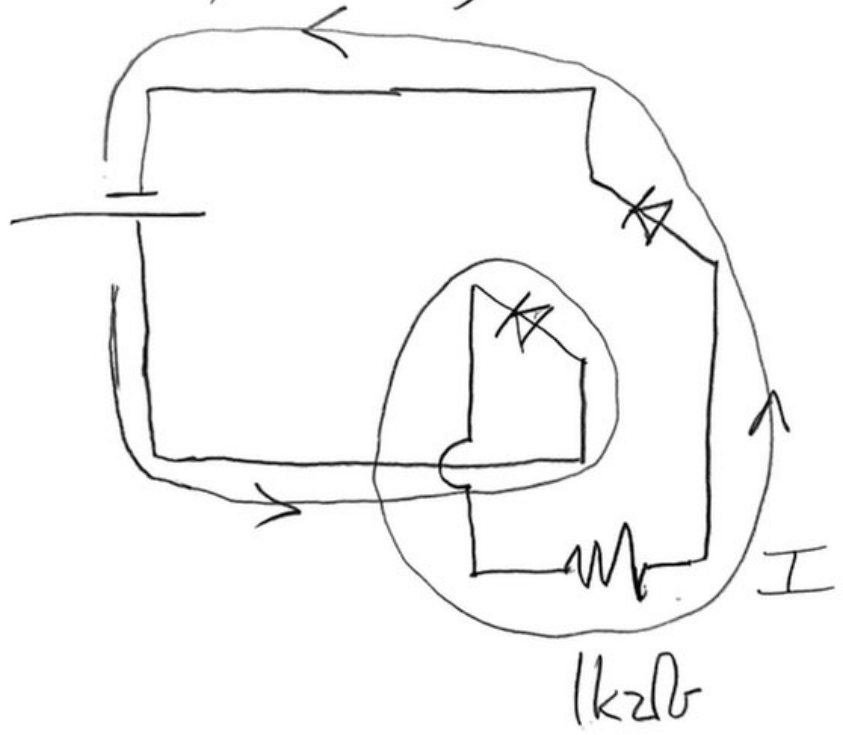
The current is
$$I = \frac{V}{R} = \frac{5V}{1k\Omega} = 5mA$$

and it is indeed to the right.

4. This time the two diodes going in this direction are "reverse-biased".



They pass no current. They can be removed, leaving



Again the current passes to the right through the resistor and is 5mA. This diode arrangement is called a "rectifier."