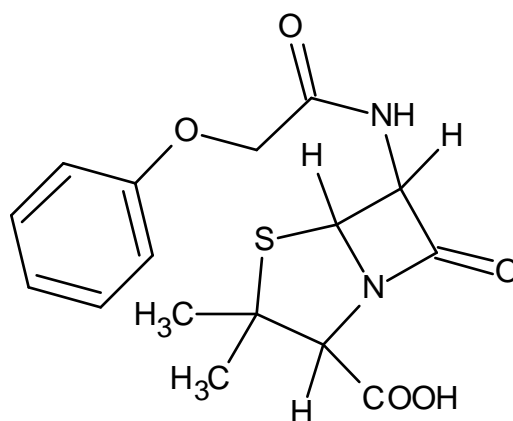# Practice MCAT Test II

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1

Preface

Practice MCAT Test II is designed to be similar to an actual MCAT exam, both in content and in presentation. However, in an actual MCAT exam you will be given each test booklet separately, and a table of contents is not provided. Explanatory answers to this practice test are available from the authors upon payment of the purchase price. We encourage you to study the answers, even for questions you have answered correctly. Completing the practice test and studying the answers will help you become familiar with the exam format and help you to review and better understand the MCAT subject areas.

Practice MCAT Test II is offered through the internet for two reasons:

1.   there are no printing and shipping costs so the price can be set low; and
2.   potential buyers can "test-drive" before purchasing.

If you decide to use this book, please send a check or money order for U.S. $4.00, or the equivalent Canadian or Australian amount, made payable to **Ken Evans**. Also include your e-mail address so that we can send you the answers. Send to:

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Thank you for your interest in our publication and good luck with the MCAT.

Ken Evans
Charlene Bramwell

Cover: Structure of penicillin V. This antibiotic interferes with the synthesis of cell wall peptides in various bacteria. The cell wall eventually lyses resulting in death of the bacterium. Since it is resistant to hydrolysis in the stomach and is relatively well absorbed in the gastrointestinal tract, penicillin V is administered orally. It is generally indicated for mild to moderate gram-positive streptococcal infections and for certain prophylactic purposes.

Contents

Verbal Reasoning

Time: 85 minutes
Questions: 1-65

Directions: There are nine passages, each followed by several questions. After reading a passage, select one best answer to each question. If you are uncertain of an answer, eliminate the alternatives that you know to be incorrect and then select an answer from the remaining alternatives.

Passage I

There is a confused notion in the minds of many persons that the gathering of the property of the poor into the hands of the rich does no ultimate harm, since in whoever hands it may be, it must be spent at last, and thus, they think, return to the poor again. This fallacy has been again and again exposed; but granting the plea true, the same apology may, of course, be made for blackmail, or any other form of robbery. It might be (though practically it never is) as advantageous for the nation that the robber should have the spending of the money he extorts, as that the person robbed should have spent it. But this is no excuse for the theft. If I were to put a turnpike on the road where it passes my own gate, and endeavor to exact a shilling from every passenger, the public would soon do away with my gate, without listening to any pleas on my part that it was as advantageous to them, in the end, that I should spend their shillings, as that they themselves should. But if, instead of outfacing them with a turnpike, I can only persuade them to come in and buy stones, or old iron, or any other useless thing, out of my ground, I may rob them to the same extent, and be, moreover, thanked as a public benefactor and promoter of commercial prosperity. And this main question for the poor of England - for the poor of all countries - is wholly omitted in every treatise on the subject of wealth.

Even by the laborers themselves, the operation of capital is regarded only in its effect on their immediate interests, never in the far more terrific power of its appointment of the kind and the object of labor. It matters little, ultimately, how much a laborer is paid for making anything; but it matters fearfully what the thing is, which he is compelled to make. If his labor is so ordered as to produce food, fresh air, and fresh water, no matter that his wages are low, the food and the fresh air and water will be at last there, and he will at last get them. But if he is paid to destroy food and fresh air, or to produce iron bars instead of them, the food and air will finally not be there, and he will not get them, to his great and final inconvenience. So that, conclusively, in political as in household economy, the great question is, not so much what money you have in your pocket, as what you will buy with it and do with it.

1. We may infer that the author probably lived in the
    A. 1960's in the United States.
    B. early days of British industrialization.
    C. 18th-century France.
    D. Golden Age of Greece.

2. It can be inferred that the author probably favors
    A. capitalism.
    B. totalitarianism.
    C. socialism.
    D. anarchism.

3. According to the passage, the individual should be particularly concerned with
    A. how much wealth he can accumulate.
    B. the acquisition of land property rather than money.
    C. charging the customer a fair price.
    D. the quality of goods which he purchases with his funds.

4. The passage implies that
    A. "A stitch in time saves nine."
    B. "It is better late than never."
    C. "He who steals my purse steals trash."
    D.   "All's well that ends well."

5. It can be inferred that, in regard to the accumulation of wealth, the author
    A. equates the rich with the thief.
    B. thinks that there are few honest businessmen.
    C. condones some dishonesty in business dealings.
    D. believes destruction of property is good because it creates consumer demand.

6. What is the "main question for the poor" referred to by the author in the passage?
    A. the use to which the laborer can put his money
    B. the methods by which capital may be accumulated
    C. the results of their work and their lack of authority to determine to what ends their work shall be put
    D. whether full measure of recompense shall be accorded to the laboring person for the investment of his time in worthy work

7. According to the views expressed in the passage, people should be happiest doing which of the following?
    A. mining ore for the manufacture of weapons
    B. cleaning sewage ponds at a treatment plant
    C. waiting tables for a rich man
    D. helping a poor man do his job

8. The tone of the passage is
    A. humorous.
    B. sardonic.
    C. persuasive.
    D. cynical.

Passage II

Shams and delusions are esteemed for soundest truths, while reality is fabulous. If men would steadily observe realities only, and not allow themselves to be deluded, life, to compare it with such things as we know, would be like a fairy tale and the Arabian Nights' entertainments. If we respect only what is inevitable and has a right to be, music and poetry would resound along the streets. When we are unhurried and wise, we perceive that only great and worthy

5

things have any permanent and absolute existence, that petty fears and petty pleasures are but the shadow of the reality. This is always exhilarating and sublime. By closing the eyes and slumbering, and consenting to be deceived by shows, men everywhere establish and confirm their daily life of routine and habit, which still is built on purely illusory foundations. Children, who play life, discern its true law and relations more clearly than men who fail to live it worthily, but who think that they are wiser by experience; that is, by failure.

I have read in a Hindu book that there was a king's son who, being expelled in infancy from his native city, was brought up by a forester, and, growing up to maturity in that state, imagined himself to belong to the barbarous race with which he lived. One of his father's ministers, having discovered him, revealed to him what he was, and the misconception of his character was removed, and he knew himself to be a prince. "So soul," continues the Hindu philosopher, "from the circumstances in which it is placed, mistakes its own character, until the truth is revealed to it by some holy teacher, and then it knows itself to be *Brahme*.

We think that that *is* which *appears* to be. If a man should give us an account of the realities he beheld, we should not recognize the place in his description. Look at a meeting-house, or a court-house, or a jail, or a shop, or a dwelling house, and say what that thing really is before a true gaze, and they would all go to pieces in your account of them. Men esteem truth remote, in the outskirts of the system, behind the farthest star, before Adam and after the last man. In eternity there is indeed something true and sublime. But all these times and places and occasions are now and here. God himself culminates in the present moment, and will never be more divine in the lapse of all ages. And we are enabled to apprehend at all what is sublime and noble only by the perpetual instilling and drenching of the reality that surrounds us. The universe constantly and obediently answers to our conceptions; whether we travel fast or slow, the track is laid for us. Let us spend our lives in conceiving then. The poet or the artist never yet had so fair and noble a design but some of his posterity at least could accomplish it.

9. The writer's attitude toward the arts is one of
   A. indifference.
   B. suspicion.
   C. admiration.
   D. repulsion.

10. The author believes that children are often more acute than adults in their appreciation of life's relations because
   A. children know more than adults.
   B. children can use their experience better.
   C. children's eyes are unclouded by failure.
   D. experience is the best teacher.

11. The passage implies that human beings
   A. cannot distinguish the true from the untrue.
   B. are immoral if they are lazy.
   C. should be bold and fearless.
   D. believe in fairy tales.

12. The word fabulous in the first sentence means
   A. wonderful.
   B. delicious.
   C. birdlike.
   D. illusory.

13. The author is primarily concerned with urging the reader to
   A. meditate on the meaninglessness of the present.
   B. look to the future for enlightenment.
   C. appraise the present for its true value.
   D. honor the wisdom of past ages.

14. The passage is primarily concerned with problems of
   A. history and economics.
   B. society and population.
   C. biology and physics.
   D. theology and philosophy.

15. Which of the following best describes the author's idea of the relationship between man and the universe?
   A. Each person's mind can control the galaxies.
   B. What you see is what you get.
   C. Our lives are predetermined.
   D. We may choose to live quickly or slowly.

Passage III

The origin of continental nuclei has long been a puzzle. Theories advanced so far have generally failed to explain the first step in continent growth, or have been subject to serious objections. It is the purpose of this article to examine the possible role of the impact of large meteorites or asteroids in the production of continental nuclei.

Unfortunately, the geological evolution of the Earth's surface has had an obliterating effect on the original composition and structure of the continents to such an extent that further terrestrial investigations have small chance of arriving at an unambiguous answer to the question of continental origin. Paradoxically, clues to the origin and early history of the surface features of Earth may be found on the moon and planets, rather than on Earth, because some of these bodies appear to have had a much less active geological history. As a result, relatively primitive surface features are preserved for study and analysis.

In the case of both the moon and Mars, it is generally concluded from the appearance of their heavily cratered surfaces that they have been subjected to bombardment by large meteoroids during their geological history. Likewise, it would appear a reasonable hypothesis that Earth has also been subjected to meteoroid bombardment in the past, and that very large bodies struck Earth early in its geological history.

The largest crater on the moon listed by Baldwin has a diameter of 285 km. However, if we accept the hypothesis of formation of some of the mare basins by impact, the maximum lunar impact crater diameter is probably as large as 650 km. Based on a lunar analogy, one might expect several impact craters of at least 500 km diameter to have been formed on Earth. By applying Baldwin's equation, the depth of such a crater should be about 20 km. Baldwin admits that his equation gives excessive depths for large craters so that the actual depth should be somewhat smaller. Based on the measured depth of smaller lunar craters, a depth of 10 km is probably a conservative estimate for the depth of a 500 km impact crater. Baldwin's equation gives the depth of the zone of brecciation for such a crater as about 75 km. The plasticity of Earth's mantle at the depth makes it impossible to speak of "brecciation" in the usual sense. However, local stresses may be temporarily sustained at that depth, as shown by the existence of deep-focus earthquakes. Thus, short-term effects might be expected to a depth of more than 50 km in the mantle.

Even without knowing the precise effects, there is little doubt that the formation of a 500 km crater would be a major geological event. Numerous authors have considered the geological implications of such an event. Donn et al. have, for example, called on the impact of continent-size bodies of sialic composition to form the original continents. Two major difficulties inherent in this concept are the lack of any known sialic meteorites, and the high probability that the energy of impact would result in a wide dissemination of sialic material, rather than its concentration at the point of impact.

Gilvarry, on the other hand, called on meteoroid impact to explain the production of ocean basins. The major difficulties with this model are that the morphology of most of the ocean basins is not consistent with impact, and that the origin and growth of continents are not adequately explained.

We agree with Donn et al. that the impact of large meteorites or asteroids may have caused continent formation, but would rather think in terms of the localized addition of energy to the system, rather than in terms of the addition of actual sialic material.

16. The author's purpose in writing the passage was to
   A. analyze ways in which asteroids and meteorites could have influenced the development of continents on Earth.
   B. discuss the possible causes of continent formation.
   C. review lunar continent formation.
   D. discuss the theories of continental nuclei formation.

17. A mare basin is most probably
   A. an area where animal life flourished at one time.
   B. a formula for determining the relationship between the depth and width of craters.
   C. a valley that is filled in when a spatial body.
   D. an area of the moon that is the result of collision between the moon and some other body.

18. As used in the passage, the term "brecciation" seems to mean
   A. volcanism.
   B. breaking and bending.
   C. mountain building.
   D. sea bed raising.

19. According to the passage, the largest crater that is found on the moon today is approximately
   A. 1.6 km across.
   B. 20 km across.
   C. 50 km across.
   D. 650 km across.

20. The passage is primarily concerned with
   A. the origin of continents on Earth
   B. the origin of craters on the moon
   C. differences of opinion among schools of geological thought
   D. the relationship between asteroids and meteorites and other space bodies.

21. The writer does not believe that
   A. an asteroid is larger than a meteorite.
   B. material from space, upon hitting the Earth, was eventually distributed.
   C. oceans were formerly craters.
   D. Earth, at one time, had craters.

22. It may be inferred from the passage that the author believes geologists researching continental origins and development would do well to devote much, if not most, of their study to
   A. asteroids and large meteorites.
   B. Earth.
   C. the sun.
   D. other planets and the moon.

Passage IV

The Planning Commission asserts that the needed reduction in acute care hospital beds can best be accomplished by closing the smaller hospitals, mainly voluntary and proprietary. This strategy follows from the argument that closing entire institutions saves more money than closing the equivalent number of beds scattered throughout the health system.

The issue is not that simple. Larger hospitals generally are designed to provide more complex care. Routine care at large hospitals costs more than the same care given at smaller hospitals. Therefore, closure of all the small hospitals would commit the city to paying, considerably more for inpatient care delivered at acute care hospitals than would be the case with a mixture of large and small institutions. Since reimbursement rates at the large hospitals are now based on total costs, paying the large institutions a lower rate for routine care would simply raise the rates for complex care by a comparable amount. Such a reimbursement rate-adjustment might make the charges for each individual case more accurately reflect the actual costs, but there would be no reduction in total costs.

There is some evidence that giant hospitals are not the most efficient. Service organizations – and medical care remains largely a service industry - frequently find that savings of scale have an upper limit. Similarly, the quality of routine care in the very largest hospitals appears to be less than optimum. Also, the concentration of all hospital beds in a few locations may affect the access to care.

Thus, simply closing the smaller hospitals will not necessarily save money or improve the quality of care.

Since the fact remains that there are too many acute care hospital beds in the city, the problem is to devise a proper strategy for selecting and urging the closure of the excess beds, however many it may turn out to be.

The closing of whole buildings within large medical centers has many of the cost advantages of closing the whole of smaller institutions, because the fixed costs can also be reduced in such cases. Unfortunately, many of the separate buildings at medical centers are special use facilities, the relocation of which is extremely costly. Still, a search should be made for such opportunities.

The current lack of adequate ambulatory care facilities raises another possibility. Some floors or other large compact areas of hospitals could be transferred from inpatient to ambulatory uses. Reimbursement of ambulatory services is chaotic, but the problem is being addressed. The overhead associated with the entire hospital should not be charged even pro rata to the ambulatory facilities. Even

if it were, the total cost would probably be less than that of building a new facility. Many other issues would also need study, especially the potential over-centralization of ambulatory services.

The Planning Commission language seems to imply that one reason for closing smaller hospitals is that they are "mainly voluntary and proprietary," thus preserving the public hospital system by making the rest of the hospital system absorb the needed cuts. It is important to preserve the public hospital system for many reasons, but the issue should be faced directly and not hidden behind arguments about hospital size, if indeed that was the Commission's meaning.

23. The best title for the passage would be
   A. "Maintaining Adequate Hospital Facilities"
   B. "Defending the Public Hospitals"
   C. "Methods of Selecting Hospital Beds to be Closed"
   D. "Economic Efficiency in Hospital Bed Closings"

24. The Planning Commission is accused by the author of being
   A. unfair.
   B. racist.
   C. foolish.
   D. shortsighted.

25. On the subject of the number of hospital beds, the author
   A. is in complete agreement with the Planning Commission.
   B. wishes to see large numbers of beds closed.
   C. wishes to forestall the closing of any more hospital beds.
   D. is unsure of the number of excess beds there really are.

26. All of the following are reasons the author opposes the Planning Commission's recommendation except
   A. Service industries have an upper limit for savings of scale.
   B. Single buildings of large centers may be closable instead of smaller hospitals.
   C. public hospitals have a unique contribution to make and should not be closed.
   D. the smaller hospitals recommended for closure provide services more cheaply than larger hospitals.

8

27. With which of the following would the author probably not agree?
- **A.** Large medical centers provide better and more complex care than smaller hospitals.
- **B.** Reimbursement rates do not necessarily reflect the actual costs of providing medical care to a given patient.
- **C.** Patients needing only routine medical care can often be distinguished from those requiring complex care prior to hospitalization.
- **D.** Too much centralization of ambulatory care is possible.

28. The author's purpose in discussing ambulatory care is to
- **A.** discuss alternatives to closing hospital beds.
- **B.** present a method of reducing the fiscal disadvantages of closing only parts of larger hospitals.
- **C.** show another opportunity for saving money.
- **D.** help preserve the public hospital system.

29. With which of the following is the author least likely to agree?
- **A.** a proposal to save costs in a prison system by building only very large prison complexes
- **B.** a plan to stop the closing of any hospital beds whatsoever in the city until the costs of various alternatives can be fully considered
- **C.** an order by the Planning Commission mandating that no public hospitals be closed
- **D.** a proposal by an architecture firm that new hospital buildings have centralized record systems

Passage V

Every profession or trade, every art, and every science has its technical vocabulary, the function of which is partly to designate things or processes which have no names in ordinary English, and partly to secure greater exactness in nomenclature. Such special dialects, or jargons, are necessary in technical discussion of any kind. Being universally understood by the devotees of the particular science or art, they have the precision of a mathematical formula. Besides, they save time, for it is much more economical to name a process than to describe it. Thousands of these technical terms are very properly included in every large dictionary, yet, as a whole, they are rather on the outskirts of the English language than actually within its borders.

Different occupations, however, differ widely in the character of their special vocabularies. In trades and handicrafts and other vocations, such as farming and fishing, that have occupied great numbers of men from remote times, the technical vocabulary is very old. It consists largely of native words, or of borrowed words that have worked themselves into the very fiber of our language. Hence, though highly technical in many particulars, these vocabularies are more familiar in sound, and more generally understood, than most other technicalities. The special dialects of law, medicine, divinity, and philosophy have also, in their older strata, become pretty familiar to cultivated persons, and have contributed much to the popular vocabulary. Yet, every vocation still possesses a large body of technical terms that remain essentially foreign, even to educated speech. And the proportion has been much increased in the last fifty years, particularly in the various departments of natural and political science and in the mechanic arts. Here new terms are coined with the greatest freedom, and abandoned with indifference when they have served their turn. Most of the new coinages are confined to special discussions, and seldom get into general literature or conversation. Yet, no profession is nowadays, as all professions once were, a closed guild. The lawyer, the physician, the man of science, the cleric, all associate freely with his fellow creatures, and do not meet them in a merely professional way.

Furthermore, what is called "popular science" makes everybody acquainted with modern views and recent discoveries. Any important experiment, though made in a remote or provincial laboratory, is at once reported in the newspapers, and everybody is soon talking about it as in the case of the Roentgen rays and wireless telegraphy. Thus, our common speech is always taking up new technical terms and making them commonplace.

30. Which of the following words is least likely to have started its life as jargon?
- **A.** sun
- **B.** calf
- **C.** plow
- **D.** loom

31. The author's main purpose in the passage is to
- **A.** describe a phenomenon.
- **B.** argue a belief.
- **C.** propose a solution.
- **D.** stimulate action.

32. When the author refers to professions as no longer being "closed guilds" he means that
- **A.** it is much easier to become a professional than in the past.
- **B.** there is more social intercourse between professionals and others.
- **C.** popular science has told its secrets to the world.
- **D.** anyone can now understand anything in a profession.

33. If the author of the passage wished to study a new field, he would probably
A. call in a dictionary expert.
B. become easily discouraged.
C. look to the histories of the words in the new field.
D. pay careful attention to the new field's technical vocabulary.

34. The writer of this article was probably a(n)
A. linguist.
B. attorney.
C. scientist.
D. politician.

35. The author of the passage probably lived in
A. 1904 in India.
B. 1914 in the United States.
C. 1944 in Russia.
D. 1964 in England.

36. It seems that the passage implies that
A. English is always becoming larger and larger.
B. the words of the English language are always changing.
C. one can never be sure of what a word means without consulting an expert.
D. technical terms in most non-scientific fields have little chance of becoming part of the main body of the language in these scientific days.

Passage VI

Suppose you go into a fruiterer's shop wanting an apple. You take up one, and on biting it you find it is sour; you look at it, and see that it is hard and green. You take up another one, and that, too, is hard, green, and sour. The shopman offers you a third; but, before biting it, you examine it, and find that it is hard and green, and you immediately say that you will not have it, as it must be sour, like those that you have already tried.

Nothing can be simpler than that, you think; but if you will take the trouble to analyze and trace out into its logical elements what has been done by the mind, you will be greatly surprised. In the first place you have performed the operation of induction. You found that, in two experiences, hardness and greenness in apples went together with sourness. It was so in the first case, and it was confirmed by the second.

True, it is a very small basis, but still it is enough from which to make an induction; you generalize the facts, and you expect to find sourness in apples where you get hardness and greenness. You found upon that a general law, that all hard and green apples are sour; and that, so far as it goes, is a perfect induction. Well, having got your

natural law in this way, when you are offered another apple, which you find, is hard and green, you say, "All hard and green apples are sour; this apple is hard and green, therefore, this apple is sour." That train of reasoning is what logicians call a syllogism, and has all its various parts and terms - its major premise, its minor premise, and its conclusion. And, by the help of further reasoning, which, if drawn out, would have to be exhibited in two or three other syllogisms, you arrive at your final determination, "I will not have that apple." So that, you see, you have, in the first place, established a law by induction, and upon that you have founded a deduction, and reasoned out the special particular case.

Well now, suppose, having got your conclusion of the law, that at some times afterwards, you are discussing the qualities of apple with a friend; you will say to him, "It is a very curious thing, but I find that all hard and green apples are sour!" Your friend says to you, "But how do you know that?" You at once reply, "Oh, because I have tried them over and over again, and have always found them to be so. Well, if we were talking science instead of common sense, we should call that an experimental verification. And, if still opposed, you go further and say, "I have heard from the people in Somersetshire and Devonshire, where a large number of apples are grown, and in London, where many apples are sold and eaten, that they have observed the same thing. It is also found to be the case in Normandy, and in North America. In short, I find it to be the universal experience of mankind wherever attention has been directed to the subject." Where upon, your friend, unless he is a very unreasonable man, agrees with you, and is convinced that you are quite right in the conclusion you have drawn. He believes, although perhaps he does not know he believes it, that the more extensive verifications have been made, and results of the same kind arrived at - that the more varied the conditions under which the same results are attained, the more certain is the ultimate conclusion, and he disputes the question no further. He sees that the experiment has been tried under all sorts of conditions, as to time, place, and people, with the same result; and he says with you, therefore, that the law you have laid down must be a good one, and he must believe it.

37. The writer is probably
A. French.
B. English.
C. American.
D. Italian.

38. The author has the approach of a(an)
A. scientist.
B. artist.
C. novelist.
D. economist.

10

39. The term "natural law" as it appears in the text refers to
  A. common sense.
  B. the "honor system."
  C. the result of an induction.
  D. the order of nature.

40. Which of the following would be the best title for the passage?
  A. Discovering the Natural Laws of Apples
  B. The Uses of Induction
  C. Syllogistic Reasoning in Common Circumstances
  D. The Logic of Everyday Reasoning

41. Apples are used
  A. in order to convince the reader that fruit has no intellect.
  B. to illustrate the subject of the passage.
  C. to give color to the story.
  D. to show how foolish logic is.

42. If you find a hard and green apple that is not sour, you should
  A. try further apples to see if the natural law has changed.
  B. eat the rest of the apple at once.
  C. reject the law stating hard and green apples are usually sour.
  D. conduct further investigations and make adjustments to the law of apples as necessary.

43. "All giraffes are beautiful and graceful."
  Twiga is a giraffe.
  Twiga is beautiful and graceful."
  According to the passage, the above reasoning is a(an)
  A. empirical verification.
  B. induction from cases.
  C. syllogism.
  D. experimental conclusion.

44. A disease that is acquired by being exposed to other person's who have the disease is thought, by a physician, to be caused by an infectious agent. This reasoning is an example of
  A. the scientific method.
  B. induction.
  C. deduction.
  D. hypothesis testing.

Passage VII

Consumers rely on several methods to acquire information about product quality. The most straightforward, of course, is to "experience" the product - eat it or use it. Low-priced, frequently purchased products require the experience approach, but some goods have "search" characteristics. Information on search goods can be obtained by inspection, asking one's friends, or even reading technical reports.

Nelson has suggested advertising intensity as yet another index of product quality. Based largely on the experience and search characteristics and rational behavior by consumers, his theory is noteworthy in light of the widespread controversy over the information content of advertising.

Television advertising has often been criticized on the grounds that it lacks concrete product information. But Nelson finds fault with the criticisms. If advertising provides no information, then why do consumers respond to it? If there was truly no information provided, consumers would most likely learn to ignore or to be quite skeptical of the many commercials they see each day. Finally, only a relatively small proportion of products are heavily advertised. Apparently, there are many products for which advertising does not elicit strong consumer response.

Search product advertising is relatively non-controversial, since it provides "hard" information (such as price, location, brand, objective quality ratings, etc.) to consumers probably more cheaply than they can get it elsewhere. It can also be checked for accuracy before buying. It is advertising of experience goods that is often criticized for its lack of informational value and its effect on market performance.

Because such information may be misleading and consumers have no way of separating the truthful from the misleading, consumers have good reason not to respond to "informational" advertising about experience characteristics. Thus, there is less incentive for advertisers of experience goods to provide hard iformation beyond the product's function. Do heavy expenditures on experience goods advertising provide any benefit to consumers if little accurate product information is conveyed? Nelson contends that they do. He says that heavy advertising is itself indirect information. Advertising is costly, and this cost may be incurred long before appreciable sales are made. Makers of heavily advertised, inferior products cannot expect repeated sales. Consumers will learn through experience that the brand is inferior. On the other hand, consumers who purchase a heavily advertised, superior product are likely to make further purchases as their experience reveals the product's superiority. For that reason, Nelson argues that the makers of superior products can expect a greater return from advertising (more sales per unit of advertising) than can the makers of inferior products.

11

Producers of inferior products gain only initial purchases in response to advertising, while makers of superior products net initial plus repeat purchases. Since producers of superior products expect a higher return from their advertising, they have a greater incentive to advertise. If producers respond to this incentive, then superior products should be more heavily advertised than inferior, and consumers can with good reason use advertising as an indicator of product quality.

Nelson's contention, that more heavily advertised products provide more quality for the price, is still quite controversial. It depends crucially on the ability of consumers to accurately assess product characteristics after purchase. His hypothesis is not concerned with characteristics whose quality cannot be determined even after use (for example, the efficacy of a drug). Nor is it concerned with the issue of whether advertising alters consumers' perceptions. The validity of Nelson's hypothesis is difficult to test.

Recently some preliminary tests of the hypothesis have been undertaken. Advertised brands in 11 different food product classes were selected for the test. Quality ratings of each brand were obtained from *Consumer Reports*. Sales and brands within each class were ranked according to their advertising expenditure per unit of sales. The research question was whether there was any tendency for brands ranked high in quality to also be ranked high in advertising per unit of sales. The results indicate a tendency for advertising intensity and quality to be positively associated in those samples. The coefficient was negative only for one product class.

The samples in this preliminary study are small, ranging from 5 to 12 brands in each product class; for that reason an inference that our estimates would hold for all brands in a product class is not justified. In addition, we are not testing Nelson's strong contention that heavily advertised products provide more quality per dollar, but a weaker contention (held by most adherents to Nelson's position) that heavily advertised products are of higher quality (without consideration of price).

Given the small sample size, we cannot say that the hypothesis is conclusively supported, nor can we make precise assertions about the strength of associations between advertising-sales ratios and product quality. However, Nelson's hypothesis cannot be rejected on the basis of our data – he may be right and his theory deserves to be taken seriously. A key factor may be the extent to which consumers actually learn through experience.

45. The author's purpose in writing this article is to
  A. support Nelson's theory.
  B. oppose Nelson's theory.
  C. present and discuss some tests of Nelson's theory.
  D. present an alternative to Nelson's theory.

46. The author's tone is
  A. skeptical.
  B. intensive.
  C. supportive.
  D. scientific.

47. The preliminary study reported
  A. confirms Nelson.
  B. disputes Nelson.
  C. gives some support to Nelson.
  D. supports further funding of Nelson's research.

48. According to the passage, Nelson's theory can be characterized by all of the following except that it is
  A. hard to test in its strongest form.
  B. based on rational decision-making by consumers.
  C. opposed to the idea that television advertising has no informational content.
  D. dependent on others for testing.

49. Which of the following future research findings would, if true, tend to weaken Nelson's hypothesis?
  I. New brands tend to be both heavily advertised and perceived as high quality.
  II. Most non-search product advertising succeeds in blunting the consumer's ability to evaluate the true quality of a product.
  III. The reason many products are not advertised is that the response which is sure to be generated is hard to convert to profits for the advertiser when the product is not branded.
  A. I only
  B. II only
  C. III only
  D. I and III

50. Nelson's hypothesis would apply to all of the following except
  A. tomato soup.
  B. caviar.
  C. fish fillets.
  D. milk.

51. The passage seems to
  A. treat television advertising as the major part of advertising.
  B. give too much weight to Nelson's hypothesis.
  C. be overly cautious in its interpretations.
  D. confuse "experience" products with "search" products.

12

Passage VIII

It is almost a definition of a gentleman to say he is one who never inflicts pain. His benefits may be considered as parallel to what are called comforts or conveniences in arrangements of a personal nature: such as an easy chair or a good fire, which do their part in dispelling cold and fatigue, though nature provides both means of rest and animal heat without them.

The true gentleman, in like manner, carefully avoids whatever may cause a jar or a jolt in the minds of those with whom he is cast – all clashing of opinion, or collision of feeling, all restraint, or suspicion, or gloom, or resentment; his great concern being to make everyone at their ease and at home. He has his eyes on all his company; he is tender towards the bashful, gentle towards the distant, and merciful towards the absurd; he can recollect to whom he is speaking; he guards against unseasonable allusions, or topics which may irritate; he is seldom prominent in conversation, and never wearisome. He makes light of favors while he does them, and seems to be receiving when he is conferring. He never speaks of himself except when compelled, never defends himself by a mere retort, he has no ears for slander or gossip, is scrupulous in imputing motives to those who interfere with him, and interprets everything for the best. He is never mean or little in his disputes, never takes unfair advantage, never mistakes personalities or sharp sayings for arguments, or insinuates evil which he dare not say out.

From a longsighted prudence, he observes the maxim of the ancient sage, that we should ever conduct ourselves towards our enemy as if he were one day to be our friend. He has too much good sense to be affronted at insults, he is too well employed to remember injuries, and too indolent to bear malice. If he engages in controversy of any kind, his disciplined intellect preserves him from the blundering discourtesy of better, perhaps, but less educated minds, who, like blunt weapons, tear and hack instead of cutting clean; who mistake the point in argument, waste their strength on trifles, misconceive their adversary, to leave the question more involved than they find it. He may be right or wrong in his opinion, but he is too clear-headed to be unjust; he is as simple as he is forcible, and as brief as he is decisive.

If he be an unbeliever, he will be too profound and large-minded to ridicule religion or to act against it. He is a friend of religious toleration, and that, not only because his philosophy has taught him to look on all forms of faith with an impartial eye, but also from the gentleness and effeminacy of feeling, which is the attendant on civilization.

Sometimes he acknowledges the being of God, sometimes he invests an unknown principle or quality with the attributes of perfection. And this deduction of his reason, or creation of his fancy, he makes the occasion of such excellent thoughts, and the starting-point of so varied and systematic a teaching, that he even seems like a disciple of Christianity itself. From the very accuracy and steadiness of his logical powers, he is able to see what sentiments are consistent in those who hold any religious doctrine at all, and he appears to others to feel and to hold a whole circle of theological truths, which exist in his mind not otherwise than as a number of deductions.

52. According to the passage, the gentleman when engaged in debate is
   A. soothing and conciliatory.
   B. brilliant and insightful.
   C. opinionated and clever.
   D. concise and forceful.

53. A gentleman, here, is analogized to
   A. a jar or jolt.
   B. an easy chair or a good fire.
   C. a blunt weapon.
   D. a sharp saying.

54. A person who is "scrupulous in imputing motives" is
   A. careful about accusing others of base motives.
   B. eager to prove another guilty of improper intentions.
   C. willing to falsify another's moods.
   D. unable to make decisions about people's motives.

55. This passage does not take into account the commonly held concept that a gentleman is known for his
   A. consideration for others.
   B. refusal to slander.
   C. leniency toward the stupid.
   D. neatness in attire.

56. The most appropriate title for this passage would be
   A. A Gentleman Now and Before
   B. Definition of a Gentleman
   C. Intellectualism and the Gentleman
   D. Can a Gentleman Be Religious?

57. The word "effeminacy" as used in this selection really means
   A. womanliness.
   B. childishness.
   C. cowardice.
   D. delicacy.

58. According to the passage
- **A.** gentlemen will never disagree with each other.
- **B.** gentlemen can have the same religious beliefs as common men and in the same way.
- **C.** the power of a gentleman's thought on religious matters can give him the appearance of a true christian.
- **D.** the gentleness of a gentleman disarms all who would oppose him.

Passage IX

A Polish proverb claims that fish, to taste right, should swim three times: in water, in butter, and in wine. The early efforts of the basic scientists in the food industry were directed at improving the preparation, preservation, and distribution of safe and nutritious food. Our memories of certain foodstuffs eaten during the Second World War suggest that, although these might have been safe and nutritious, they certainly did not taste right nor were they particularly appetizing in appearance or smell. This neglect of the sensory appeal of foods is happily becoming a thing of the past. Indeed, in 1957, the University of California considered the subject of sufficient importance to warrant the setting-up of a course in the analysis of foods by sensory methods. The book, Principles of Sensory Evaluation of Food, grew out of this course. The authors hope that it will be useful to food technologists in industry and also to others engaged in research into the problem of sensory evaluation of foods.

The scope of the book is well illustrated by the chapter headings: "The Sense of Taste"; "Olfaction"; "Visual, Auditory, Tactile, and Other Senses"; and "Factors Influencing Sensory Measurements." There are further chapters on panel testing, difference and directional difference tests, quantity-quality evaluation, consumer studies, statistical procedures including design of experiments, and physical and chemical tests.

An attempt has clearly been made to collect every possible piece of information which might be useful, more than one thousand five hundred references being quoted. As a result, the book seems at first sight to be an exhaustive and critically useful review of the literature. This it certainly is, but this is by no means its only achievement, for there are many suggestions for further lines of research, and the discursive passages are crisply provocative of new ideas and new ways of looking at established findings.

Of particular interest is the weight given to the psychological aspects of perception, both objectively and subjectively. The relation between stimuli and perception is well covered, and includes a valuable discussion of the uses and disadvantages of the Weber Law of Sensory Perception in the evaluation of differences. It is interesting to find that in spite of many attempts to separate and define the modalities of taste, nothing better has been achieved than the familiar classification into sweet, sour, salty, and bitter. Nor is there as yet any clear-cut evidence of the physiological nature of the taste stimulus. With regard to smell, systems of classification are of little value because of the extraordinary sensitivity of the nose and because the response to the stimulus is so subjective. The authors suggest that a classification based on the size, shape, and electronic status of the molecule involved merits further investigation, as does the theoretical proposition that weak physical binding of the stimulant molecule to the receptor site is a necessary part of the mechanism of stimulation.

Apart from taste and smell, there are many other components of perception of the sensations from food in the mouth. The basic modalities of pain, cold, warmth, and touch, together, with vibration sense, discrimination, and localization may all play a part, as, of course, does auditory reception of bone-conducted vibratory stimuli from the teeth when eating crisp or crunchy foods. In this connection the authors rightly point out that this type of stimulus requires much more investigation, suggesting that a start might be made by using subjects afflicted with various forms of deafness. It is, of course, well-known that extraneous noise may alter discrimination, and the attention of the authors is directed to the work of Prof. H. J. Eysenck on the "stimulus hunger" of extroverts and the "stimulus avoidance" of introverts. (It is perhaps unfair to speculate, not that the authors do, that certain breakfast cereals rely on sound volume to drown any deficiencies in flavor, or that the noisier types are mainly eaten by extroverts.)

59. The author uses a Polish proverb at the beginning of the article in order to
- **A.** introduce, in an interesting manner, the discussion of food.
- **B.** show the connection between food and nationality.
- **C.** indicate that there are various ways to prepare food.
- **D.** bring out the difference between American and Polish cooking.

60. The author's appraisal of Principles of Sensory Evaluation of Food is one of
- **A.** mixed feelings.
- **B.** indifference.
- **C.** faint praise.
- **D.** high praise.

61. The writer of the article does not express the view, either directly or by implication, that
  A. more sharply defined classifications of taste are needed than those which are used at present.
  B. more research should be done regarding the molecular constituency of food.
  C. food values are objectively determined by an expert "smeller."
  D. psychological consideration would play an important part in food evaluation.

62. The authors of the book suggest the use of deaf subjects because
  A. deaf people are generally introverted
  B. all types of subjects should be used to insure the validity of an experiment.
  C. they are more objective in their attitude than normal subjects would be when it comes to food experimentation.
  D. the auditory sense is an important factor in food evaluation.

63. Which of the following can be inferred from the chapter headings of Principles of Sensory Evaluation of Food as cited by the passage?
  A. The sense of smell is less important than the sense of taste.
  B. The sense of taste is less important than the sense of smell.
  C. The sense of taste is less important than the sense of sound.
  D. The sense of touch is less important than the sense of smell.

64. Which of the following Webers is most likely to have originated the Weber's Law referred to in the passage?
  A. Max Weber 1881-1961, an American painter.
  B. Ernest Heinrich Weber 1795-1878, German physiologist.
  C. Baron Karl Maria Friedrich Ernest Von Weber 1786-1826, German composer.
  D. Max Weber 1864-1920, German political economist and sociologist.

65. The famous Guide Michelin includes ambience in rating the quality of restaurants. The author of the passage would likely
  A. prefer that only food be considered in rating restaurants.
  B. object that French cooking should not be the standard for the world.
  C. be uninterested in the opinions of restaurant foods.
  D. agree to the inclusion of ambience in the rating system.

STOP. IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK. YOU MAY GO BACK TO ANY QUESTION IN THE VERBAL REASONING TEST BOOKLET.

15

Physical Sciences

Time: 100 minutes
Questions: 66-142

Directions: Most questions in the Physical Sciences test are organized into groups, each preceded by a descriptive passage. After studying the passage, select the one best answer to each question. Some questions are not based on a descriptive passage and are also independent of each other. You should also select the one best answer to these independent questions. A periodic table is provided and you may consult it whenever you wish.

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VII A	VIII A
1 **H** 1.0																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 17.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 97.9	44 **Ru** 101	45 **Rh** 102	46 **Pd** 106	47 **Ag** 107	48 **Cd** 112	49 **In** 114	50 **Sn** 118	51 **Sb** 121	52 **Te** 127	53 **I** 126	54 **Xe** 131
55 **Cs** 132	56 **Ba** 137	57--71 bel-ow	72 **Hf** 178	73 **Ta** 180	74 **W** 183	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 200	81 **Tl** 204	82 **Pb** 207	83 **Bi** 209	84 **Po** 209	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226	89-103 bel-ow	104 **Unq**	105 **Unp**	106 **Unh**	107 **Uns**	108 **Uno**	109 **Une**									

57 **La** 138	58 **Ce** 140	59 **Pr** 140	60 **Nd** 144	61 **Pm** 144	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 158	66 **Dy** 162	67 **Ho** 164	68 **Er** 167	69 **Tm** 168	70 **Yb** 173	71 **Lu** 175
89 **Ac** 227	90 **Th** 232	91 **Pa** 231	92 **U** 238	93 **Np** 237	94 **Pu** 244	95 **Am** 243	96 **Cm** 247	97 **Bk** 247	98 **Cf** 251	99 **Es** 252	100 **Fm** 257	101 **Md** 258	102 **No** 259	103 **Lr** 262

Passage I

The ideal gas laws can be summed up as the ideal gas equation below:

$$PV = nRT$$

In many instances, the ideal gas equation can be used for actual gases provided certain conditions are met. However, under conditions of high pressure and/or relatively low temperature, gases behave differently than would be expected using the ideal gas equation. In these situations, the Van der Waals equation provides a better approximation:

$$\left(P + \frac{n^2a}{V^2}\right)(V - nb) = nRT$$

where a and b are constants specific for each gas.

66. Two identical evacuated flasks of negligible weight are filled with different gases to the same pressure. One is filled with hydrogen and the other with propane. Compared with the first flask, the flask filled with propane weighs
    A. 11 times more.
    B. 22 times more.
    C. the same.
    D. 44 times more.

67. A soccer ball with initial pressure P and initial volume V is inflated with air until the pressure is 2P and the volume is 1.1V. Temperature is kept constant. The weight of air in the ball has increased by a factor of
    A. 2.2
    B. 1.1
    C. 1.0
    D. 2.0

68. Assume the composition by volume of air is N_2 80% and O_2 20%. Which of the following gases are denser than air assuming the same temperature and pressure? CH_4, Cl_2, CO_2, NH_3, NO_2, O_3, SO_2
    A. CH_4, CO_2, Cl_2, SO_2
    B. CO_2, Cl_2, SO_2, NH_3, O_3
    C. Cl_2, CO_2, NH_3, NO_2, O_3, SO_2
    D. Cl_2, CO_2, NO_2, O_3, SO_2

69. Given that the critical temperature of oxygen is 154 K and its critical pressure is 50 atm, which of the following statements is/are true?
    I.   In a closed container at 154 K and 50 atm, the solid, liquid, and gaseous phases of oxygen are in dynamic equilibrium.
    II. Oxygen can be compressed into a liquid at room temperature.

III. It can be reasoned that ammonia has a critical temperature above 154 K.
    A. I is true
    B. II and III are true
    C. III is true
    D. I and III are true

70. In the Van der Waals equation, the purpose of the nb term is to
    A. take into account that gas molecules exert intermolecular attractive forces.
    B. take into account that gas molecules have a finite volume.
    C. take into account that gas molecules react chemically with each other and the equilibrium constant depends on P and T.
    D. take into account Heisenberg's uncertainty principle.

71. In the Van der Waals equation, the purpose of the n^2a/V^2 term is to
    A. take into account that gas molecules exert intermolecular attractive forces.
    B. take into account that gas molecules have a finite volume.
    C. take into account that gas molecules react chemically with each other and the equilibrium constant depends on P and T.
    D. take into account Heisenberg's uncertainty principle.

Passage II

A conservative method of treating fractures of the femur (thigh bone) is to place the affected bone in traction while it heals. Traction realigns the broken pieces of the femur, which usually have been pulled out of proper alignment and past each other by the large quadriceps and hamstring muscles.

A medical student, on his first day on an orthopedics rotation, is asked to design a system for providing traction to the femur of a patient. Noticing that he has many pulley components but a lack of weights, he initially produces the design below.

traction rope attached to
pin driven through tibia

fracture in femur

pulley A

weight

pulley B

pillow under lower leg
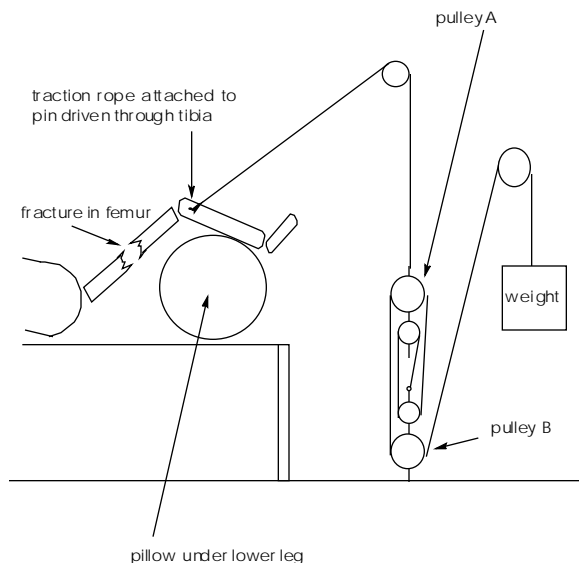
The angle between the rope segment attached to the pin and the horizontal is 30^0.
Pulley A weighs 40 N.
Pulley B weighs 50 N and is attached to the floor by means of a screw.

72. What is the mechanical advantage of the pulley sytem?
   A. 3
   B. 4
   C. 5
   D. 6

73. If the weight moves down 1 cm, how far does the patient's leg move?
   A. 0.25 cm
   B. 0.5 cm
   C. 1 cm
   D. 4 cm

74. The student wishes to create a traction force of 200 N. The weight would have to be
   A. 50 N
   B. 32 N
   C. 40 N
   D. 60 N

75. With a traction force of 200 N, the tension in the screw securing pulley B to the floor is
   A. 150 N
   B. 200 N
   C. 80 N
   D. 160 N

76. How much vertical downward force is acting on the single pulley that is directly above pulley A?
   A. 200 N
   B. 300 N
   C. 340 N
   D. 400 N

77. Although there is probably enough friction between the patient and the bed to prevent him from being pulled down to the foot of the bed, the student decides that the the bed should be inclined so that the horizontal component of the traction force is exactly countered by the horizontal component of the patient's weight (excluding the weight of his leg). This weight is estimated to be 800 N. Which equation allows the calculation of the angle θ between the bed and the floor at which this equilibrium would be achieved?
   A. $\sin\theta + \cos\theta = \frac{1}{4}\cos30^0$
   B. $4\tan\theta = \sin30^0$
   C. $4\sin\theta = \sin30^0$
   D. $\sin\theta.\cos\theta = \frac{1}{4}\cos30^0$

Passage III

The valence-shell electron-pair repulsion (VSEPR) theory is used to predict the shapes of molecules and ions. Electron pairs, whether as bonding pairs or as lone pairs, repel each other, and the shape that allows the maximum distances between electron pairs is the shape the molecule or ion assumes.

Below are the Lewis electron dot structures for various molecules. As can be seen, electrons are either in bonding pairs or lone pairs.

SF_4

BrF_5

PCl_5

SF_6

19

Cl x . .
. P .
Cl x . x
Cl

<u>PCl</u>$_3$

F
. x
.
. Cl x F
.
. x
F

<u>ClF</u>$_3$

F
. x
. . F
. x
Xe
. x F
. x
F

<u>XeF</u>$_4$
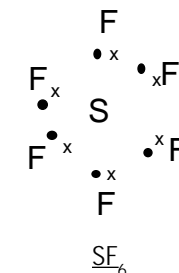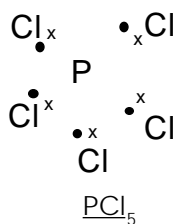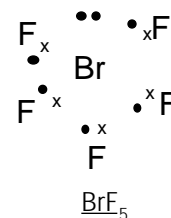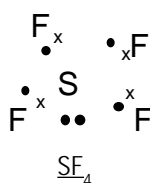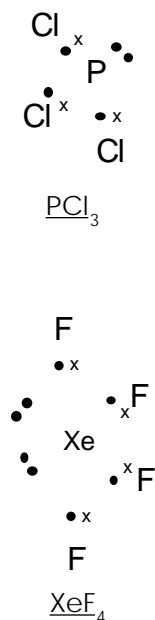
78. Using the VSEPR theory, the shape of SF$_4$ is
    A. seesaw.
    B. tetrahedral.
    C. trigonal pyrimidal.
    D. square planar.

79. Using the VSEPR theory, the shape of BrF$_5$ is
    A. seesaw.
    B. square pyrimidal.
    C. trigonal bipyrimidal.
    D. square planar.

80. Using the VSEPR theory, the shape of PCl$_5$ is
    A. pentagonal planar.
    B. octahedral.
    C. trigonal bipyrimidal.
    D. square pyrimidal.

81. Using the VSEPR theory, the shape of SF$_6$ is
    A. octahedral.
    B. tetrahedral.
    C. trigonal bipyrimidal.
    D. square pyrimidal.

82. Using the VSEPR theory, the shape of PCl$_3$ is
    A. trigonal planar.
    B. tetrahedral.
    C. trigonal pyrimidal.
    D. square planar.

83. Using the VSEPR theory, the shape of ClF$_3$ is
    A. trigonal planar.
    B. tetrahedral.
    C. trigonal pyrimidal.
    D. T-shaped.
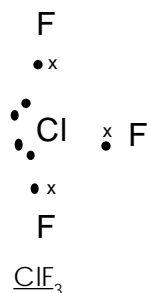
84. Using the VSEPR theory, the shape of XeF$_4$ is
    A. tetrahedral.
    B. seesaw.
    C. trigonal bipyrimidal.
    D. square planar.

Passage IV

Doppler ultrasound is commonly used to assess the health of blood vessels. As shown below, it consists of a probe that emits and receives ultrasonic waves. The emitted waves reflect off surfaces where there is a difference in acoustical impedance. The reflected waves are detected by the receiver, which then converts the sound energy into electrical signals that are then analyzed. If the object(s) causing reflection is moving, the frequency of the reflected wave will be different from that of the incident wave. This Doppler shift is given by

$$f_d = 2f_t v \cos\theta \ /c$$

where f_d is the doppler shift, f_t is the transmitted frequency, v is the velocity of the reflecting surface, q is the angle between the path of the sound and the blood vessel, and c is the speed of sound in the tissue.
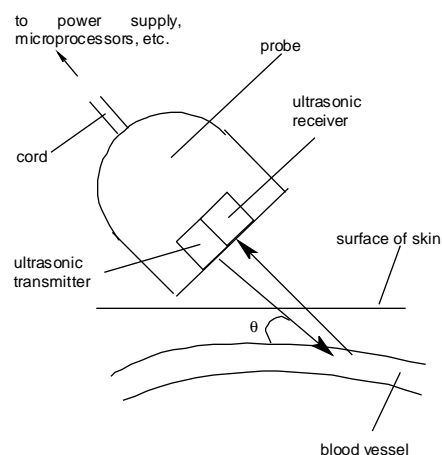
85. Given that f_t is 5 MHz, θ is 60°, c is 1500 m/s, and f_d is 1.60 kHz, what is the velocity of blood inside the vessel in the diagram above?
    A. 0.048 cm/s
    B. 48 cm/s
    C. 24 cm/s
    D. 96 cm/s

86. If it takes 100 μs for sound to reach the vessel and return to the probe, how far is the vessel from the probe?
    A. 15 cm
    B. 7.5 mm
    C. 15 mm
    D. 7.5 cm

87. The instrument is used to assess another vessel and no doppler shift is detected. Possible reasons for this are:
    I.   A vessel has not been located.
    II. There is no blood flow in the vessel.
    III. θ is 90°.
    IV. θ is so large that there is excessive refraction and reflection at tissue boundaries.
    A. I and II are correct
    B. I, II, and III are correct
    C. All are correct
    D. I, II, and IV are correct

88. While assesing the length of an artery, it is discovered that the velocity of blood is much higher in a 2 cm portion than anywhere else. A possible reason for this is
    A. there is a localized narrowing of the artery in that portion.
    B. there is a localized widening of the artery in that portion.
    C. there is hemorrhaging of the artery in that portion.
    D. the artery branches into two at that portion.

89. While assesing the length of an artery, it is discovered that the velocity of blood is much lower in a 2 cm portion than anywhere else. A possible reason for this is
    A. there is a localized narrowing of the artery in that portion.
    B. there is a localized widening of the artery in that portion.
    C. there is hemorrhaging of the artery in that portion.
    D. the artery branches into two at that portion.

90. Doppler ultrasound, although useful for assessing large vessels and those near to the skin, is still difficult to use for relatively small vessels deep in the body such as the coronary arteries. A possible solution to this problem is the injection of a contrast agent into the blood that will reflect the sound waves better than red blood cells do. Supposing it were possible to have a contrast agent that actually emitted ultrasound instead of just reflecting it. In such a case, the equation for the doppler shift would be
    A. $f_d = 2f_t v\cos\theta \ /c$
    B. $f_d = 2f_t v/c$
    C. $f_d = 2f_t \cos\theta \ /c$
    D. $f_d = f_t v\cos\theta \ /c$

Passage V

Consider the data in the table below, which pertain to the reaction $A + B \rightarrow C$. This equation may or may not be balanced.

Experiment no.	[A]	[B]	Initial rate of formation of C (M/s)
1	0.10	0.10	4.0×10^{-5}
2	0.10	0.20	4.0×10^{-5}
3	0.20	0.10	16.0×10^{-5}

91. The rate law for the reaction is
    A. Rate = $k[A][B]$
    B. Rate = $k[A]^2[B]$
    C. Rate = $k[A]^2$
    D. Rate = $k[A][B]^2$

92. Which graph would show a linear relationship? (t stands for time.)
    A. $1/[A]$ versus t
    B. $\ln[A]$ versus t
    C. $[A]$ versus t
    D. $[A]^2$ versus t

93. The rate constant, k, is
    A. $4.0 \times 10^{-3} \ M^{-1}s^{-1}$
    B. $4.0 \times 10^{-3} \ Ms^{-1}$
    C. $4.0 \times 10^{-5} M^{-1}s^{-1}$
    D. $4.0 \times 10^{-5} \ Ms^{-1}$

94. What is the half-life of A when the inital concentration of A is 0.2 M?
    A. 15.7 mins
    B. 18.4 mins
    C. 20.8 mins
    D. 23.5 mins

95. The mechanism of the above reaction most likely involves
    A. a termolecular rate-determining step.
    B. a bimolecular rate-determining step involving two molecules of A, followed by a fast step involving a molecule of B.
    C. A fast step involving a molecule of A and a molecule of B, followed by a bimolecular rate-determining step involving another molecule of A.
    D. a bimolecular rate-determining step involving a molecule of A and a molecule of B, followed by a fast step involving another molecule of A.

96. Which of the following statements is/are true?
- I.   k increases with activation energy.
- II. k increases with temperature.
- III. k decreases with increasing concentrations of products.
- **A.** Only II is true
- **B.** I and II are true
- **C.** II and III are true
- **D.** All are true

Questions 97 to 102 are independent of any passage and of each other.

97. Assume that the standard reduction potential for the reaction $A^{3+} + e^- \rightarrow A^{2+}$ is E^o_A, and the standard reduction potential for the reaction $B^+ + e^- \rightarrow B$ is E^o_B. A solution initially containing $[A^{3+}] = 1.0$ M, $[A^{2+}] = 1.0$ M, and $[B^+] = 1.0$ M is agitated with excess solid B metal. When equilibrium is attained, the solution contains $[A^{3+}] = 0.7$ M, $[A^{2+}] = 1.3$ M, and $[B^+] = 1.3$. Which of the following can be concluded?
- **A.** $E^o_A = E^o_B$
- **B.** $E^o_A > E^o_B$
- **C.** $E^o_A < E^o_B$
- **D.** $E^o_A + E^o_B = 0$

98. Which of the following has the greatest ionic character in its bonds?
- **A.** RbCl
- **B.** Li Cl
- **C.** BCl_3
- **D.** Ca Cl_2

99. For a gas, the following is/are true:
- I.   kinetic energy is proportional to temperature
- II. the velocity of a molecule is proportional to the 1/(square root of its molecular weight)
- III. the velocity of a molecule is proportional to the square root of temperature
- **A.** I and III
- **B.** I and II
- **C.** II and III
- **D.** All are true

100. A stone is dropped into a well. Ten seconds later a splash is heard. How deep is the water level below the well opening (ignore the time taken for sound to travel)?
- **A.** 1000 m
- **B.** 500 m
- **C.** 50 m
- **D.** 200 m

101. Three children of mass 20 kg, 40 kg, and 60 kg want to balance themseves on a 8 m long see-saw, pivoted at its center. The 60 kg child sits 1 m from the left end. The 40 kg child sits at the right end. Where must the 20 kg child sit?
- **A.** 3 m from the right end
- **B.** 3 m from the left end
- **C.** 1 m from the right end
- **D.** 2 m from the right end

102. If the intensity of a sound goes up by 20 dB, How many times does the sound intensity increase?
- **A.** 20 times
- **B.** 1000 times
- **C.** 10 times
- **D.** 100 times

Passage VI

Typically domestic electric power is first generated from fossil fuels, nuclear reactions, or falling water. An a.c. emf is produced which is stepped-up in voltage for long-distance transmission, then stepped down gradually so that finally each household receives 120V/240V power as shown in the simplified diagram below.

In the house depicted, there are three circuits: two 120V and one 240V. The wire labelled 'd' is the neutral wire, which is grounded. Assume all resistances are non-inductive.

22
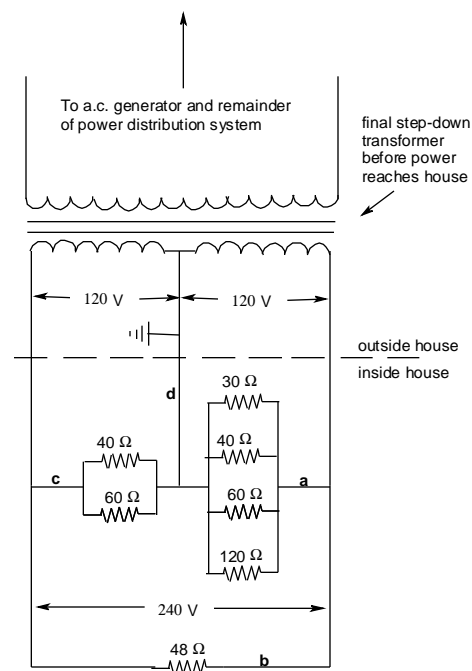
103. The root-mean-square voltage between wires 'a' and 'd' is 120V. What is the peak voltage and mean square voltage between these wires, respectively? (Note: $\sqrt{2}$ = 1.4)
   A. 170 V and 28,900 V^2
   B. 170 V and 14,400 V^2
   C. 240 V and 28,900 V^2
   D. 240 V and 14,400 V^2

104. What is the root-mean-square current in wire 'a'?
   A. 30 A
   B. 5 A
   C. 20 A
   D. 10 A

105. What is the root-mean-square current in wire 'b'?
   A. 30 A
   B. 5 A
   C. 20 A
   D. 10 A

106. What is the root-mean-square current in wire 'c'?
   A. 30 A
   B. 5 A
   C. 20 A
   D. 10 A

107. What is the root-mean-square current in wire 'd'?
   A. 0 A
   B. 5 A
   C. 20 A
   D. 10 A

108. What is the average power consumption of the house?
   A. 3 kW
   B. 5 kW
   C. 2 kW
   D. 13 kW

Passage VII

Solutions have some unique properties that are termed colligative. These properties depend only on the ratio of the number of particles of solute and solvent and not on the identity of the solute.

109. Which is the correct ordering for the following solutions when listed from highest boiling point to lowest boiling point? (K_a of HF is 7.2×10^{-4}.)
   0.05 M $Mg(NO_3)_2$
   0.10 M sucrose
   0.15 M KCl
   0.10 M NaI
   0.05 M HF

   A. $Mg(NO_3)_2$, KCl, NaI, HF, sucrose
   B. KCl, NaI, $Mg(NO_3)_2$, sucrose, HF
   C. NaI, KCl, $Mg(NO_3)_2$, sucrose, HF
   D. KCl, $Mg(NO_3)_2$, NaI, sucrose, HF

110. The vapor pressure of water at 25^0C is 23.6 mmHg. If 0.180 kg of glucose is added to 0.900 kg of water, what is the vapor pressure of this solution?
   A. 23.1 mmHg
   B. 24.1 mmHg
   C. 22.5 mmHg
   D. 22.2 mmHg

111. How much ethylene glycol ($C_2H_6O_2$) must be added to 1 kg of water to depress the freezing point to -40ºC? Assume the K_f of water is 1.9 K/m.
   A. 0.9 kg
   B. 0.87 kg
   C. 130 g
   D. 1.3 kg

112. 78 g of benzene (C_6H_6; vapor pressure at 20ºC is 75 mmHg) are mixed with 184 g of toluene (C_7H_8; vapor pressure at 20ºC is 22 mmHg). There is no chemical reaction. The vapor pressure of this mixture at 20ºC is
   A. 48.5 mmHg
   B. 75 mmHg
   C. 40 mmHg
   D. 45 mmHg

113. A protein solution with concentration 80 g/L has an osmotic pressure of 0.0205 atm at 27ºC. What is the approximate molecular weight of the protein? (The gas constant is 0.082 L-atm/K-mol.)
   A. 96,000
   B. 192,000
   C. 48,000
   D. 1,500

114. Capillaries are much more permeable than most semi-permeable membranes. The only plasma constituents they do not allow through them are proteins. Given that the concentration of protein in plasma is roughly 1.5 mmol/L and the concentration of all solutes in plasma is roughly 290 mmol/L, what is the oncotic pressure of plasma at 37ºC as far as capillaries are concerned? (Assume the gas constant is 60 L-torr/K-mol.)
   A. 43 mmHg
   B. 35 mmHg
   C. 5400 mmHg
   D. 28 mmHg

Passage VIII

Bernoulli's equation can be used to describe the flow of water down a pipe. It is commonly expressed in the form below.

$$P_1 + \rho g h_1 + \tfrac{1}{2}\rho v_1^2 = P_2 + \rho g h_2 + \tfrac{1}{2}\rho v_2^2$$

Consider a dam that is used to generate hydroelectric power. Water flows down a pipe to turbines at the bottom, causing them to spin, which causes electromagnetic induction of e.m.f. in generator coils, producing electricity. The top of the pipe is practically at the level of the surface of the water behind the dam. Each minute 120,000 m³ of water drops a vertical distance of 45m. Assume the density of water is 1,000 kg/m³ and g is 10m/s².

115. The sequence of energy transformations is best described as:
A. potential energy, rotational kinetic energy, translational kinetic energy, electrical energy.
B. hydrostatic energy, translational kinetic energy, rotational kinetic energy, electrical energy.
C. potential energy, translational kinetic energy, rotational kinetic energy, electrical energy.
D. potential energy, translational kinetic energy, rotational kinetic energy, electromagnetic radiation.

116. The difference in pressure between water at the top of the pipe and water coming out at the bottom is:
A. 450 kPa
B. 0 kPa
C. 45 kPa
D. 450 Pa

117. What is the velocity of water at the bottom of the pipe (assume the velocity at the top is zero)?
A. 900 m/s
B. 21 m/s
C. 35 m/s
D. 30 m/s

118. Theoretically, what is the maximum electrical power that can be generated with this flow of water?
A. 900 megawatts
B. 90 megawatts
C. 900 kilowatts
D. 90 kilowatts

119. If the bottom of the pipes became completely blocked, what would be the hydrostatic pressure in the pipes at that point?
A. 450 kPa
B. 0 kPa
C. 45 kPa
D. 450 Pa

120. Suppose that the power company wants to decrease the maximum amount of power available. Possible ways to accomplish this include:
    I.   Re-positioning the opening of the pipe at the reservoir to a certain depth below the surface of the water.
    II.   Attaching fins to the inside of the pipe to create turbulence.
    III. Reducing the cross-sectional area of the pipe.
    IV. Moving the power generator to a higher elevation so that the water falls a shorter vertical distance.
A. I, II, and III are correct
B. II, III, and IV are correct
C. I, III, and IV are correct
**D.** I, II, and IV are correct

Passage IX

Ion-selective chemical electrodes produce e.m.f.s that depend on the concentration of specific ions in fluids under test. They, therefore, can be used to measure the concentration of specific ions.

A pH meter uses a hydrogen ion-selective electrode that produces an e.m.f. according to the equation below, which is derived fom the Nernst equation.
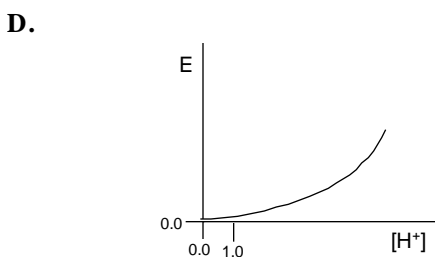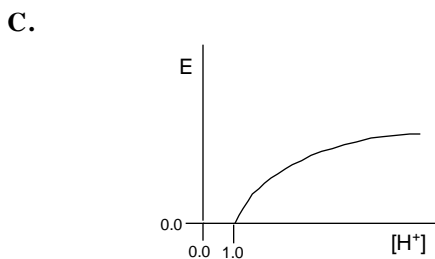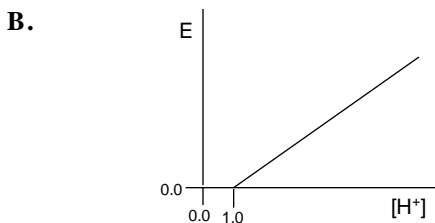
$$E = \text{constant} + 0.059\ \log_{10}[H^+]$$

where E is the e.m.f. and a temperature of 25°C is assumed. pH meters are callibrated so that the effect of the constant term is cancelled out.

121. Which graph shows the correct relationship between E and $[H^+]$?

A.

B.

C.

D.
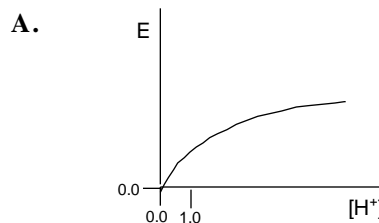
122. If the pH of a solution is increased by 1.0, E will

   A. increase by 59 mV.
   B. decrease by 59 mV.
   C. decrease by $\log_{10} 0.059$ mV.
   D. depends on initial pH.

123. A 0.10 M solution of formic acid (CH_2O_2) has a pH of 2.38. What is the Ka of formic acid?

   A. 1.8×10^{-3}
   B. 1.8×10^{-4}
   C. 1.8×10^{-5}
   D. 1.8×10^{-6}

124. What is the pH of a 0.1 M solution of NH_4Cl (K_b of NH_3 is 1.8×10^{-5})?

   A. 3.4
   B. 5.5
   C. 7.0
   D. 9.7

125. H_2SO_4 has $K_{a1} = 1.0 \times 10^3$ and $K_{a2} = 1.2 \times 10^{-2}$ What is the approximate hydrogen ion concentration of 1.0 M H_2SO_4?

   A. 1.00 M
   B. 1.01 M
   C. 1.05 M
   D. 1.10 M

126. Phosphoric acid (H_3PO_4) has $K_{a1} = 7.5 \times 10^{-3}$, $K_{a2} = 6.2 \times 10^{-8}$, and $K_{a3} = 4.2 \times 10^{-13}$. What is the pH of 1.0 M phosphoric acid?

   A. 1.1
   B. 3.5
   C. 5.2
   D. 6.8

127. What is the pH of 0.01 M trisodium phosphate (Na_3PO_4)?

   A. 7.0
   B. 8.4
   C. 10.9
   D. 12.2

Passage X

Flexible endoscopes are used extensively in medicine to visualize internal structures such as the respiratory tract, stomach, and colon. The advantage of a flexible endoscope over a rigid endoscope is that it can bend and thus go around "corners." This means less discomfort for the patient and the endoscope can be advanced farther into the cavity of interest.

An endoscope has a number of channels, e.g. for irrigation, suctioning, surgical manipulation, illumination, and imaging. Below is a diagrammatic representation of the imaging components of a relatively simple flexible endoscope.

25
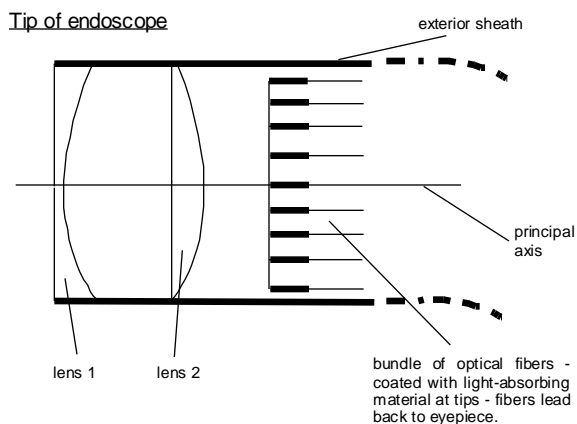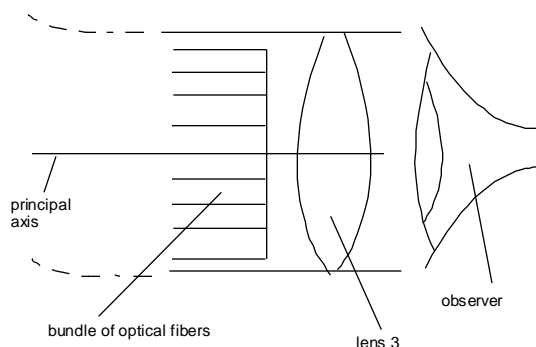
Lens 1 focal length is -2 cm.
Lens 2 focal length is 1 cm.
Lens 3 can be easily removed and replaced with another lens. Also, the distance between the lens and the end of the optical fibers can be adjusted.

Each optical fiber consists of a cylindrical core surrounded by a cladding. Light enters one end of a fiber and is total internally reflected repeatedly until it exits the fiber at the opposite end.

128. For the best image quality, the following conditions should be met.
- I. The core of the fibers must not absorb a significant amount of light.
- II. The cladding must have a higher optical density than the core.
- III. Light rays must be incident on the core-cladding interface at angles of incidence greater than the critical angle.
- IV. The endoscope must not be bent too acutely.
- **A.** I, II, and III are correct
- **B.** I, II, and IV are correct
- **C.** I, III, and IV are correct
- **D.** All are correct

129. The critical angle of the core-cladding interface is given by
- **A.** critical angle = $\sin^{-1}(n_{cladding}/n_{core})$
- **B.** critical angle = $\sin^{-1}(n_{core}/n_{cladding})$
- **C.** critical angle = $\sin^{-1}(1/n_{core})$
- **D.** critical angle = $\sin^{-1}(1/n_{cladding})$

130. If each fiber core is 1 mm in diameter, n_{core} is 1.50, and $n_{cladding}$ is 1.20, what is the minimum length of light-absorbing material required at the ends of the fibers to prevent refraction of light into the cladding?
- **A.** 1 mm
- **B.** 1.33 mm
- **C.** 1.5 mm
- **D.** 2 mm

131. The principle of the optical system shown is that light from an object is focused by the two objective lenses (1 and 2) onto the plane at which the optical fibers terminate. This image is then transmitted through the optical fiber bundle to the eyepiece. If lenses 1 and 2 are 1 cm apart at their optical centers and lens 2 is 2 cm from the optical fiber bundle, how far away must the object be from lens 1 to form a sharp image on the end of the optical fiber bundle?
- **A.** 1.0 cm
- **B.** 1.5 cm
- **C.** 2.0 cm
- **D.** 2.5 cm

132. The effect of lens 1 is
- I. to possibly reduce overall chromatic aberration
- II. to produce a virtual, erect, and diminished image that is the object for lens 2
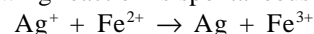- III. create a wider field of view
- **A.** I and II are correct
- **B.** I and III are correct
- **C.** II and III are correct
- **D.** I, II, and III are correct

133. When light has travelled the length of the optical fibers it exits the ends of them and passes through lens 3, which acts like a magnifying glass. If an observer chooses a lens of 50 diopters, how far should lens 3 be from the end of the optical fibers to form an image at infinity?
- **A.** 2.0 cm
- **B.** 2.5 cm
- **C.** 3.0 cm
- **D.** 3.5 cm

Questions 134 to 142 are independent of any passage and of each other.

134. The following reaction is spontaneous:
$$Ag^+ + Fe^{2+} \rightarrow Ag + Fe^{3+}$$
If a voltaic cell has one half cell as Ag^+/Ag and the other half cell as Fe^{2+}/Fe^{3+}, the silver electrode will be:
- **A.** the anode and negative
- **B.** the anode and positive
- **C.** the cathode and positive
- **D.** the cathode and negative

135. A ball is thrown up in the air with a velocity of 10 m/s. Which of the following is true?
- **A.** time in air is 1 s; maximum height is 5 m.
- **B.** time in air is 1 s; maximum height is 10 m.
- **C.** time in air is 2 s; maximum height is 5 m.
- **D.** time in air is 2 s; maximum height is 10 m.

136. The effect of weightlessness can be produced by flying a plane in a circular arc (i.e. ascending then descending in a smooth motion). If the speed of the plane is constant at 100 m/s, what is the radius of the arc that must be flown?
- **A.** 1,000 m
- **B.** 10,000 m
- **C.** 100 m
- **D.** 1,500 m

26

137. What is the concentration of Bi^{3+} in a saturated solution containing 0.01 M of S^{2-}? (Assume the K_{sp} of bismuth sulfide is 10^{-70}.)
  A. 10^{-32} M
  B. 10^{-64} M
  C. 10^{-68} M
  D. 10^{-34} M

138. Which of the following energy sublevels can contain the most electrons?
  A. $n=4$, $l=0$
  B. $n=5$, $l=2$
  C. $n=6$, $l=3$, $l_m=+1$
  D. $n=4$, $l=3$

139. Tl decays by the emission of beta particles (half-life = 3.1 mins). As a result, Pb is produced. After 9.3 mins, an initially pure sample of Tl contains 7 g of Pb. What was the approximate mass of the original sample?
  A. 7 g
  B. 8 g
  C. 28 g
  D. 32 g

140. The isoelectric point of glycine is 6.0. When glycine is in a buffer with a pH of 6.0, which form predominates?
  A. H_3N^+-CH_2-COO^-
  B. H_2N-CH_2-$COOH$
  C. H_3N^+-CH_2-$COOH$
  D. H_2N-CH_2-COO^-

141. For an oxidation-reduction reaction, which of the following is a consistent set of relations?
  A. $\Delta G°<0$, $\Delta E°>0$, $K_{eq}<1$
  B. $\Delta G°>0$, $\Delta E°<0$, $K_{eq}<1$
  C. $\Delta G°<0$, $\Delta E°<0$, $K_{eq}<1$
  D. $\Delta G°<0$, $\Delta E°<0$, $K_{eq}>1$

142. Which of the following is not a basic physical quantity?
  A. Luminous intensity
  B. Temperature
  C. Number of moles
  D. Force

STOP. IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK. YOU MAY GO BACK TO ANY QUESTION IN THE PHYSICAL SCIENCES TEST BOOKLET.

Writing Sample

Time: 60 minutes total;
30 minutes per essay, each separately timed.

Essay Topic 1

Politicians too often base their decisions on what will please the voters, not on what is best for the country.

Write a unified essay in which you perform the following tasks. Explain what you think the above statement means. Describe a specific situation in which a politician might make an unpopular decision for the good of the country. Discuss the principles you think should determine whether political decisions should be made to please the voters or to serve the nation.

Essay Topic 2

Justice is best served by truth.

Write a unified essay in which you perform the following tasks. Explain what you think the above statement means. Describe a specific situation in which justice might **not** be served by truth. Discuss what you think determines whether or not truth serves justice.

Biological Sciences

Time: 100 minutes
Questions: 143-219

Directions: Most questions in the Biological Sciences test are organized into groups, each preceded by a descriptive passage. After studying the passage, select the one best answer to each question. Some questions are not based on a descriptive passage and are also independent of each other. You should also select the one best answer to these independent questions. A periodic table is provided and you may consult it whenever you wish.

Periodic Table of the Elements

IA	IIA											IIIA	IVA	VA	VIA	VIIA	VIIIA
1 **H** 1.0																	2 **He** 4.0
3 **Li** 6.9	4 **Be** 9.0											5 **B** 10.8	6 **C** 12.0	7 **N** 14.0	8 **O** 16.0	9 **F** 17.0	10 **Ne** 20.2
11 **Na** 23.0	12 **Mg** 24.3											13 **Al** 27.0	14 **Si** 28.1	15 **P** 31.0	16 **S** 32.1	17 **Cl** 35.5	18 **Ar** 40.0
19 **K** 39.1	20 **Ca** 40.1	21 **Sc** 45.0	22 **Ti** 47.9	23 **V** 50.9	24 **Cr** 52.0	25 **Mn** 54.9	26 **Fe** 55.8	27 **Co** 58.9	28 **Ni** 58.7	29 **Cu** 63.5	30 **Zn** 65.4	31 **Ga** 69.7	32 **Ge** 72.6	33 **As** 74.9	34 **Se** 79.0	35 **Br** 79.9	36 **Kr** 83.8
37 **Rb** 85.5	38 **Sr** 87.6	39 **Y** 88.9	40 **Zr** 91.2	41 **Nb** 92.9	42 **Mo** 95.9	43 **Tc** 97.9	44 **Ru** 101	45 **Rh** 102	46 **Pd** 106	47 **Ag** 107	48 **Cd** 112	49 **In** 114	50 **Sn** 118	51 **Sb** 121	52 **Te** 127	53 **I** 126	54 **Xe** 131
55 **Cs** 132	56 **Ba** 137	57--71 bel-ow	72 **Hf** 178	73 **Ta** 180	74 **W** 183	75 **Re** 186	76 **Os** 190	77 **Ir** 192	78 **Pt** 195	79 **Au** 197	80 **Hg** 200	81 **Tl** 204	82 **Pb** 207	83 **Bi** 209	84 **Po** 209	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226	89-103 bel-ow	104 **Unq**	105 **Unp**	106 **Unh**	107 **Uns**	108 **Uno**	109 **Une**									

57 **La** 138	58 **Ce** 140	59 **Pr** 140	60 **Nd** 144	61 **Pm** 144	62 **Sm** 150	63 **Eu** 152	64 **Gd** 157	65 **Tb** 158	66 **Dy** 162	67 **Ho** 164	68 **Er** 167	69 **Tm** 168	70 **Yb** 173	71 **Lu** 175
89 **Ac** 227	90 **Th** 232	91 **Pa** 231	92 **U** 238	93 **Np** 237	94 **Pu** 244	95 **Am** 243	96 **Cm** 247	97 **Bk** 247	98 **Cf** 251	99 **Es** 252	100 **Fm** 257	101 **Md** 258	102 **No** 259	103 **Lr** 262

Passage I

The autonomic nervous system consists of two divisions: the synpathetic nervous system, which is mainly concerned with activating organs for "fight or flight"; and the parasynpathetic nervous system, which essentially counteracts the sympathetic nervous system when there are no stressors and thus allows the body to resume a more restful and restorative state.

The functions of the autonomic nervous system are reflexly controlled. The two divisions usually act in a balanced fashion: the activity of an organ at any one time is the result of the two opposing influences. However, this is not always true, for example: most blood vessels have only sympathetic innervation.

The main types of receptors in the synpathetic nervous system are adrenergic; that is, they are stimulated by norepinepherine and substances similar to norepinepherine. Various pharmaceuticals take advantage of this fact to stimulate (adrenergic agonists) or inhibit (adrenergic antagonists) specific adrenergic receptors and thus treat certain medical conditions.

The table below shows a few of the effects that stimulation of the various types of adrenergic receptors produces.

Tissue	Predominant adrenergic receptor	Response
bronchiolar smooth muscle	β_2	relaxation
myocardium	β_1	increased conduction velocity & contractility
sino-atrial node	β_1	increased heart rate
smooth muscle in cardiac & skeletal muscle arterioles	β_2	relaxation
smooth muscle in skin & mucosal arterioles	α_1	contraction

143. Prazosin, an α_1 antagonist, could be used to
- **A.** treat diabetes.
- **B.** treat an asthmatic attack.
- **C.** lower high blood pressure.
- **D.** treat peptic ulcer disease.

144. Propranolol, a β_1 and β_2 antagonist, should not be used by individuals who
- I. have arthritis
- II. have peripheral vascular disease (poor circulation in the extremities)
- III. have asthma (episodic narrowing of the bronchioles)
- IV. have heart failure
- **A.** I, II, and III are correct
- **B.** I, II, and IV are correct
- **C.** II, III, and IV are correct
- **D.** I, III, and IV are correct

145. Salbutamol, a β_2 agonist, is best used to
- **A.** treat wound infections.
- **B.** treat asthmatic attacks.
- **C.** lower high blood pressure.
- **D.** treat peptic ulcer disease.

146. Anaphylaxis (an allergic reaction in which there is severe bronchoconstriction and general vasodilation causing hypotension [shock]) is best treated with
- **A.** norepinephrine, which is an α_1 and β_1 agonist.
- **B.** isoproterenol, which is a β_1 and β_2 agonist.
- **C.** phenylephrine, which is an α_1 agonist.
- **D.** epinephrine, which is an α_1, β_1, and β_2 agonist.

147. Nasal congestion due to a cold is best treated with
- **A.** norepinephrine, which is an α_1 and β_1 agonist.
- **B.** isoproterenol, which is a β_1 and β_2 agonist.
- **C.** phenylephrine, which is an α_1 agonist.
- **D.** epinephrine, which is an α_1, β_1, and β_2 agonist.

148. All of the following are correct statements regarding the fight or flight response except
- **A.** liver glycogen is converted into glucose
- **B.** sphincters in the GI tract contract
- **C.** sweating is inhibited
- **D.** blood pressure increases

Passage II

Grignard reagents (organomagnesium halides) were discovered by the French chemist Victor Grignard in 1900. He was awarded the Nobel Prize for his discovery in 1912.

31

Grignard reagents behave as if they were carbanions. They have extensive use in organic synthesis. They are usually prepared by reacting an organic halide with magnesium in an anhydrous ether solvent as follows.

$$RX + Mg \rightarrow RMgX$$
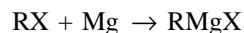
where R is a suitable organic group and X is I, Br, or Cl.

149. Grignard reagents are
    I. Strong acids
    II. Strong bases
    III. Strong electrophiles
    IV. Strong nucleophiles
  A. I is correct
  B. II is correct
  C. I and III are correct
  D. II and IV are correct

150. In the preparation of a Grignard reagent, the reason why the ether solvent must be anhydrous is that
  A. hydrogen ions from any water present would immediately react with any Grignard reagent produced.
  B. Grignard reagents are insoluble in water.
  C. water is necessary for Grignard reagents to ionize.
  D. water is the universal solvent.

151. Which of the following are suitable organic reactants for synthesizing Grignard reagents?
    I. C_3H_7I
    II. CH_3OCH_2Br
    III. $HSCH_2CH_2I$
    IV. CH_3COCH_2Br
  A. I and II
  B. II and III
  C. III and IV
  D. I and IV

152. One of the products of the reaction between propylmagnesium bromide and ethyne is
  A. 1-pentyne.
  B. propane.
  C. 1-pentene.
  D. propene.

153. A tertiary alcohol can be ultimately formed most directly by reacting a Grignard reagent with
  A. methanal.
  B. an aldehyde with at least two carbon atoms.
  C. a ketone.
  D. a carboxylic acid.

154. One of the products of the reaction between an ester and twice as many moles of a Grignard reagent followed by the addition of dilute acid is
  A. a primary alcohol.
  B. a secondary alcohol.
  C. a tertiary alcohol.
  D. another ester.

155. One of the products of the reaction below is
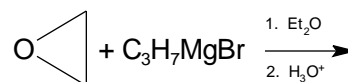
  A. 1-pentanol.
  B. 2-pentanol.
  C. ethyl propyl ether.
  D. pentanoic acid.

Passage III

The maintenance of a narrow range of blood pH is essential to normal functioning. The body maintains normal pH by means of chemical buffer systems, the kidneys, and the lungs.

156. The major buffer system in the body is the carbonic acid/bicarbonate buffer system. Other buffer systems include
    I. $H_2PO_4^-/HPO_4^{2-}$
    II. intracellular and plasma proteins
    III. hemoglobin
    IV. phosholipids
  A. I and II
  B. I, II, and III
  C. II, III, and IV
  D. All of the above

157. Given that the pKa of H_2CO_3 is 6.1 and $[H_2CO_3]$ in mmol/L is 0.03 x $PaCO_2$ in mmHg (where $PaCO_2$ is the partial pressure of arterial CO_2), which of the following expresses arterial $[H^+]$ in terms of $[HCO_3^-]$ and $PaCO_2$?
  A. $[H^+]$ in nmol/L = 800 x $PaCO_2$ in mmHg/ $[HCO_3^-]$ in mmol/L
  B. $[H^+]$ in mmol/L = 24 x $PaCO_2$ in mmHg / $[HCO_3^-]$ in mmol/L
  C. $[H^+]$ in mmol/L = 24 x $PaCO_2$ in mmHg / $[HCO_3^-]$ in mmol/L
  D. $[H^+]$ in nmol/L = 24 x $PaCO_2$ in mmHg / $[HCO_3^-]$ in mmol/L

158. Aerobic metabolism produces 13 to 24 moles of CO_2 per day. This represents how much potential H^+ production per day?
- **A.** 13 to 24 moles
- **B.** 26 to 48 moles
- **C.** 6.5 to 12 moles
- **D.** 104 to 255 moles

159. What happens to the acid load referred to in the previous question?
- **A.** At the tissue capillaries, CO_2 enters red bood cells where carbonic anhydrase catalyses the production of H^+. H^+ combines with hemoglobin and is transported to the lungs where the reverse process occurs and CO_2 is exhaled.
- **B.** At the tissue capillaries, CO_2 combines with water to form carbonic acid, which is transported to the lungs where the reverse process occurs and CO_2 is exhaled.
- **C.** At the tissue capillaries, CO_2 combines with water to form carbonic acid, which is transported to the kidneys where H^+ is actively transported into the lumen of the proximal tubule.
- **D.** At the tissue capillaries, CO_2 combines with water to form carbonic acid, which is transported to the kidneys where H^+ is actively transported into the lumen of the distal tubule.

160. H^+ excretion in the kidneys is enhanced by all of the following except
- **A.** increased levels of aldosterone
- **B.** increased concentration of ammonia and HPO_4^{2-} in the tubular lumen
- **C.** acidosis
- **D.** increased concentration of potassium in the blood

161. During metabolism more H^+ ions are produced than are consumed. All of the following are sources of H^+ ions except
- **A.** anaerobic respiration during intense excercise
- **B.** metabolism of dietary protein (especially from meat)
- **C.** aerobic respiration
- **D.** lipogenesis

Questions 162 to 166 are independent of any passage and of each other.

162. The base sequence of one strand of a piece of double-stranded DNA is found to be 5'-TGTCA-3'. The sequence of the other strand is
- **A.** 5'-TGACA-3'
- **B.** 5'-ACTGT-3'
- **C.** 5'-TGTCA-3'
- **D.** 5'-GTCAC-3'

163. The correct order of increasing basicity for the following amines is
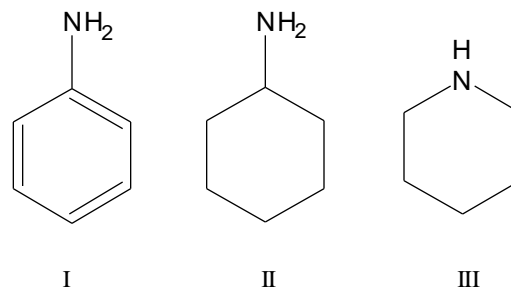
I   II   III

- **A.** II, I, III
- **B.** I, II, III
- **C.** III, I, II
- **D.** III, II, I

164. The primary spermatocyte gives rise to four spermatozoa. The primary oocyte gives rise to
- **A.** 8 ova.
- **B.** 4 ova.
- **C.** 2 ova.
- **D.** 1 ovum.

165. Which of the following is the strongest acid?
- **A.** CCl_3CO_2H
- **B.** CH_2ClCO_2H
- **C.** $CHCl_2CO_2H$
- **D.** CH_3CO_2H

166. Fruit flies that are heterozygous for a dominant eye color can be distinguished from those that are homozygous dominant by
- **A.** crossing them with homozygous dominant flies.
- **B.** crossing them with other offspring from the same parents.
- **C.** crossing them with homozygous recessive flies.
- **D.** crossing them with heterozygous flies.

Passage IV

When magnetic nuclei are subjected to a strong magnetic field their spins orient either with or against the field. On irradiation with radiofrequency (rf) waves, they absorb energy and "spin-flip" to a higher energy state. This absorption of rf is detected, amplified, and displayed as a nuclear magnetic resonance (NMR) spectrum.

A ^{1}H NMR spectrum is typically obtained by irradiating a sample with rf of constant frequency and slowy changing the magnitude of the magnetic field. Each chemically distinct ^{1}H nucleus in a molecule comes into resonance at a slightly different value of the applied field, thus producing a unique absorption signal. The position of a peak is called the chemical shift. Chemical shifts are caused by electrons setting up tiny local magnetic fields that shield a nearby nucleus from the applied field.

167. Which of the following nuclei are capable of undergoing NMR?

    I. ^{2}H
    II. ^{14}N
    III. ^{12}C

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

168. How many peaks are there in a ^{1}H NMR spectrum of 2,3-dimethyl-2-butene?

  A. 1
  B. 2
  C. 4
  D. 12

169. How many peaks are there in a ^{1}H NMR spectrum of 2-methyl-2-butene?

  A. 1
  B. 2
  C. 4
  D. 10

170. For methyl 2,2-dimethylpropanoate, which statement about its ^{1}H NMR spectrum is correct?

  A. There is 1 peak.
  B. There are 2 peaks, with one having 2 times the area as the other.
  C. There are 2 peaks, with one having 3 times the area as the other.
  D. There are 4 peaks - all the same size.

171. Which compound is the ^{1}H NMR spectrum below consistent with?
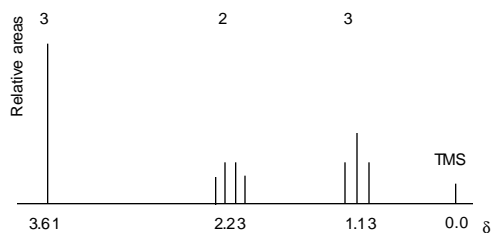
  A. $CH_3COCH_2OCH_3$
  B. $CH_3CH_2COOCH_3$
  C. $CH_3CH_2OCH_2CH_3$
  D. C_4H_9OH

Passage V

The main purpose of the circulatory system is to deliver food and oxygen to tissues and remove wastes from tissues. These processes occur in capillaries, which are the smallest blood vessels in the body and the only ones that are semi-permeable.

The flow of blood to a particular organ is regulated by the calibre of the arterioles in the organ as well as by the calibre of the precapillary sphincters. Generally, the percentage of cardiac output flowing to a particular organ is related to the metabolic activity of that organ in comparison with the other organs in the body.

172. Which of the folowing is not a determinant of blood flow?

  A. colloid osmotic pressure
  B. pressure gradient
  C. blood vessel diameter
  D. blood viscosity

173. An organ in which the percentage of cardiac output flowing to it is not related to its metabolic activity in comparison with the other organs in the body is

  A. the heart.
  B. the intestine.
  C. the kidney.
  D. the brain.

174. During exercise, blood flow in skeletal muscle increases. Circulatory system adjustments responsible for this change include

    I.   Increased cardiac output.
    II. Vasodilation in skeletal muscle.
    III. Increased alveolar ventilation rate.

  A. I is correct
  B. I and II are correct
  C. I and III are correct
  D. II and III are correct

175. In which of the following organs will blood flow change the least during exercise?

  A. intestine
  B. skin
  C. heart
  D. brain

34

176. Net movement of fluid from the intravascular space to the interstitial space occurs with all of the following except
- **A.** decreased plasma protein concentration
- **B.** lymphatic obstruction
- **C.** constriction of precapillary arterioles
- **D.** constriction of postcapillary venules

177. Lymph flow is increased by all of the following except
- **A.** bradykinin
- **B.** elevated plasma protein concentration
- **C.** elevated capillary pressure
- **D.** elevated interstitial fluid protein concentration

178. All of the following statements concerning blood are correct except
- **A.** blood is a type of connective tissue
- **B.** its functions include the transport of various substances, the redistribution of heat, defence against foreign agents, and the maintenance of extracellular fluid pH and osmolarity
- **C.** the rate of red blood cell production is controlled by renin
- **D.** neutrophils are the most common type of white blood cell, are granulocytes, are polymorphonuclear, and are capable of phagocytosis

Passage VI

A characteristic of alkyl halides is their ability to undergo nucleophilic substitution reactions with nucleophiles and elimination reactions with bases, although reactants are often both nucleophiles and bases. Depending on factors such as the relative strength of nucleophile versus base, steric effects, temperature, and carbocation stability, the reaction mechanism and most abundant products of certain reactions involving alkyl halides can be predicted.

179. What is the major product of the reaction below, and what is the mechanism by which it is produced?
$$CH_3CH_2Br + CH_3O^- \rightarrow$$
temperature: 50^0C; solvent: CH_3OH
- **A.** ethene; E1
- **B.** ethene; E2
- **C.** ethyl methyl ether; S_N2
- **D.** ethyl methyl ether; S_N1
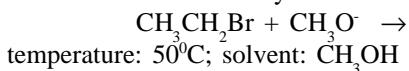
180. What is the major product of the reaction below, and what is the mechanism by which it is produced?
$$(CH_3CH_2)_3CBr + OH^- \rightarrow$$
temperature: 50^0C; solvent: CH_3OH
- **A.** $(CH_3CH_2)_3COH$; S_N1
- **B.** $(CH_3CH_2)_3COH$; S_N2
- **C.** $CH_3CH=C(CH_2CH_3)_2$; E2
- **D.** $CH_3CH=C(CH_2CH_3)_2$; E1
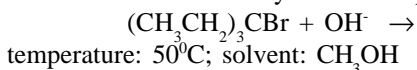
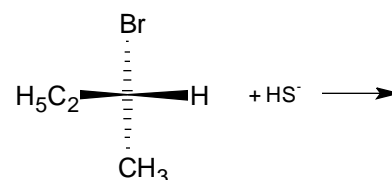**181.** What is the major product of the reaction below, and what is the mechanism by which it is produced?
$$(CH_3CH_2)_3CBr + CH_3OH \rightarrow$$
temperature: 25^0C; solvent: CH_3OH
- **A.** $(CH_3CH_2)_3COCH_3$; S_N1
- **B.** $(CH_3CH_2)_3COCH_3$; S_N2
- **C.** $CH_3CH=C(CH_2CH_3)_2$; E2
- **D.** $CH_3CH=C(CH_2CH_3)_2$; E1
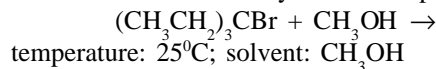
182. What is the major product of the reaction below, and what is the mechanism by which it is produced?
$$CH_3CH_2Br + (CH_3)_3CO^- \rightarrow$$
temperature: 50^0C; solvent: $(CH_3)_3COH$
- **A.** $(CH_3)_3COCH_2CH_3$; S_N1
- **B.** $(CH_3)_3COCH_2CH_3$; S_N2
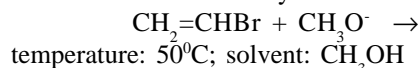- **C.** $CH_2=CH_2$; E1
- **D.** $CH_2=CH_2$; E2
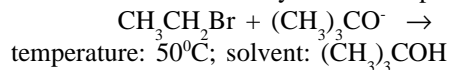
183. What is the major product of the reaction below, and what is the mechanism by which it is produced?

temperature: 50^0C; solvent: CH_3OH
- **A.** (R)-2-butanethiol; S_N2
- **B.** (S)-2-butanethiol; S_N2
- **C.** (±)-2-butanethiol; S_N1
- **D.** (S)-2-butanethiol; S_N1

184. What is the major product of the reaction below, and what is the mechanism by which it is produced?
$$CH_2=CHBr + CH_3O^- \rightarrow$$
temperature: 50^0C; solvent: CH_3OH
- **A.** no reaction occurs
- **B.** ethyne; E2
- **C.** methoxyethene; S_N2
- **D.** methoxyethene; S_N1

Passage VII

A test subject at rest is connected to a spirometer and asked to breath normally for a few seconds then to inspire maximally and expire maximally. The spirometer and the subject form a closed system so that air cannot leak in or out. Air moving into the subject causes an upward deflection of the spirometer needle, while expiration causes the reverse. The following graph of volume of air breathed in and out versus time is produced. (As shown, the subject is connected to the spirometer midway through expiration.)

5 s   25 s
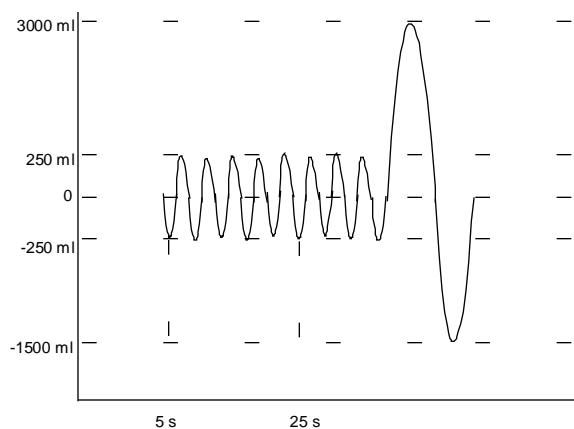
185. What is the respiratory minute volume at rest?
   A. 5000 ml/min
   B. 2500 ml/min
   C. 7500 ml/min
   D. 2000 ml/min

186. What is the inspiratory capacity?
   A. 4500 ml
   B. 3000 ml
   C. 3500 ml
   D. 3250 ml

187. The spirometer initially contains 12 L of air with 10% helium. After several minutes of breathing, the concentration of helium falls to 8%. Ignoring any helium absorption into the blood, what is the residual volume?
   A. 1.0 L
   B. 1.5 L
   C. 2.0 L
   D. 3.0 L

188. If the patient's anatomical dead space is 200 ml, what is his alveolar ventilation rate at rest?
   A. 4000 ml/min
   B. 4200 ml/min
   C. 4500 ml/min
   D. 7500 ml/min

189. Which maneuver will increase a person's alveolar ventilation rate the most?
   A. Doubling tidal volume and decreasing respiratory rate by half
   B. Doubling respiratory rate and decreasing tidal volume by half
   C. Breathing 100% oxygen while maintaining the initial tidal volume and respiratory rate
   D. Breathing 100% oxygen and using positive end-expiratory pressure while maintaining the initial tidal volume and respiratory rate

190. The concentration of carbon dioxide is lowest in
   A. the alveoli at the end of inspiration
   B. the alveoli at the end of expiration
   C. the trachea at the end of inspiration
   D. the trachea at the end of expiration

Questions 191 to 195 are independent of any passage and of each other.

191. Which of the following structures is(are) not prominent during mitosis?
   A. nucleolus
   B. spindles
   C. chromatids
   D. centrioles

192. One percent of a population exhibits the trait for a recessive allele. What is the probability that an individual selected at random from this population carries at least one copy of the allele?
   A. 1%
   B. 10%
   C. 18%
   D. 19%

193. How many isomers can conceivably be formed by mononitration of chlorobenzene?
   A. 1
   B. 2
   C. 3
   D. 4

194. Which is the predominant product when 1,4-dimethylcyclohexane is reacted with the same number of moles of chlorine gas under photochemical conditions?
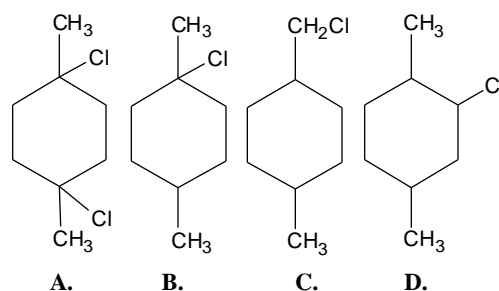

A.   **B.**   **C.**   **D.**

195. Of five genes (A, B, C, D, E) on a chromosome, genes D and E have a higher rate of recombination than for any other pair. A probable gene order would be
   A. EDCBA
   B. DCAEB
   C. DBCAE
   D. BEDAC

36

Passsage VIII

Isomers are compounds that have the same chemical formula but different structures. There are two fundamental types of isomerism: constitutional isomerism and stereoisomerism.
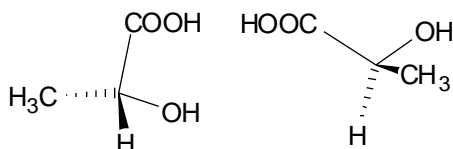
Constitutional isomers are compounds whose atoms are connected differently. Stereoisomers are compounds whose atoms are connected in the same order but with a different geometry. Subtypes of stereoisomers include enantiomers (mirror-image stereoisomers) and diastereomers (non-mirror-image stereoisomers). Further, diastereomers can be classified as either cis-trans diastereomers or configurational diastereomers.

196. What kind of isomers are the two compounds below?
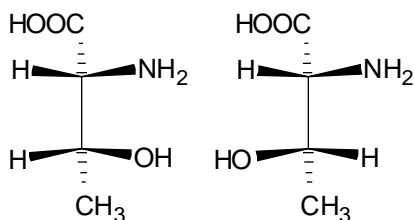
    A. Configurational diastereomers
    B. Enantiomers
    C. Constitutional isomers
    D. Cis-trans diastereomers

197. What kind of isomers are the two compounds below?

    A. Configurational diastereomers
    B. Enantiomers
    C. Constitutional isomers
    D. They are exactly the same compound.

198. What kind of isomers are the two compounds below?
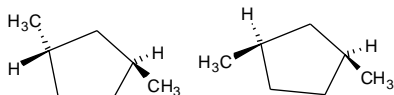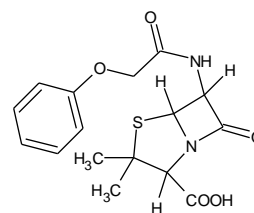

    A. Configurational diastereomers
    B. Enantiomers
    C. Cis-trans diastereomers
    D. They are exactly the same compound.

199. What kind of isomers are the two compounds below?
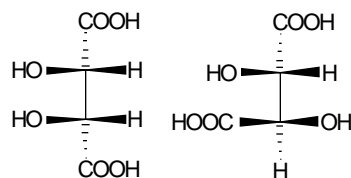
    A. Configurational diastereomers
    B. Enantiomers
    C. Cis-trans diastereomers
    D. They are exactly the same compound

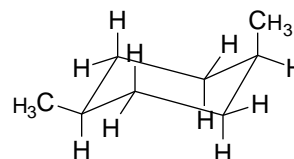**200.** How many stereogenic centers does penicillin V (structure shown below) have?

    A. 2
    B. 3
    C. 4
    D. 5

201. Theoretically what is the maximum number of stereoisomers penicillin V can have?
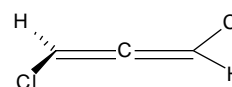   **A.** 4
    B. 6
    C. 8
    D. 16

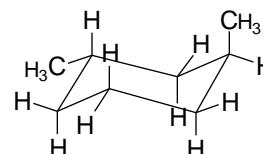**202.** Which of the following compounds is(are) capable of optical activity?
    I.

    II.

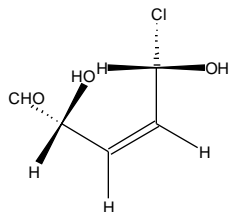   III.

37

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

203. What is the name of the compound below?

A. (Z,2R,5S)-5-chloro-2,5-dihydroxy-3-pentenal
B. (E,2R,5S)-5-chloro-2,5-dihydroxy-3-pentenal
C. (Z,2R,5R)-5-chloro-2,5-dihydroxy-3-pentenal
D. (Z,2S,5S)-5-chloro-2,5-dihydroxy-3-pentenal

Passage IX

The digestive system breaks down complex food molecules into simpler molecules. These are then absorbed and distributed throughout the body by means of the circulatory system.

204. Which of the following supports the idea that monosaccharides are absorbed in the gut by means of active transport?
    I.   There is a maximum rate of transport.
    II. Transport is selective for different sugars
    III. Transport can be blocked by certain chemicals
    IV. Transport is not coupled with an exergonic chemical reaction
A. II and III are correct
B. I, II, and III are correct
C. II, III, and IV are correct
D. I, III, and IV are correct

205. All of the following statements concerning pancreatic juice are correct except
A. it has a high hydrogen carbonate concentration
B. it is alkaline with a pH of approximately 8.0
C. its secretion is stimulated by gastrin, secretin, cholecystokinin/pancreozymin, and impulses from the vagus nerve
D. its secretion is primarily under neural control

206. The exocrine functions of the pancreas include all of the following except
A. increasing pepsin activity
B. digesting proteins and fats
C. digesting carbohydrates and nucleic acids
D. neutralizing acidic chyme

207. After trypsinogen is secreted into the duodenum, it is converted to trypsin by
A. enteropeptidase.
B. chymotrypsin.
C. a high pH environment.
D. procarboxypeptidase.

208. Bile salts facilitate the absorption of fats because of all of the following except
A. They form water-soluble complexes with fat molecules called micelles
B. They increase the transit time of fats
C. They reduce the surface tension of fats
D. They emulsify fats

209. Fat, after being absorbed by mucosal cells, enters the lymphatic system as
A. fatty acids and glycerol.
B. monoglycerides.
C. triglycerides.
D. chylomicrons.

Passage X

Synthesis I
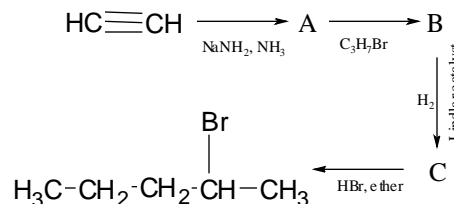
Synthesis II
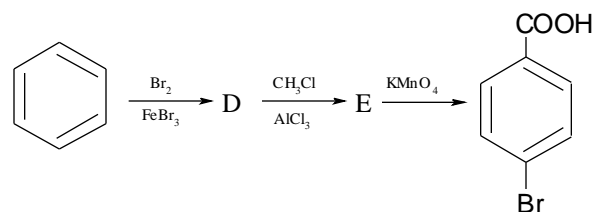
210. In Synthesis I, compound A is
A. ethene.
B. ethane.
C. 1,3-butadiene.
D. acetylide ion.

211. In Synthesis I, compound B is
A. 1-pentyne.
B. 2-pentyne.
C. 1-pentene.
D. 2-pentene.

38

212. In Synthesis I, compound C is
  A．pentane.
  B．2-bromo-1-pentene.
  C．1-pentene.
  D．2-pentene.

213. In Synthesis II, compound D is
  A．1,2-dibromobenzene.
  B．bromobenzene.
  C．bromocyclohexane.
  D．1,4-dibromobenzene.

214. In Synthesis II, compound E is
  A．p-bromomethylbenzene.
  B．m-bromomethylbenzene.
  C．p-bromophenol.
  D．p-bromobenzaldehyde.

Questions 215 to 219 are independent of any passage and of each other.

215. Which of the following distinguishes bacterial reproduction from viral reproduction?
  A．semi-conservative DNA replcation
  B．DNA polymerase
  C．cross-overs
  D．spindle formation

216. Which of the following is not involved in protein synthesis?
  A．acetyl CoA
  B．RNA polymerase
  C．tRNA
  D．anticodons

217. Ketones result from the oxidation of
  A．primary alcohols.
  B．secondary alcohols.
  C．tertiary alcohols.
  D．ethers.

218. What is the percentage by weight of carbon in methanal?
  A．28%
  B．34%
  C．40%
  D．47%

219. On the western side of the Grand Canyon, the species of squirrel have white tails; whereas, on the eastern side, the species of squirrel have grey tails. This is an example of
  A．competition
  B．adaptive radiation
  C．reproductive isolation
  D．mutualistic symbiosis

STOP. IF YOU FINISH BEFORE TIME IS CALLED, CHECK YOUR WORK. YOU MAY GO BACK TO ANY QUESTION IN THE BIOLOGICAL SCIENCES TEST BOOKLET.

END OF MCAT EXAM

39