

[TP] A redox reaction has $K = 10$. If there are only reactants present, $-\log(Q/K)$ is ...

17% 1. $+\infty$
17% 2. 2
17% 3. 1
17% 4. 0
17% 5. -1
17% 6. $-\infty$

Response Counter

10

Lecture 27 CH102 A1 (MWF 9:05 am)

Monday, April 3, 2017

- Complete: Cell voltage versus spontaneity.
- The Nernst equation.

Next lecture: Complete ch16: Exploring the Nernst equation. Concentration cells: Mixing → electric current

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17% 1. $+\infty$
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Response Counter

10

[Quiz] For the redox process

$$Cu^{2+}(aq) + Zn(s) \rightarrow Cu(s) + Zn^{2+}(aq)$$

when $[Cu^{2+}] = 0.001$ and $[Zn^{2+}] = 0$, the voltage is ...

33% 1. < 0
33% 2. 0
33% 3. > 0

Response Counter

10

Voltage *E* versus *Q*/*K*

Make a table of Q, Q/K and $-\log(Q/K)$ for a reaction with $K = 10$, for values $Q = 0, 0.1, 1, 10, 100$, and ∞.

Q	Q/K	$-\log(Q/K)$
0		
0.1		
1		
10		
100		
∞		

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Voltage *E* versus *Q*/*K*

Make a table of Q, Q/K and $-\log(Q/K)$ for a reaction with $K = 10$, for values $Q = 0, 0.1, 1, 10, 100$, and ∞.

Q	Q/K	$-\log(Q/K)$
0	0	$+\infty$
0.1	0.01	2
1	0.1	1
10	1	0
100	10	-1
∞	∞	$-\infty$

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Voltage *E* versus *Q*/*K*

Using your table, sketch $-\log(Q/K)$ versus Q/K, with $K = 10$, for values $Q = 0, 0.1, 1, 10, 100$, and ∞.

Q	Q/K	$-\log(Q/K)$
0	0	$+\infty$
0.1	0.01	2
1	0.1	1
10	1	0
100	10	-1
∞	∞	$-\infty$

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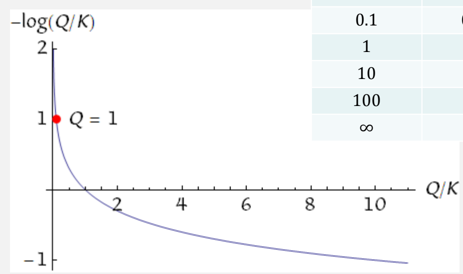
Voltage *E* versus *Q*/*K*

Using your table, plot $-\log(Q/K)$ versus Q/K, with $K = 10$, for values $Q = 0, 0.1, 1, 10, 100$, and ∞.

Q	Q/K	$-\log(Q/K)$
0	0	$+\infty$
0.1	0.01	2
1	0.1	1
10	1	0
100	10	-1
∞	∞	$-\infty$



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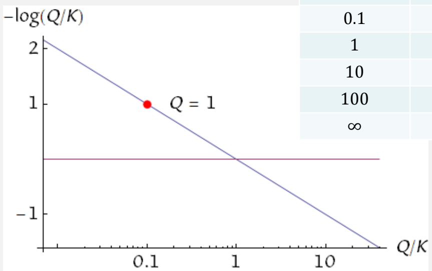
Voltage *E* versus *Q*/*K*

Using your table, plot $-\log(Q/K)$ versus Q/K, with $K = 10$, for values $Q = 0, 0.1, 1, 10, 100$, and ∞.

Q	Q/K	$-\log(Q/K)$
0	0	$+\infty$
0.1	0.01	2
1	0.1	1
10	1	0
100	10	−1
∞	∞	$-\infty$



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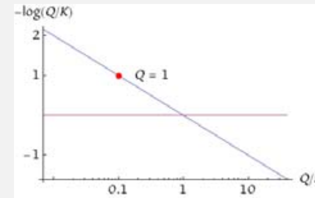
Voltage *E* versus *Q*/*K*

We have discovered that $-\log(Q/K)$ behaves as we expect voltage E to behave versus Q/K.

We will learn that at 25 °C, the constant of proportionality is $-(0.06/n_e)$, so that

$$E = -(0.06/n_e)\ \text{V} \log(Q/K)$$

in terms of the number of moles n_e of electrons transferred per reaction unit.



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$E = -(0.06/n_e)\ \text{V} \log(Q/K)$

Calculate the voltage at 25 °C for $n_e = 1$ when $Q = (1/100) \times K$

$E = 0.12$ V

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$E = -(0.06/n_e)\ \text{V} \log(Q/K)$

Calculate the voltage at 25 °C for $n_e = 1$ when $Q = (1/10) \times K$

$E = 0.06$ V

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$E = -(0.06/n_e)$ V $\log(Q/K)$

Calculate the voltage at 25 °C for $n_e = 1$ when $Q = (10) \times K$

$E = -0.06$ V

$E = -(0.06/n_e)$ V $\log(Q/K)$

At 25 °C for $n_e = 1$, ...
each order of magnitude change in Q/K ...
changes voltage by 0.06 V.

$E = -(0.06/n_e)$ V $\log(Q/K)$

Write an expression for E when $Q = 1$.

$E = -(0.06/n_e)$ V $\log(Q/K)$

The value of E when $Q = 1$ is called the standard voltage and at 25 °C is written as

$$E(Q = 1) = E^{\circ} = +(0.06/n_e) \text{ V} \log(K)$$

[TP] The value of E when $Q = 1$ at 25 °C is

$$E(Q = 1) = E^o = +(0.06/n_e) \text{ V} \log(K)$$

For $n_e = 1$, if K is different by a factor of ten (say, 17 instead of 1.7), the magnitude of standard voltage will change by …

20% 1. 10 V
20% 2. 1 V
20% 3. 0.1 V
20% 4. 0.06 V
20% 5. Some other amount

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[TP] The value of E when $Q = 1$ at 25 °C is

$$E(Q = 1) = E^o = +(0.06/n_e) \text{ V} \log(K)$$

For $n_e = 3$, if K is different by a factor of ten (say, 17 instead of 1.7), the magnitude of standard voltage will change by …

25% 1. 0.18 V
25% 2. 0.06 V
25% 3. 0.02 V
25% 4. Some other amount

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[Quiz] The value of E when $Q = 1$ at 25 °C is

$$E(Q = 1) = E^o = +(0.06/n_e) \text{ V} \log(K)$$

A typical physiological value of E^o is 0.18 V.
For $n_e = 1$ this corresponds to the value of K equal to …

17% 1. 0.1
17% 2. 1
17% 3. 10
17% 4. 100
17% 5. 1000
17% 6. Some other value

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$E = -(0.06/n_e) \text{ V} \log(Q/K)$

The value of E when $Q = 1$ at 25 °C is

$$E(Q = 1) = E^o = +(0.06/n_e) \text{ V} \log(K)$$

Calculate K corresponding to $E^o = 1.8$ V for $n_e = 1$.

$K = 10^{30}$. Very large!

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$E = -(0.06/n_e)$ V $\log(Q/K)$

The value of E when $Q = 1$ at 25 ^{o}C is

$E(Q = 1) = E^{o} = +(0.06/n_e)$ V $\log(K)$

Express the cell voltage for any value of Q in terms of E^{o}, that is, in term of the cell voltage when $Q = 1$.

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$E = -(0.06/n_e)$ V $\log(Q/K)$

The value of E when $Q = 1$ at 25 ^{o}C is

$E(Q = 1) = E^{o} = +(0.06/n_e)$ V $\log(K)$

The cell voltage at 25 ^{o}C for any value of Q in terms of the cell voltage when $Q = 1$ is

$E(\text{any } Q) = E^{o} - (0.06/n_e)$ V $\log(Q)$

This is called the Nernst equation

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