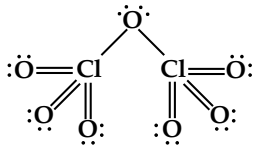
Redox & Electrochemistry Practice Items

1. An oxidizing agent

A. receives electrons in a redox reaction.
B. supplies electrons in a redox reaction.
C. tends to contain atoms with low oxidation numbers.
D. reacts spontaneously with O_2.

2. What is the oxidation number of chlorine in dichlorine heptoxide?



A. –4
B. 0
C. +4
D. +7

3. Which of the following statements is true regarding the reaction of copper(II) sulfate with iron?

$$Fe\ (s) + CuSO_4\ (aq) \longrightarrow FeSO_4\ (aq) + Cu\ (s)$$

I. Iron is reduced
II. Copper is reduced
III. Sulfate ion serves as an oxidizing agent

A. I only
B. II only
C. I and III
D. II and III

4. Which of the following is true regarding molecular oxygen and molecular hydrogen?

A. O_2 is usually reduced in reaction (not with fluorine), while H_2 is usually oxidized (though not by metals).
B. The oxidation number of oxygen in O_2 is –2, while the oxidation number of hydrogen in H_2 is +1.
C. O_2 is a strong reducing agent, while H_2 is usually an oxidizing agent.
D. Hydrogen gas production from a reaction vessel is often the result of the reduction of a metal.

5. Which of the following metals will react vigorously with liquid water to give H_2?

A. Ag
B. Au
C. Hg
D. L

6. Potassium permanganate, $KMnO_4$, is a strong oxidizing agent. In reactions with potassium permanganate, which atom is reduced?

A. K
B. Mn
C. O
D. The substrate is reduced.

7. Many pure metals can be produced by reaction of their chlorides with sodium because

A. sodium forms an ionic compound with chlorine.
B. sodium ion possesses a very high negative standard reduction potential.
C. sodium is a very electrophilic element.
D. sodium chloride has a large lattice energy.

8. What is the coefficient on chlorine molecule when the following oxidation reduction reaction (in acidic solution) is balanced?

$$Cr_2O_7^{2-} + Cl^- \longrightarrow Cr^{3+} + Cl_2$$

A. 1
B. 3
C. 6
D. 7

9. In the reaction below, which species is oxidized and which is reduced?

$$NH_4 + NO_2 \longrightarrow N_2 + 2H_2O$$

A. H is oxidized and N is reduced.
B. N is oxidized and O is reduced.
C. N is both oxidized and reduced.
D. N is oxidized and H is reduced.

10. A large, positive standard reduction potential for a substance indicates that the substance is

A. a strong reducing agent.
B. a strong oxidizing agent.
C. easily oxidized.
D. a cation.

11. In an electrolytic cell

A. oxidation occurs at the positive anode.
B. reduction occurs at the positive anode.
C. oxidation occurs at the negative anode.
D. reduction occurs at the negative anode.

12. In a galvanic cell

A. oxidation occurs at the positive anode.
B. reduction occurs at the positive anode.
C. oxidation occurs at the negative anode.
D. reduction occurs at the negative anode.

13. Which of the following results from the electrolysis of a solution of 5M sodium chloride?

I. production of sodium at the anode and chlorine gas at the cathode
II. production of chlorine gas at the anode and hydrogen gas at the cathode
III. a basic solution around the cathode

A. I only
B. II only
C. I and III
D. II and III

14. The anode and cathode reactions are as follows:

$$Zn\,(s) + 2OH^-\,(aq) \longrightarrow Zn(OH)_2\,(s) + 2e^-$$
$$Ag_2O\,(s) + H_2O + 2e^- \longrightarrow 2Ag\,(s) + 2OH^-(aq)$$

The standard reduction potential of Zn^{2+} is –0.762 V, and that of Ag^+ is +0.800 V. What is the approximate emf of a silver oxide battery?

A. 0.04 V
B. 0.8 V
C. 1.6 V
D. 2.4 V

15. A battery runs dead when the redox reaction

A. has moved charge through the salt bridge equaling capacitance times voltage.
B. has consumed all available reagents.
C. has led to creation of an equal and opposite potential in the salt bridge.
D. reaches the equilibrium state.

16. Placing metallic zinc into a solution of 1M $CuCl_2$ will result in a layer of copper being deposited on the zinc. Placing an aluminum rod in a 1M solution of $ZnCl_2$ will result in metallic zinc being deposited on the aluminum. Which of the following can be concluded from these observations?

I. Zinc is a stronger reducing agent than copper.
II. The standard reduction potential of copper is more positive than that of zinc.
III. Copper ions would spontaneously oxidize aluminum.

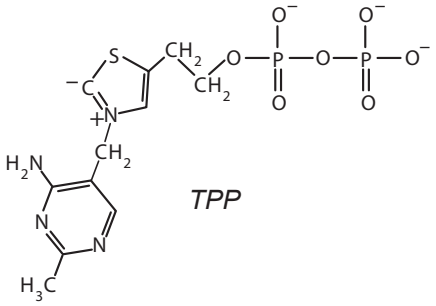
A.. I only
B. II only
C. I and III
D. I, II and III

17. Commercial aluminum is formed electrolytically from aluminum oxide (Al_2O_3), which is reduced at the cathode. Approximately how long must a current of 1000*A* be applied to form 50 g of aluminum?

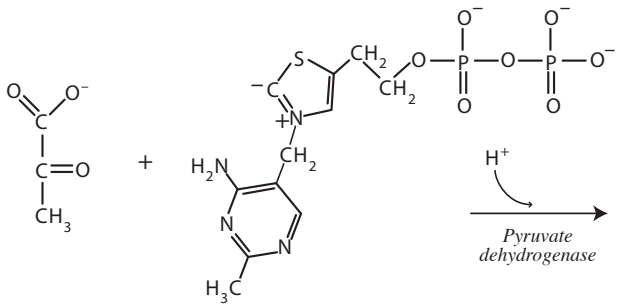
A. 1 second
B. 1 1/2 minutes
C. 10 minutes
D. 17 hours

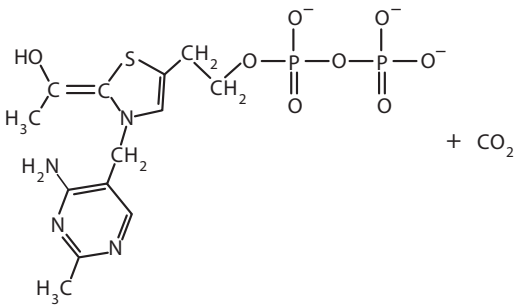
The following passage pertains to questions 18 - 22.

Thiamine pyrophosphate (TPP) is a thiamine (vitamin B1) derivative consisting of a pyrimidine ring which is connected to a thiazole ring, which is in turn connected to a pyrophosphate (diphosphate) functional group.



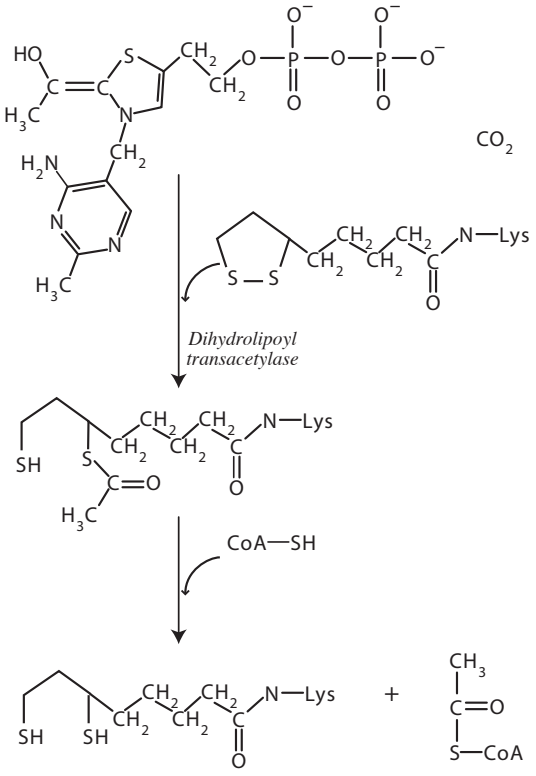
TPP performs an essential role in the catalytic activity of a number of enzymes. TPP is synthesized in the mitochondria for the activity of the pyruvate dehydrogenase complex (PDC). PDC is a complex of three enzymes that converts pyruvate into acetyl-CoA. This complex links glycolysis to the citric acid cycle. IN the mechanism of the pyruvate dehydrogenase enzyme, the anionic C2 carbon of TPP performs a nucleophilic attack on the C2 carbonyl of pyruvate. The resulting hemithioacetal undergoes decarboxylation.



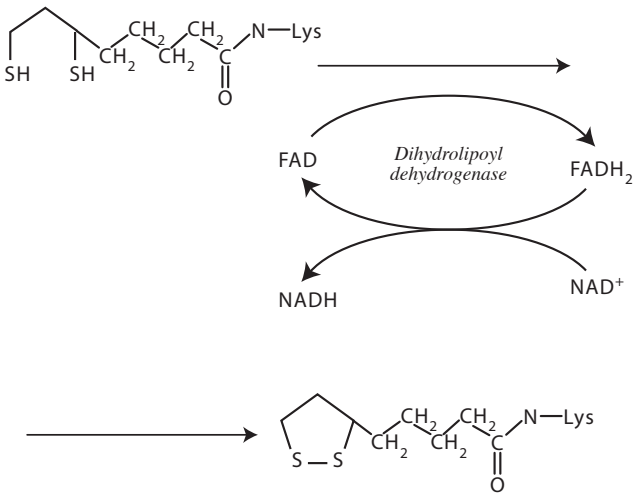


The two carbon remnant of pyruvate, now attached to TPP, attacks the sulfur of the disulfide lipoic acid ring coenzyme attached to a lysine residue of the dihydrolipoyl transacetylase enzyme of the complex. In a ring-opening SN2-like mechanism, the second sulfur is displaced as a sulfide. Release of the TPP cofactor and generates a thioacetate on lipoate. This is the rate-limiting step of the whole pyruvate dehydrogenase complex.

At this point, the lipoate-thioester functionality is translocated into the dihydrolipoyl transacetylase active site, where a transacylation reaction transfers the acetyl from the "swinging arm" of lipoyl to the thiol of coenzyme A. This produces acetyl-CoA, which is released from the enzyme complex and subsequently enters the citric acid cycle.



The dihydrolipoate, still bound to a lysine residue of the complex, then migrates to the dihydrolipoyl dehydrogenase active site where FAD converts dihydrolipoate back to its lipoate resting state, producing $FADH_2$. Then, a NAD^+ cofactor converts $FADH_2$ back to its FAD resting state, producing NADH.



18. Which of the following describes the activity of NAD^+ in the dihydrolypoyl dehydrogenase mechanism.

I. oxidizing agent
II. reducing agent
III. Brønsted base

A. I only
B. II only
C. I and III
D. I, II and III

19. In the dihydrolypoyl transacetylase mechanism, the conversion of the disulfide into the dithiol form of lipoamide produces which change in the oxidation state of each sulfur atom?

A. –1 to –2
B. 0 to –1
C. 0 to –2
D. 0 to +1

20. Which is a net result of the mechanism of pyruvate dehydrogenase complex?

A. Flavin is oxidized and nicotinamide is reduced.
B. Sulfur is oxidized and flavin is reduced.
C. Carbon is oxidized and nicotinamide is reduced.
D. Sulfur is oxidized and nicotinamide is reduced.

21. The standard reduction potential, $E°$, of lipoamide disulfide is –0.29V. The standard reduction potential of NAD^+ is –0.32V. Which of the following is necessarily true regarding the mitochondrial concentrations of these species during aerobic metabolism?

A. $[NAD^+]$[lipoamide dithiol] > [NADH][lipoamide disulfide]
B. $[NAD^+]$[lipoamide disulfide] > [NADH][lipoamide dithiol]
C. [FAD][NADH] > [lipoamide dithiol]$[NAD^+]$
D. [lipoamide dithiol][lipoamide disulfide] > $[NAD^+]$[FAD]

22. The carbon atom of the carboxyl group of pyruvate will be oxidized, becoming CO_2 through the mechanism of the pyruvate dehydrogenase enzyme of the complex. What is the oxidizing agent?

A. thiamine pyrophosphate
B. lipoamide dithiol
C. another carbon of pyruvate
D. coenzyme A