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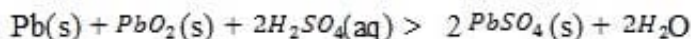




QUESTION 1

The lead-acid battery, also called a lead storage battery, is the battery of choice for starting automobiles. It contains 6 cells connected in series, each composed of a lead oxide cathode "sandwiched" between 2 lead anodes. Insulating separators are placed between the electrodes to prevent internal short-circuits. Aqueous sulfuric acid is the electrolyte.

When the battery is being discharged, the following reaction takes place:



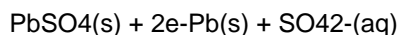
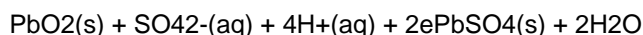
Reaction 1

The electrode reactions, both written as reductions, are shown in Table 1.

Table 1

Half-reaction

E°(V)



1.69

-0.36

As a car operates, the battery is recharged by electricity produced by the car's alternator, an AC generator whose ultimate power source is the car's internal combustion engine. In spite of this, batteries eventually lose their power. The battery is said to be "dead" when Reaction 1 has proceeded completely to the right.

Often in cold weather the battery goes "dead". Thermodynamic data confirms that the voltage of most electrochemical cells decreases with decreasing temperature. If the battery is warmed to room temperature, it often recovers its ability to deliver normal power. The battery appeared "dead" because:

I) the resistance of the electrolyte had decreased. II) the viscosity of the electrolyte had increased. III) the viscosity of the electrolyte had decreased.

A. I only

B. II only

C. I and II only

D. I and III only

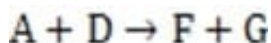
Correct Answer: B

The reason that the battery "goes dead" with decreasing temperature is that the viscosity of the electrolyte increases. At higher viscosities the ions are moving much slower, which leads to an increase in resistance and a decrease in the power output. Roman numeral I states that the resistance of the electrolyte has decreased. This is not true, the resistance of the electrolyte increases with decreasing temperature. Since choice A, choice C, and choice D all contain Roman numeral I, they can be eliminated, leaving choice B as the correct answer.



QUESTION 2

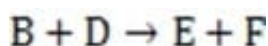
Several techniques have been developed to determine the order of a reaction. The rate of a reaction cannot be predicted on the basis of the overall equation, but can be predicted on the basis of the rate-determining step. For instance, the following reaction can be broken down into three steps.



Step 1



(Slow) Step 2



(fast) Step 3



(fast)

Reaction 1 In this case, the first step in the reaction pathway is the rate-determining step. Therefore, the overall rate of the reaction must equal the rate of the first step, $k_1 [A]$ where k_1 is the rate constant for the first step. (Rate constants of the different steps are denoted by k_x , where x is the step number.)

In some cases, it is desirable to measure the rate of a reaction in relation to only one species. In a second-order reaction, for instance, a large excess of one species is included in the reaction vessel. Since a relatively small amount of this large concentration is reacted, we assume that the concentration essentially remains unchanged. Such a reaction is called a pseudo first-order reaction. A new rate constant, k' , is established, equal to the product of the rate constant of the original reaction, k , and the concentration of the species in excess. This approach is often used to analyze enzyme activity.

In some cases, the reaction rate may be dependent on the concentration of a short-lived intermediate. This can happen if the rate-determining step is not the first step. In this case, the concentration of the intermediate must be derived from the equilibrium constant of the preceding step. For redox reactions, the equilibrium can be correlated with the voltage produced by two half-cells by means of the Nernst equation. This equation states that at any given moment:

$$E = E^\circ - \left(\frac{RT}{nf}\right) \ln$$

$$\left(\frac{[C]^c [D]^d}{[A]^a [B]^b}\right)$$

Equation 1 When



Reaction 2



Note: $R = 8.314 \text{ J/K}\cdot\text{mol}$; $F = 9.6485 \times 10^4 \text{ C/mol}$.)

If Step 2 above were the rate-determining step of Reaction 1, which of the following equations would correctly define the rate?

A. $\text{Rate} = \frac{k_1 k_2 [D]}{k_{-1}} [C]$

B. $\text{Rate} = \frac{k_1 k_2 [D]}{k_{-1} k_{-2}} [C]$

C. $\text{Rate} = \frac{k_1 k_2 [A][D]}{k_{-1}} [C]$

D. $\text{Rate} = \frac{k_1 k_2 [A][D]}{k_{-1} k_{-2}} [C]$

- A. Option A
- B. Option B
- C. Option C
- D. Option D

Correct Answer: C

In this question we are trying to find the rate of the second step of reaction 1. The rate of this step is equal to: $k_2 [B][D]$, where k_2 is the rate constant of step 2, as described in the passage. The problem is that we can't measure the

$$k_{eq} = \frac{[B][C]}{[A]},$$

concentration of B since it is an intermediate. But, according to the passage, we can figure it out from the equilibrium constant of step 1. The equation for the equilibrium constant of step 1 is: or rearranging for [B],

$$[B] = k_{eq} \times [A] / [C]$$

$$\frac{k_{eq} - \text{step 1} \times k_2 \times [A][D]}{[C]}$$

By combining this formula with the rate constant for step 2, we find that the rate of step 2 equals . .

But none of the choices is expressed in terms of the equilibrium constant; instead they're in terms of k_1 and k_{-1} so to answer this question, you need to remember that the equilibrium constant for step one is equal to k_1/k_{-1} , where k_1 is the

rate constant for the forward reaction in step 1, and k_{-1} is the rate constant for the reverse reaction. This leaves us with choice C as the correct answer.



QUESTION 3

The Russia which emerged from the terrible civil war after the 1917 Revolution was far from the Bolsheviks' original ideal of a non-exploitative society governed by workers and peasants. By 1921, the regime was weakened by widespread famine, persistent peasant revolts, a collapse of industrial production stemming from the civil war, and the consequent dispersal of the industrial working class -- the Bolsheviks' original base of support. To buy time for recovery, the government in 1921 introduced the New Economic Policy, which allowed private trade in farm products (previously banned) and relied on a fixed grain tax instead of forced requisitions to provide food for the cities. The value of the ruble was stabilized. Trade unions were again allowed to seek higher wages and benefits, and even to strike. However, the Bolsheviks maintained a strict monopoly of power by refusing to legalize other parties. After the death of the Revolution's undisputed leader, Lenin, in January 1924, disputes over the long-range direction of policy led to an open struggle among the main Bolshevik leaders. Since open debate was still possible within the Bolshevik Party in this period, several groups with differing programs emerged in the course of this struggle. The program supported by Nikolai Bukharin -- a major ideological leader of the Bolsheviks with no power base of his own -- called for developing agriculture through good relations with wealthy peasants, or "kulaks." Bukharin favored gradual industrial development, or "advancing towards Socialism at a snail's pace." In foreign affairs, Bukharin's policy was to ally with non-Socialist regimes and movements that were favorable to Russia. A faction led by Leon Trotsky, head of the Red Army and the most respected revolutionary leader after Lenin, called for rapid industrialization and greater central planning of the economy, financed by a heavy tax on the kulaks. Trotsky rejected the idea that a prosperous, human Socialist society could be built in Russia alone (Stalin's slogan of "Socialism in One Country"), and therefore called for continued efforts to promote working-class revolutions abroad. As time went on, he became bitterly critical of the new privileged elite emerging within both the Bolshevik Party and the Russian state. Joseph Stalin, General Secretary of the Bolshevik Party, was initially considered a "center," conciliating figure, not clearly part of a faction. Stalin's eventual supremacy was ensured by three successive struggles within the party, and only during the last did his own program become clear. First, in 1924-25, Stalin isolated Trotsky, allying for this purpose with Grigori Zinoviev and Lev Kamenev, Bolshevik leaders better known than Stalin himself, whom Trotsky mistakenly considered his main rivals. Stalin maneuvered Trotsky out of leadership of the Red Army, his main potential power base. Next, Stalin turned on Zinoviev and Kamenev, using his powers as head of the Party organization to remove them from party leadership in Leningrad and Moscow, their respective power bases. Trotsky, Zinoviev, and Kamenev then belatedly formed the "Joint Opposition" (1926-27). With Bukharin's help, Stalin easily outmaneuvered the Opposition: Bukharin polemicized against Trotsky, while Stalin prevented the newspapers from printing Trotsky's replies, organized gangs of toughs to beat up his followers, and transferred his supporters to administrative posts in remote regions. At the end of 1927, Stalin expelled Trotsky from the Bolshevik Party and exiled him. (Later, in 1940, he had him murdered.) Zinoviev and Kamenev, meanwhile, recanted their views in order to remain within the Party. The final act now began. A move by kulaks to gain higher prices by holding grain off the market touched off a campaign against them by Stalin. Bukharin protested, but with the tradition of Party democracy now all but dead, Stalin had little trouble silencing Bukharin. Meanwhile, he began a campaign to force all peasants -- not just kulaks -- onto state-controlled "collective farms," and initiated a crash industrialization program during which he deprived the trade unions of all rights and cut real wages by 50%. Out of the factional struggle in which he emerged by 1933 as sole dictator of Russia, Stalin's political program of building up heavy industry on the backs of both worker and peasant emerged with full clarity.

An important feature of Bukharin's program was:

- A. a tax on the peasants.
- B. avoiding confrontations with the trade unions.
- C. forming alliances with friendly foreign regimes.
- D. maintaining open debate within the Party.

Correct Answer: C

The features of Bukharin's program are listed in Paragraph 3. At the end of the paragraph, the author states that one of Bukharin's policies was to form alliances with non-socialist foreign regimes that were favorable to Russia. This makes



Choice C correct.

Choice A is one of Trotsky's policies, not Bukharin's. Avoiding confrontations with the trade unions (Choice B) was presumably the idea behind the New Economic Policy's lifting of restrictions; this wasn't Bukharin's policy either. Choice D was

not a feature of anyone's program.

QUESTION 4

Which of following must be present in human's diet to prevent thyroxin deficiency?

- A. Iron
- B. Calcium
- C. Iodine
- D. Phosphorus

Correct Answer: C

QUESTION 5

Although nihilism is commonly defined as a form of extremist political thought, the term has a broader meaning. Nihilism is in fact a complex intellectual stance with venerable roots in the history of ideas, which forms the theoretical basis for many positive assertions of modern thought. Its essence is the systematic negation of all perceptual orders and assumptions. A complete view must account for the influence of two historical crosscurrents: philosophical skepticism about the ultimacy of any truth, and the mystical quest for that same pure truth. These are united by their categorical rejection of the "known". The outstanding representative of the former current, David Hume (1711-1776), maintained that external reality is unknowable, since sense impressions are actually part of the contents of the mind. Their presumed correspondence to external "things" cannot be verified, since it can be checked only by other sense impressions. Hume further asserts that all abstract conceptions turn out, on examination, to be generalizations from sense impressions. He concludes that even such an apparently objective phenomenon as a cause-and-effect relationship between events may be no more than a subjective fabrication of the observer. Stanley Rosen notes: "Hume terminates in skepticism because he finds nothing within the subject but individual impressions and ideas". For mystics of every faith, the "experience of nothingness" is the goal of spiritual practice. Buddhist meditation techniques involve the systematic negation of all spiritual and intellectual constructs to make way for the apprehension of pure truth. St. John of the Cross similarly rejected every physical and mental symbolization of God as illusory. St. John's spiritual legacy is, as Michael Novak puts it, "the constant return to inner solitude, an unbroken awareness of the emptiness at the heart of consciousness. It is a harsh refusal to allow idols to be placed in the sanctuary. It requires also a scorching gaze upon all the bureaucracies, institutions, manipulators, and hucksters who employ technology and its supposed realities to bewitch and bedazzle the psyche". Novak's interpretation points to the way these philosophical and mystical traditions prepared the ground for the political nihilism of the nineteenth and twentieth centuries. The rejection of existing social institutions and their claims to authority is in the most basic sense made possible by Humean skepticism. The political nihilism of the Russian intelligentsia combined this radical skepticism with a near mystical faith in the power of a new beginning. Hence, their desire to destroy becomes a revolutionary affirmation; in the words of Stanley Rosen, "Nihilism is an attempt to overcome or repudiate the past on behalf of an unknown and unknowable, yet hoped-for, future." This fusion of skepticism and mystical re-creation can be traced in contemporary thought, for example as an element in the counterculture of the 1960s.

In the passage, quotations from writers about nihilism are used in order to:



I. summarize specific points made in the course of the passage.

II. contrast points of view on the subject under discussion.

III.

make transitions between points in the discussion.

A.

I only

B.

I and II only

C.

I and III only

D.

II and III only

Correct Answer: C

The third question is in Roman numeral format. You have to decide which statement or statements accurately describe how the author uses quotations from other writers. Let's take the statements one by one.

Statement I is true. There are three quotations used in the passage, two by Stanley Rosen in the second and fourth paragraphs, and one by Novak in Paragraph 3. Rosen's first quote, at the end of Paragraph 2, summarizes Hume's argument, and Rosen's second quote sums up what the author wants to say about the political nihilism of the Russian intelligentsia. Statement I will therefore be part of the correct answer; this eliminates Choice D, which does not include Statement I.

Statement II is false because the author never presents any contrasting points of view in the entire passage. This rules out Choice B. Statement III, on the other hand, is true. In the opening sentence of Paragraph 4, the author refers to the quote from Novak in the previous paragraph in order to make the transition from the discussion of mysticism to the larger point about how skepticism and mysticism paved the way for nihilism.

Since Statements I and III are true, Choice C is correct.

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