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QUESTION 1

A researcher in a molecular biology lab planned to carry out an extraction procedure known as an alkaline plasmid prep, which is designed to purify plasmids, small pieces of the hereditary material DNA, from bacterial cells. The bacteria are first placed into a test tube containing liquid nutrient medium and allowed to grow until they reach a high population density. The culture, which consists of solid cells suspended in the medium, is then centrifuged; a solid pellet is formed. The supernatant is poured out, leaving the pellet behind, and the cells are resuspended in a mL of lysis buffer solution (50 mM glucose, 25 mM Tris buffer and 10 mM ethylenediaminetetraacetic acid (EDTA), with 5 mg of the enzyme lysozyme added). They are then incubated for 30 minutes at 0°C, during which time the bacterial cell walls break down and the cell contents are released into the solution. After incubation, 1 mL of 0.4 N sodium hydroxide and 1 mL of 2% sodium dodecyl sulfate (SDS) are added, and the solution is again incubated on ice for 10 minutes. 2 mL of 3 M sodium acetate are added and the mixture is incubated for 30 minutes at 0°C. The test tube is centrifuged once more and the supernatant is decanted into a clean tube, leaving behind the protein and most other cell components in the pellet. Finally, 10 mL of pure ethanol are added to the supernatant from the previous step to precipitate out the DNA, and the test tube is incubated at –20°C for 60 minutes, during which the mixture remains liquid. The mixture is centrifuged a final time and the supernatant removed. The translucent precipitate that results is washed with 70% ethanol (70% ethanol and 30% water by volume), allowed to dry, and resuspended in 1 mL of TE buffer (10 mM Tris, 1 mM EDTA). In preparation for this experiment, the researcher prepared stock solutions of the various chemicals that she will need in the experiment. Stock solutions are highly concentrated solutions of commonly used chemicals in water from which dilute solutions are prepared for daily use. Table 1 shows the chemicals, their molecular formulas and weights, and the composition of commonly used stock solutions.

Table 1

Compound	Formula	MW	Stock
Tris	$(CH_2OH)_3CNH_2$	121	1*M* (pH 8)
EDTA	$(HOOCCH_2)_4(CNH_2)_2$	292	0.5 *M* (pH 8)
Sodium hydroxide	NaOH	40	5 *N*
SDS	$C_{11}H_{23}CH_2OSO_3^-Na^+$	288	10%
Sodium acetate	$CH_3COO^-Na^+$	82	3 *M* (pH 5.2)
Ethanol	CH_3CH_2OH	46	95%

Pure ethanol (CH3CH2OH) is difficult to prepare and therefore expensive; 95% ethanol is much cheaper. Consequently, 95% ethanol is generally used in the preparation of dilute ethanol solutions. How much 95% ethanol would be needed to produce a 500 mL solution of 70% ethanol by volume in water?

A. 333 mL

B. 350 mL

C. 368 mL

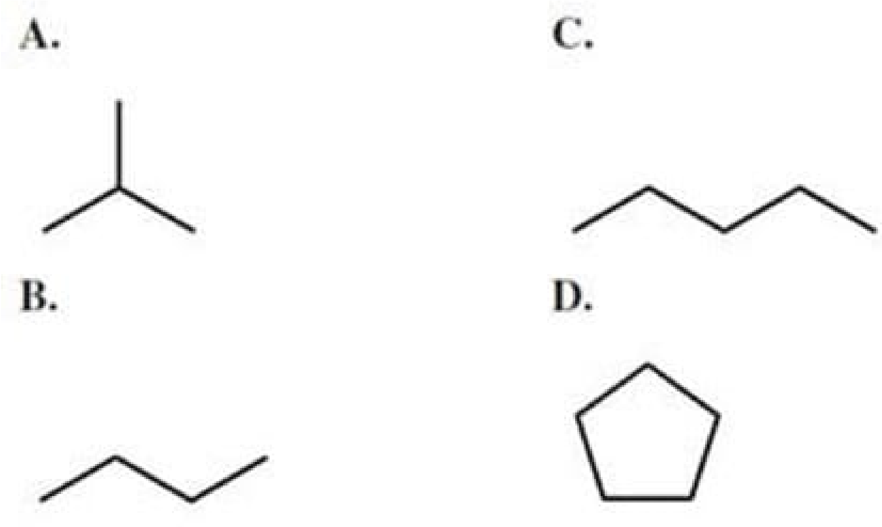
D. 475 mL

Correct Answer: C

The easiest way to do it is to figure out how much ethanol is in the solution at the end of the dilution, and work backwards from the end. Now, notice that the meaning of the percentage sign in this question and in the preceding question is different -- there we were talking about percentage by mass, whereas this question tells you clearly that it\\'s dealing with percentage by volume. Also, you\\'re told in the passage that a 70% ethanol solution contains 70% ethanol and 30% water by volume. In practice, this is how researchers do usually measure solutions, just for convenience-- it\\'s easiest to measure liquids by their volume and measure solids by their mass. Anyway, 500 milliliters of a 70% ethanol solution will contain 350 milliliters of ethanol and 150 milliliters of water. So we need an amount of 95% ethanol that contains 350 milliliters of ethanol. If we call this amount X, then 0.95X equals 350 milliliters. So we want a choice that\\'s just a little more than 350, and the only one that fits is C. Sure enough, if we solve the equation, we find that X equals 368 milliliters, choice C.

QUESTION 2

Which of the following species will form the most stable radical?



A. Option A

B. Option B

C. Option C

D. Option D

Correct Answer: A

The stability of free radicals decreases from tertiary>secondary>primary>methyl. Choice A is the only choice that can form a tertiary radical. Choices B, C, and D will form secondary radicals.

QUESTION 3

Due to ever-increasing paranoia about the transmission of hepatitis and AIDS via blood transfusions and the frequent difficulty of procuring matching blood donors for patients, researchers have been working at a feverish pace to produce disease-free and easy-to-use blood substitutes. The difficulty most synthetic blood researches have had is in formulating a substance that combines qualities of sterility, high capacity for carrying oxygen to body tissues, and versatility within the human body. Three major substitute technologies have been developed to date; each has certain advantages and shortcomings.

"Red blood," the first of the blood substitute technologies, is derived from hemoglobin which has been recycled from old, dead, or worn-out red blood cells and modified so that it can carry oxygen outside the red blood cell. Hemoglobin, a complex protein, is the blood\\'s natural oxygen carrier and is attractive to scientists for use in synthetic blood because of its oxygen-carrying capacity. However, hemoglobin can sometimes constitute a two-fold threat to humans when it is extracted from the red blood cell and introduced to the body in its naked form. First, hemoglobin molecules are rarely sterile and often remain contaminated by viruses to which they were exposed in the cell. Second, naked hemoglobin is extremely dangerous to the kidneys, causing blood flow at these organs to shut down and leading, ultimately, to renal failure. Additional problems arise from the fact that hemoglobin is adapted to operate optimally within the intricate environment of the red blood cell. Stripped of the protection of the cell, the hemoglobin molecule tends to suffer breakdown within several hours. Although modification has produced more durable hemoglobin molecules which do not cause renal failure, undesired side effects continue to plague patients and hinder the development of hemoglobin-based blood substitutes.

Another synthetic blood alternative, "white blood", is dependent on laboratory synthesized chemicals called perfluorocarbons (PFCs). Unlike blood, PFCs are clear oil like liquids, yet they are capable of absorbing quantities of oxygen up to 50% of their volume, enough of an oxygen carrying potential for oxygen-dependent organisms to survive submerged in the liquid for hours by "breathing" it. Although PFCs imitate real blood by effectively absorbing oxygen, scientists are primarily interested in them as constituents of blood substitutes because they are inherently safer to use than hemoglobin-based substitutes. PFCs do not interact with any chemicals in the body and can be manufactured in near-perfect sterility. The primary pitfall of PFCs is in their tendency to form globules in plasma that can block circulation. Dissolving PFCs in solution can mitigate globulation; however, this procedure also seriously curtails the PFCs\\' oxygen capacity.

The final and perhaps most ambitious attempt to form a blood substitute involves the synthesis of a modified version of human hemoglobin by genetically-altered bacteria. Fortunately, this synthetic hemoglobin seems to closely mimic the qualities of sterility, and durability outside the cellular environment, and the oxygen-carrying efficiency of blood. Furthermore, researchers have found that if modified hemoglobin genes are added to bacterial DNA, the bacteria will produce the desired product in copious quantities. This procedure is extremely challenging, however, because it requires the isolation of the human gene for the production of hemoglobin, and the modification of the gene to express a molecule that works without support from a living cell.

While all the above technologies have serious drawbacks and difficulties, work to perfect an ideal blood substitute continues. Scientists hope that in the near future safe synthetic blood transfusions may ease blood shortages and resolve the unavailability of various blood types.

According to the passage, how much oxygen can be absorbed by a 300 cc sample of PFC?

A. 50 cc

B. 100 cc

C. 150 cc D. 300 cc

Correct Answer: C

This is an application question which requires you to apply information from the passage to solve a problem. The passage mentions that PFCs are capable of absorbing quantities of oxygen up to 50% of their volume. Applying this information, then, a 300 cc sample of PFC can absorb up to 150 cc, 50% of 300 cc. The correct answer, then, is choice (C), 150 cc.

QUESTION 4

Hemoglobin (Hb) and myoglobin (Mb) are the O2-carrying proteins in vertebrates. Hb, which is contained within red blood cells, serves as the O2 carrier in blood and also plays a vital role in the transport of CO2 and H+. Vertebrate Hb consists of four polypeptides (subunits) each with a heme group. The four chains are held together by noncovalent attractions. The affinity of Hb for O2 varies between species and within species depending on such factors as blood pH, stage of development, and body size. For example, small mammals give up O2 more readily than large mammals because small mammals have a higher metabolic rate and require more O2 per gram of tissue.

The binding of O2 to Hb is also dependent on the cooperativity of the Hb subunits. That is, binding at one heme facilitates the binding of O2 at the other hemes within the Hb molecule by altering the conformation of the entire molecule. This conformational change makes subsequent binding of O2 more energetically favorable. Conversely, the unloading of O2 at one heme facilitates the unloading of O2 at the others by a similar mechanism.

Figure 1 depicts the O2-dissociation curves of Hb (Curves A, B, and C) and myoglobin (Curve D), where saturation, Y, is the fractional occupancy of the O2-binding sites. The fraction of O2 that is transferred from Hb as the blood passes through the tissue capillaries is called the utilization coefficient. A normal value is approximately 0.25.

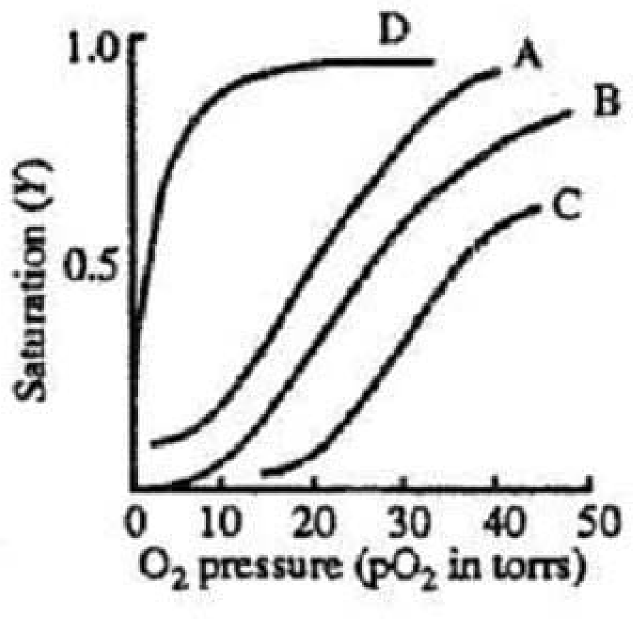


Figure 1

Myoglobin facilitates transport in muscle and serves as a reserve store of O2. Mb is a single polypeptide chain containing a heme group, with a molecular weight of 18 kd. As can be seen in Figure 1, Mb (Curve D) has a greater affinity for than Hb.

The llama is a warm-blooded mammal that lives in regions of unusually high altitudes, and has evolved a type of Hb that adapts it to such an existence. If Curve B represents the O2-dissociation curve for horse Hb, which curve would most closely resemble the curve for llama Hb?

A. Curve A

B. Curve B

C. Curve C

D. Curve D

Correct Answer: A

The key to answering this question lies in knowing that at high altitudes, atmospheric pressure is low, meaning that there is less oxygen in the air than at sea level. We\\'re told that the llama has adapted to life at high altitudes by evolving a different type of hemoglobin. Since the partial pressure of oxygen is lower up in the mountains, llama hemoglobin must be able to bind oxygen MORE readily at low partial pressures of oxygen. And this means that for a given value of oxygen pressure on the X-axis of Figure 1, the llama\\'s hemoglobin will be more saturated with oxygen than the horse\\'s hemoglobin, since horses don\\'t typically live in regions of unusually high altitude. In terms of Figure 1, this means that the llama oxygen- dissociation curve will be to the left of the horse\\'s. So if Curve B is the horse curve, then the llama curve most closely resembles Curve A. Thus, choices B and C are wrong. As for Curve D; remember, we\\'re told in the passage that Curves A, B, and C are hemoglobin curves, while Curve D is the myoglobin curve. So, choice D is wrong.

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?776), 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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