[TP] For the redox process

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

when $[Cu^{2+}] = 0$ and $[Zn^{2+}] = 4$, the voltage is …

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

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Lecture 25 CH102 A2 (MWF 11:15 am)

Wednesday, March 28, 2018

- Complete: Cell voltage versus spontaneity
- Cell voltage versus Q/K: The Nernst equation

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

Standard reduction potentials, https://goo.gl/kBdf8W

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[TP] For the redox process

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

when $[Cu^{2+}] = 0$ and $[Zn^{2+}] = 4$, the voltage is …

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

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[TP] 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 …

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

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

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

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Lecture 25 CH102 A2 (MWF 11:15 am) Spring 2018

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

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

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Lecture 25 CH102 A2 (MWF 11:15 am) Spring 2018

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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Lecture 25 CH102 A2 (MWF 11:15 am) Spring 2018

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, accurately 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	+∞
0.1	0.01	2
1	0.1	1
10	1	0
100	10	−1
∞	∞	−∞

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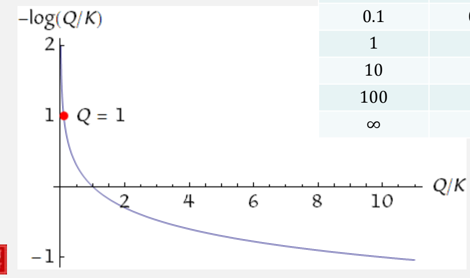
Voltage *E* versus *Q*/*K*

Using your table, accurately 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	+∞
0.1	0.01	2
1	0.1	1
10	1	0
100	10	−1
∞	∞	−∞



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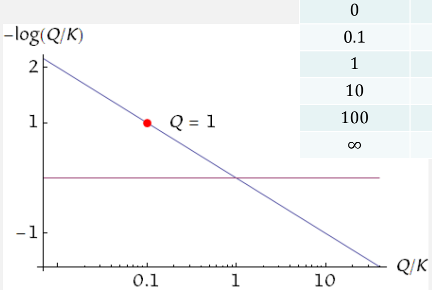
Voltage *E* versus *Q*/*K*

Using your table, accurately 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	+∞
0.1	0.01	2
1	0.1	1
10	1	0
100	10	−1
∞	∞	−∞



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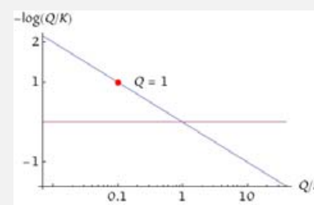
Voltage *E* versus *Q*/*K*



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 $-(0.06/n_e)$ in terms of the number of moles n_e of electrons transferred per reaction unit.

Therefore, at 25 °C, voltage depends on Q and K as

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

When needed, a more precise value of the constant is $-(0.05912/n_e)$.

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

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

$E = 0.12$ 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 $Q = (1/10) \times K$

$E = 0.06$ 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

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$E = -(0.06/n_e)$ 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.

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

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

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

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

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

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

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

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 …

0% 1. 10 V

0% 2. 1 V

0% 3. 0.1 V

0% 4. 0.06 V

0% 5. Some other amount

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

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

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 …

0% 1. 0.18 V

0% 2. 0.06 V

0% 3. 0.02 V

0% 4. Some other amount

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

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

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

0% 1. 0.1
0% 2. 1
0% 3. 10
0% 4. 100
0% 5. 1000
0% 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

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

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

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

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