

PCAT^{*}

Practice Test Explanations



**TEST PREP AND
ADMISSIONS**

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VERBAL ABILITY ANSWER KEY

- | | | |
|------|-------|-------|
| 1. B | 9. A | 17. D |
| 2. D | 10. B | 18. D |
| 3. B | 11. C | 19. D |
| 4. D | 12. D | 20. D |
| 5. D | 13. A | 21. D |
| 6. B | 14. A | 22. A |
| 7. B | 15. B | 23. A |
| 8. C | 16. A | 24. C |

VERBAL ABILITY ANSWERS AND EXPLANATIONS

1. (B)

“Corral” here is a verb meaning to pin down or gather in. In noun form it’s a fenced-in area for horses.

(A) “Comfort” doesn’t fit the sentence: clearly the researcher is trying to keep the birds still, not comfort them.

(C) To “domesticate” is to tame, make suitable for a home (or domestic space). It has too broad a scope for the simple action of picking up the birds that the researcher is trying to perform.

(D) The researcher is not trying to tell the birds apart, so “identify” doesn’t work.

2. (D)

A minor knowledge of scientific terms is necessary here. “Centripetal” force acts to push something toward a center or axis, which is what the string is doing to the stone in this example.

(A) “Centrifugal” force pushes outward rather than inward—think of a centrifuge scattering bits outward as it breaks a substance down.

(B) “Frictional” force has to do with the rubbing of bodies against one another. There’s friction between the whirling stone and the air here, but the sentence is talking about the relation between string and stone.

(C) These two words seem to have to do with balance in some way, but they don’t specify the needed relationship. You could likely eliminate this one if you know the basics of centrifugal and centripetal force.

3. (B)

“Gargoyles” are carved figures with grotesque faces projecting from the sides of buildings. Thus a historian of “architecture” would study them. Even without knowing what gargoyles were, you could start toward the writing answer by using the clue provided by “cathedral”—but don’t be swayed toward (A).

(A) While the history of “religion” might be involved in studying gargoyles on cathedrals, this is not the best answer.

(C) This does not apply.

(D) This word does not apply. You could have eliminated (D) as being the choice that clearly had the least to do with the contextual clue of cathedrals.

4. (D)

“Festive” clearly signals to us that we will need a positive word charge for our blank. “Jollity,” meaning merriment or mirth, fits perfectly.

(A) “Decency” has an ethical ring to it, and we’re just looking for a word that supports “festive” and “laughter”—no need to assess the character of these people.

(B) “Comportment” means behavior, and it is far too neutral a term to fill our strongly positive blank.

(C) Like “decency,” “impropriety”—or wrongdoing, improper behavior—brings up, for no reason, the morality of the people at this party. Always stay within the bounds of context the other parts of the sentence provide.

5. (D)

“Abatement,” meaning decline or decrease, has the negative word charge we need for our first blank, to account for the turn from “stirring” to “tedious” in the second part of the sentence. “Understandable” works well for our second blank, saying the students’ lack of interest could have been expected.

(A) “Redirection” goes in the opposite direction of the negative charge we need. “Inevitable” means without fail.

(B) “Reduction” is close in meaning to “abatement,” but “indefensible,” meaning impossible to defend, is the opposite of what we need for the second blank (especially since the latter part of the sentence essentially mounts a defense of the students’ lack of interest).

(C) “Rehabilitation,” or building up anew, is the opposite of what we need for our first blank; and “impressive” misses the point for the second blank.

6. (B)

We need the blanks to work together to fit the sentence’s meaning. “Unsavory,” in the second part of the sentence, tells us caffeine will be deemed a necessity—or “integral”—to this drinker. His hypothesis about the need for caffeine is thus “strengthened.”

(A) As with (C), these two answers work at cross purposes: if caffeine is merely “incidental”—that is, unnecessary—to coffee, then unsavory decaf confirms, rather than “undermines,” the hypothesis.

(C) “Inconsequential” means not important to. Judging decaf badly would not “defeat” such a hypothesis; it would strengthen it.

(D) “Inimical” means antithetical to, hostile toward. That’s not how our drinker feels about caffeine, since the sentence deems decaffeinated options “unsavory.” To “rescind” is to take back.

7. (B)

The second blank completes a judgment of Osborne for the action described by the first blank. His “willingness” to abuse the public trust by deceiving it made that trust into a “commodity,” or something that can be bought and sold.

(A) “Disinclination” is the opposite of the “willingness” of our right answer choice, and a “boon” is a positive factor, a godsend. Together, these two don’t work.

(C) “Decision” could work for our first blank. “Mirage,” or optical illusion, doesn’t quite work for the second blank, though, because Osborne’s actions aren’t making that trust illusory or doing away with it; they’re turning it into something else, something negative. The metaphor in **(B)** works much better.

(D) “Intention” is a possibility, but it doesn’t work with “demand” as our second blank.

8. (C)

This is an intensification structure: “not just” A but “downright” B. The article was not just “distorting,” or misrepresenting, of the community members; its depictions were “condescending,” or patronizing. The article looked down on them.

(A) Two difficult words that don’t work together in filling our blanks: “impertinent” means not relevant, and a “palliative” is something that moderates the intensity of—excitement, for instance, is a palliative for boredom.

(B) The intensification runs in the wrong direction with these two choices: “detestable” means worthy of hatred, while “objectionable” is a far more mild version of the same thing.

(D) Again, our intensification structure doesn’t work right with these choices. A “brutal” article would be excessively mean, hurtful. “Infantilizing,” as its root suggests, means to treat like a baby—a more intense version of “condescending.”

9. (A)

Here the blanks will have opposite charges, because the second is a description of what’s being warded off

by the first, as “otherwise...” signals us. The horse needs a period of “convalescence,” or physical recovery; if it would continue with daily training, that could have “negative” effects.

(B) “Intensification” means escalation, greater training. It does not work together with “permanent” for the second blank. Note that we don’t have here the opposed charges of the correct answer choices.

(C) “Rehabilitation,” close in meaning to “convalescence,” is a possibility for the first blank. But in what sense would continued training’s effects be “partial,” and how is that counteracted by the rehabilitation?

(D) Again, the contrast between the blanks is missed here. This one comes close to the meaning of **(C)** on the first blank, and “significant” doesn’t work for the second blank.

10. (B)

A FRIEND is by definition AMICABLE. A SPENDTHRIFT is by definition extravagant. A SPENDTHRIFT may or may not be STRONG, and may or may not be CAREFUL.

11. (C)

A THIEF is someone who steals, who TAKES wrongly or illegally. An ARSONIST is someone who BURNS wrongly or illegally.

12. (D)

To BEAM or smile broadly is to express JOY. To SNEER is to express CONTEMPT. While you may SNEER at someone while IRRITATED, a sneer is not necessarily an expression of irritation.

13. (A)

To DRIBBLE is to pour slowly, little by little, and to GUSH is to pour quickly and freely. To SMOLDER is to burn slowly, while to BLAZE is to burn quickly.

14. (A)

A HEDONIST is someone who loves PLEASURE. A PHILOSOPHER is someone who loves KNOWLEDGE (the word comes from the Greek *philein*, “love,” and *sophia*, “knowledge or wisdom”). A PHILOSOPHER may or may not love WRITING.

15. (B)

To SLAKE THIRST is to relieve it. To ASSUAGE HUNGER is to relieve it.

16. (A)

As applied to a comment or statement, something OBLIQUE or indirect is not POINTED or direct. Something ENGROSSING or fascinating is not TEDIOUS.

17. (D)

Something DAMP is slightly wet, while something SODDEN is so wet that it is totally soaked. The bridge here is one of degree; something DAMP is far less wet than something that is SODDEN. Similarly, something WARM is far less hot than something that is SCORCHING.

18. (D)

Someone who is AMORAL lacks morals, while a CONSCIENCE is a sense of right and wrong. A good bridge here is that someone who is AMORAL lacks a CONSCIENCE. Similarly, someone who is rash is impulsive and acts without thinking first. So, someone who is RASH lacks FORETHOUGHT.

19. (D)

A CRAB grasps things with its CLAWS. An EAGLE grasps things with its TALONS.

20. (D)

A WRANGLER is another word for cowboy, and a LARIAT is another word for lasso. Be careful about the bridge you make—if you use the bridge a WRANGLER uses a LARIAT, all the answer choices work. A LARIAT is used to rope and catch animals, usually cows, so you could say that a WRANGLER catches animals with a LARIAT. Similarly, a SHEPHERD catches animals using a CROOK. (A crook is a stick that is hooked at the end and is used by a shepherd to catch sheep.)

21. (D)

A BUTTRESS is part of a building or structure; its function is to BOLSTER or support something else. A CONDUIT is also part of a structure; its function is to CONVEY something else, such as fluids or wires.

22. (A)

A JUGGERNAUT is something that is huge and virtually unstoppable. So a JUGGERNAUT is impossible to HALT. Similarly, GIBBERISH is speech or writing that is totally incoherent and thus is impossible to UNDERSTAND.

23. (A)

APNEIC describes a person who experiences a period of no BREATHing. Taciturn describes a person who experiences periods of no talking. Choice (B), LOGORRHEA, is incorrect because it describes someone who talks a lot. Choice (C) is incorrect because APATHY is a lack of interest, not a lack of talking. And choice (D) is incorrect because DYSPEPSIA is another name for indigestion—it has nothing to do with talking.

24. (C)

To BOWDLERIZE something is to remove that of which is perceived to be OFFENSIVE. For instance, removing the scenes from a theatrical presentation that depict murder. We are looking for a word that coincides with DISINFECT to create a pair similar to the original. To DISINFECT is to remove that of which is PATHOGENIC. Thus, choice (C) is the correct answer. Choice (A) is wrong because inseparable means to be impossible to separate, which is obviously incorrect. Choice (B) is wrong because something that is *demonstrative* is serving to manifest or prove, which does not fit with the relationship amongst the original pair. Finally, *prudent* refers to exercising good judgment in decision-making, which is irrelevant to the relationship established between the original pair.

BIOLOGY ANSWER KEY

- | | | |
|------|-------|-------|
| 1. D | 9. A | 17. B |
| 2. C | 10. C | 18. B |
| 3. B | 11. C | 19. D |
| 4. A | 12. D | 20. C |
| 5. D | 13. B | 21. B |
| 6. D | 14. A | 22. B |
| 7. D | 15. B | 23. D |
| 8. D | 16. A | 24. B |

BIOLOGY ANSWERS AND EXPLANATIONS

1. (D)

Open circulatory systems, such as those found in insects, are characterized by having blood (interstitial fluid) that is in direct contact with the body tissues. The blood is circulated primarily by body movements and flows through a dorsal vessel into spaces called sinuses, where exchange occurs. Annelids have a closed circulatory system with five pairs of vessels called aortic loops, which connect the dorsal vessel to the ventral vessel and act as additional pumps. In mammalian and other highly developed circulatory systems, arteries branch into arterioles. Blood is oxygenated at the lungs in terrestrial organisms such as lizards and humans.

2. (C)

Lacteals are tiny lymph vessels that extend into the intestinal villi and are the site of absorption of fatty acids that have been packaged into chylomicrons.

3. (B)

Budding results in the production of two asymmetrical cells due to unequal division of the cytoplasm, although both cells receive duplicate copies of the parent DNA. Fission, on the other hand, results in two equally sized cells with equal amounts of cytoplasm and duplicate copies of the parent DNA. Budding may occur in yeast, a unicellular fungi, or hydra, a multicellular organism. Although budding occurs in yeast or hydra, binary fission is used by prokaryotic organisms such as bacteria. Polar bodies are produced in oogenesis via unequal cytoplasm distribution. One primary oocyte will produce one fertile egg, which contains most of the cytoplasm and two or three polar bodies.

4. (A)

Glucocorticoids, such as cortisol and cortisone, are involved in glucose regulation and protein metabolism. They are derived from cholesterol, as are mineralocorticoids and cortical sex hormones. Epinephrine, choice (B), is a peptide hormone that is secreted by the adrenal medulla. ADH, choice (C), is also a peptide hormone secreted by the hypothalamus and stored in the posterior pituitary. Insulin, choice (D), is a peptide hormone secreted by the pancreas.

5. (D)

Let's look at each statement individually:

- I. A smallpox vaccination is an example of active immunity; vaccination induces the production of antibodies. Active immunity can be conferred by vaccination when an individual is injected with a weakened, inactive, or elated form of a particular antigen, which stimulates the immune system to produce specific antibodies against it. Active immunity may require weeks to build up.
- II. Passive immunity involves the transfer of antibodies produced by another individual or organism. Passive immunity is acquired either passively or by injection. During pregnancy, some maternal antibodies cross the placenta and enter fetal circulation, conferring passive immunity upon the fetus. Although passive immunity is acquired immediately, it is very short-lived, lasting only as long as the antibodies circulate in the blood.
- III. Gamma globulin, the fraction of the blood containing a wide variety of antibodies, can be used to confer temporary protection against hepatitis and other diseases by passive immunity.

Because statements II and III are examples of passive immunity, the correct answer is choice (D).

6. (D)

The pineal gland is a tiny structure at the base of the brain that secretes the hormone melatonin. The role of melatonin in humans is unclear, but it is believed to play a role in the regulation of circadian rhythms, i.e., physiological cycles lasting 24 hours. Melatonin secretion is regulated by light and dark cycles in the environment. Prolactin is secreted by the anterior pituitary. Calcitonin is secreted by the thyroid gland. Renin is secreted by the kidney. Gastrin is secreted by the stomach.

7. (D)

Imprinting is a process in which environmental patterns or objects presented to a developing organism during a brief critical period in early life become accepted permanently as an element of the organism's behavioral environment. Behavioral displays, such as reproductive and agonistic displays, are interactions

that occur as a means of communication between members of a species. When food, mates, or territory are disputed, a dominant member of the species will prevail over a subordinate one. The social hierarchy is frequently referred to as the “pecking order.” It minimizes violent intra-specific aggression by defining stable relationships among members of the group. Members of most land-dwelling species defend a limited area or territory from intrusion by other members of the species. These territories are typically occupied by a male or a male–female pair and are frequently used for mating, nesting, and feeding.

8. (D)

The two-layer gastrula is a stage in development between the blastula and three-layer gastrula. In humans, the appendix, choice (A), is small and useless, although in herbivores it assists in the digestion of cellulose. Furthermore, in humans, the tail is reduced to a few useless bones [coccyx, choice (B)] at the base of the spine, although in other animals it functions in balance or grasping. The splints on the legs of the horse, choice (C), are the vestigial remains of the two side toes of Eohippus.

9. (A)

A deme is a small, local population. Members of a deme resemble one another more closely than they resemble the members of other demes. They are closely related genetically because mating between members of the same deme occurs more frequently. They are influenced by similar environmental factors and thus are subject to the same selection process. Biomes, choice (B), are the world’s major communities, classified according to the predominant vegetation and characterized by adaptations of organisms to the particular environment. A niche, choice (C), is the sum total of an organism’s use of both the physical and biotic environments. The gene pool, choice (D), is the sum of the genes in a population at any given time.

10. (C)

Animals have developed many adaptations for maintaining their internal osmolarity and conserving water. This is known as osmoregulation. Osmoregulation in insects and birds involves the secretion of uric acid crystals. Cooperativity, choice (A), is the interaction of the subunits of proteins; such interaction enables a conformational change in one subunit to be transmitted to others and strengthen binding. Thermoregulation, choice (B), is the maintenance of a consistent internal temperature

within a tolerable range. Passive excretion, choice (D), will occur in a hyperosmotic environment. If the salt concentration of the water is higher than that of the organism, water flows passively into the water and out of the organism. To compensate for this, the organism (such as a saltwater fish) must constantly drink and actively excrete salt across his gills.

11. (C)

The parathyroid glands are four small pea-shaped structures embedded in the posterior surface of the thyroid. These glands synthesize and secrete parathyroid hormone, which, together with calcitonin and vitamin D, regulates plasma Ca^{2+} concentration. In turn, the plasma Ca^{2+} concentration regulates PTH secretion by means of a negative feedback mechanism. PTH raises the Ca^{2+} concentration in the blood by increasing bone resorption and decreasing Ca^{2+} excretion in the kidneys. In addition, PTH converts vitamin D into its active form, which stimulates intestinal calcium absorption. Glucagon stimulates the conversion of glycogen to glucose in the liver and, therefore, increases blood glucose. Insulin lowers blood glucose and increases storage of glycogen. Aldosterone regulates plasma levels of sodium and potassium and, consequently, regulates the total extracellular water volume. It causes the active reabsorption of sodium and passive reabsorption of water in the nephron.

12. (D)

Female carriers who pass a sex-linked lethal recessive trait to their offspring will experience death of their male offspring, whereas their female offspring will be carriers. Females will never die from this recessive sex-linked lethal trait because a homozygous female would be impossible to produce without the X^a -affected allele gamete from the male, who is unable to reach maturity to produce gametes.

13. (B)

With no gamma globulins (antibodies), an organism cannot produce a specific immune response to pathogens. Clinical manifestations of this condition are frequent, severe, and prolonged infections in organisms of typically low pathogenicity.

14. (A)

There are four stages to the cell cycle: M, G_1 , S, and G_2 . Cell division, or mitosis, occurs during the M phase. In G_1 , the cell doubles in size and new organelles are produced. In S (synthesis), each chromosome is replicated. In G_2 , the cell continues to grow and

assembly of new organelles continues. Stages G_1 , G_2 , and S are interphase stages that occur between cell divisions. The correct answer is choice **(A)**.

15. (B)

Adenine pairs with Thymine (via two hydrogen bonds) and Guanine pairs with Cytosine (via three hydrogen bonds) in DNA. Adenine pairs with Uracil (via two hydrogen bonds) and Guanine pairs with Cytosine (via three hydrogen bonds) in RNA. Tyrosine is a distracter choice and is an amino acid.

16. (A)

Portal systems are unusual circulatory arrangements in the body, in which there are two capillary beds connected by a vein (circulation pathway: artery → capillary bed → first vein → second capillary bed → second vein). Thus answer choice **(B)** is eliminated. The two best-known portal systems are the hepatic and hypothalamic-hypophyseal portal systems. The hepatic portal system links the small intestine and liver. Thus answer choice **(D)** is eliminated. Blood leaving the capillaries of the small intestine, which has picked up digested food, goes through the hepatic portal vein to a capillary bed in the liver and then returns to normal circulation. The hypothalamic-hypophyseal portal system links the hypothalamus and anterior pituitary [thus choice **(C)** is eliminated], and blood traveling through this system transports releasing hormones. However, the posterior pituitary is not a direct part of the portal system, which means that choice **(A)** is false and, therefore, the correct answer.

17. (B)

The endodermal layer gives rise to intestinal mucosa. All of the other structures listed are derived from the ectodermal layer.

18. (B)

T cells mature in the thymus (T cell = Thymus), so choice **(A)** is incorrect. B cells are produced and mature in the bone marrow (B cell = Bone marrow); thus choice **(B)** is correct. Interferons are produced by cells under viral attack, so choice **(C)** is eliminated. Choice **(D)** is incorrect because lysozymes are found in tears.

19. (D)

Co-dominance is defined as the existence of multiple alleles for a given gene, when more than one allele is dominant. A classic example of co-dominance is the inheritance of the ABO blood group in humans, with A and B being co-dominant with each other. Individuals

with $I^A I^B$ blood type thus have characteristics of both blood types.

20. (C)

Illinois is located in the Midwestern area of North America, a midlatitude region, where sufficient moisture allows large deciduous trees to grow abundantly. This is a classic example of a temperate deciduous forest biome.

(A) Distortion. Tropical forests are located around the equator and harbor a complex array of animal and plant species; temperate deciduous forests do not.

(B) Distortion. Chaparral biomes are found midlatitude along coasts where cold ocean currents circulate offshore. Vegetation consists of dense spiny evergreen shrubs.

(D) Distortion. The coniferous forest biome, or taiga, is known for its evergreen trees, considerable snow, short summers, and harsh winters, unlike deciduous forests.

21. (B)

The correct answer is choice B. This is a pure knowledge question. There is really no reasoning required, so either you knew the answer or you didn't. Examples of fungi include mold, yeast, and mushrooms. Fungi are eukaryotic organisms, typically filamentous or, rarely, unicellular. The filamentous forms consist basically of continuous hyphae that form a mycelium; thus choice C is incorrect since it is true of fungi and you're asked to determine which of the choices is NOT true. All fungi have chitin-containing cell walls, as well as plasma membranes. Therefore choice B must be the correct answer. Choices A and D are wrong because they are both true. Fungi reproductive cycles often include both sexual and asexual phases, meaning that haploid and diploid states are both possible. In addition, fungi are heterotrophs that obtain nutrients through absorption. Again, choice B is the correct answer.

(A) Distortion. This is a correct statement, as both states are possible in fungi.

(C) Distortion. This is a correct statement, as fungi contain hyphae.

(D) Distortion. This is a correct statement, as fungi are heterotrophic.

22. (B)

The correct answer is choice B. From your knowledge of viral structure you know that the viral coat is the outer surface of a virus and is composed of protein.

And the viral core, the inside of the virus, contains nucleic acid in the form of either RNA or DNA. Therefore, you would expect the core antigen to be composed primarily of nucleic acids and the coat, or surface antigen, to be composed primarily of proteins. Remember, an antigen is just something that invokes an immune response in a host organism. Thus, choice A is wrong and choice B is the correct answer. Let's just take a look at the other choices quickly. From your knowledge of viral replication, you know that the viral coat and the viral core are synthesized separately and then combined to form a virion. When a host cell lyses, complete viral particles, as well as any unassembled viral components, namely the coat particle, HB_sAg, and the core particle, HB_cAg, may be released. In addition, the contents of the host cell itself will also be released. And, since you're told that the antigens are found in the serum, it is not unreasonable to expect the enzymes of the host liver cells to be in the serum too. In fact, a rise in certain liver enzymes is key to hepatitis diagnosis. Therefore, choices C and D can be eliminated. Also, since incomplete viral particles are also liberated into the serum, it might be expected that some of these viral products might also appear as antigens, such as viral DNA polymerase for example. Again, choice B is the correct answer.

(A) Distortion. HB_cAg is probably composed primarily of nucleic acids.

(C) Distortion. Serum concentration of liver enzymes is expected to increase.

(D) Distortion. Serum concentration of liver enzymes is expected to increase.

23. (D)

The correct answer is choice D. The vitamin K we need for blood coagulation is synthesized by the intestinal bacteria residing in our colons. Vitamin K is required for the liver to synthesize blood factors VII, IX, and X, and prothrombin. Deficiency of vitamin K causes hypoprothrombinemia, which manifests itself in defective coagulation of the blood. Choices A, B, and C are clearly wrong, since they all involve human synthesis of production of vitamin K, and you're told in the question stem that this is impossible. Again, choice D is the right answer.

(A) Distortion. Vitamin K cannot be synthesized by the body.

(B) Distortion. Vitamin K cannot be synthesized by the body.

(C) Distortion. Vitamin K cannot be synthesized by the body.

24. (B)

Plant cells are rigid and cannot form a cleavage furrow. They divide by the formation of a cell plate, an expanding partition that grows outward from the interior of the cell until it reaches the cell membrane.

(A) is incorrect because plant cells lack centrioles. The spindle apparatus is synthesized by microtubules organizing centers which are not visible.

(C) is incorrect: Cytokinesis in animal cells proceeds through formation of cleavage furrow.

(D) is incorrect because animal cells have centrioles from which the spindle apparatus arises.

CHEMISTRY ANSWER KEY

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|------|-------|-------|
| 1. D | 9. D | 17. D |
| 2. D | 10. A | 18. A |
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CHEMISTRY ANSWERS AND EXPLANATIONS

1. (D)

This problem has two main steps. First, we need to determine which of the reactants will limit the amount of products; then, we can use the balanced equation to calculate how much product is formed. We are told that we begin with one mole of each of the reactants. When we divide this by the coefficients of the reactants in the balanced equation, we find that hydrogen is the limiting reactant. For every two moles of hydrogen, we produce two moles of water, so with the one mole of hydrogen we're given, we can produce one mole of water.

2. (D)

When we are asked to determine an empirical formula from percentages by weight, it is usually most convenient to think of a 100-g sample. Of course, any sample would give the correct answer, but using a 100-g sample, the percentages translate directly into weights (in g). In a 100-g sample of the compound, we therefore have 42 g chlorine and 57 g oxygen. To deduce the empirical formula, we need to find out the number of moles of Cl and O atoms to which these values correspond. The atomic weight of chlorine is 35.5 g/mol, so 42 g corresponds to $42/35.5$, or 1.2 mol, and the atomic weight of oxygen is 16 g/mol, which corresponds to $57/16$, or 3.6. Our next step is to divide both of these values by the smaller of the values. From this we obtain a ratio of 3 oxygen atoms to 1 chlorine atom. The only compound in which the ratio of oxygen to chlorine is 3:1 is choice (D). Had you been really stuck, you could have eliminated choice (C) because it is the only compound of the four that contains only oxygen and chlorine, and the given weight percentages did not add up to 100, so there must have been another element in the correct compound.

3. (C)

We know that the general rate expression for a bimolecular reaction like the one given in this problem is $k[A]^x[B]^y$. We need to use the rate data given to determine the values of x and y . First, take a look at the first and second experiments. The concentration of [A] was varied, while [B] was held constant. [A] doubled, and so did the rate. This represents a first-order dependence on [A], so $x = 1$. Now take a look at the first and third experiments. The concentration of [B] doubled, while [A] was held constant and the rate

increased fourfold. This represents a second-order dependence on [B], so $y = 2$. Therefore, the rate expression is $k[A][B]^2$.

4. (D)

For dilution problems like this one, a helpful formula will simplify your calculations: $M_iV_i = M_fV_f$, where M_i and M_f are the initial and final molarity of the solution, respectively, and V_i and V_f are the initial and final volume of the solution, respectively. To determine the amount of water needed to perform the dilution, our first step is to determine the final volume of the solution (the volume after dilution):

$$(18 \text{ M})(0.025 \text{ L}) = (3 \text{ M})V_f,$$

$$V_f = 0.150 \text{ L} = 150 \text{ mL}.$$

The amount of water we need to add is therefore the difference between the final and initial volumes, or $(150 - 25)$, mL = 125 mL.

5. (C)

A compound can hydrogen bond if it has an electronegative element (N, O, or F) bonded to a hydrogen atom. In order to determine which of the listed compounds does not meet this requirement, draw the structures as carbon chains. Choice (C) cannot hydrogen bond because the fluorine atoms are bonded to a carbon atom. We know that they cannot be bonded to hydrogen atoms because fluorine only forms one bond per atom, and the compound contains more than just HF.

6. (C)

Use an effective Kaplan strategy here: estimate! The value given for sulfur trioxide is very close to -400 , and the value given for sulfur dioxide is close to -300 , so use that information to your advantage instead of keeping track of many numbers—the answer choices are quite far apart, so there is no risk that you will go astray. The enthalpy change for the reaction is simply the enthalpy of the products minus the reactants: in this case, $2(-400) - 2(-300)$, or about -200 . The only answer choice that comes close is choice (C).

7. (D)

This question might seem daunting because it asks you to put a battery into three categories: positive or negative Gibbs free energy change, spontaneity, and electrode character. In addition to that, you might be wondering, what kind of cell is a battery? The most helpful thing here is to take a step back and ask yourself what you already know about batteries. The main distinction between galvanic (or voltaic) cells and electrolytic cells is that one is used to do work, while the other requires electrical energy to induce the reaction. A battery most certainly falls into the first category—we use batteries all the time to run small appliances. Therefore, you know that the correct answer will be one that contains the attribute “spontaneous.” This eliminates choice **(B)**. The next step is to consider how spontaneity is related to the change in Gibbs free energy. When a reaction is spontaneous, it has a negative change in Gibbs free energy. This allows us to eliminate choice **(A)**. Finally, consider what is true for all kinds of cells: the oxidation half-reaction occurs at the anode, bringing us to choice **(D)**.

8. (B)

The pH and the proton (hydrogen ion) concentration of an aqueous solution are related in the following way: $\text{pH} = -\log[\text{H}^+]$. We know the pH, so we must work backwards. Luckily, we’re given a number that is relatively easy to work with. If the pH is 3, the $[\text{H}^+]$ is 10^{-3} M.

9. (D)

Protic solvents have a hydrogen atom attached to an electronegative atom, such as O or N. These solvents contain highly-polarized bonds in which the hydrogen has a proton-like character and can interact particularly strongly with anionic nucleophiles. These interactions are called hydrogen bonds. Solvents not capable of hydrogen bonding are called aprotic. Choices **(A)** and **(C)** do not have H atoms attached to the electrophilic O. Choice **(B)** is incorrect because there is no electronegative atom in the molecule. Ethanol, choice **(D)**, is the only solvent capable of hydrogen bonding.

10. (A)

The question gives a helpful clue: we are looking for a pair that has the most ionic character. What makes a bond ionic? The most ionic pair will be one in which the two ions most closely approximate point charges. This is possible when the positive ion completely donates its electron to the negative ion. Stated another way, the species involved in the bond differ greatly in electronegativity. So, we are looking for a positive ion that completely loses its valence electron, as well as a very electronegative element for the anion. Which of the anions is most electronegative? F, which appears in choice **(A)**. However, we must also consider the cation. The cation that most closely approximates a point positive charge will be one that has the most shielding between the nucleus (the positive charge) and the valence electron to be lost. This will be Rb, so choice **(A)** is correct. Choices **(B)** and **(C)** will have significant ionic character as well, but not to the extent that **(A)** does. Choice **(D)** contains an element from the center of the periodic table, Si, so it will be more difficult to pair it with elements of differing electronegativity. Therefore, these combinations will not have high ionic character when bonded.

11. (A)

This question calls for an application of Le Châtelier’s principle to the given system. Le Châtelier’s principle states that when a system is in equilibrium, any stress applied to it will cause the equilibrium to shift in a direction that alleviates the stress. The stress can be in the form of a change in temperature, pressure, volume, or concentration of any of the species in the system. For the system given in the question, we have one mole of PCl_5 in equilibrium with one mole of PCl_3 and one mole of Cl_2 . All species are in the gas phase. If we decrease the volume after the system has reached equilibrium, the equilibrium will shift towards the side with the smaller number of moles of gases, i.e., to the right. Therefore, choice **(A)** is correct. Choice **(B)** is incorrect because decreasing the pressure would have the opposite effect: it would cause the equilibrium to shift to the side with the larger number of moles of gas—in this case the reactant side. Choice **(C)** is incorrect because the reaction is exothermic ($\Delta H < 0$), increasing the temperature would favor the reactants. Choice **(D)** is incorrect because the addition of a catalyst does not affect the thermodynamics of a reaction; it increases both the forward and reverse rates of reaction, so it will not affect the equilibrium.

12. (D)

The best thing to do here is to examine the electron configuration given and determine which electrons are the valence electrons. Clearly, the $n = 1$ and $n = 2$ levels are filled, so only $n = 3$ must be considered. The s subshell is full (two electrons) and the p subshell is full (six electrons); this leaves the d orbitals. Remember that electrons prefer to be unpaired if they can be, so place each electron in an empty orbital. This works for the first five electrons; then, there is one additional electron. Place it in one of the half-full orbitals, and you will see that you have four unpaired electrons left. This is choice **(D)**.

13. (B)

The key to answering this question correctly is to balance the equation given, then choose the corresponding element. The mass and atomic numbers must be balanced in order for the equation to be valid. Only choices **(B)** and **(C)** satisfy this requirement. Choice **(C)** is incorrect because it denotes the wrong element; the subscript (6, in this case) is the atomic number of the species in question, whereas choice **(C)** uses the mass number, the superscript, to determine the identity of the element. Choice **(A)** adds the masses and atomic numbers instead of balancing them.

14. (D)

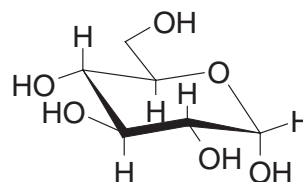
Electronegativity and ionization energy decrease down a column in the periodic table, so choices **(A)** and **(C)** are incorrect. Ductility (the ability of a substance to be pulled into wires) varies by substance and does not demonstrate a clear trend based on the position within a column of the periodic table, so choice **(B)** is incorrect. Only **(D)**, atomic radius, increases as we move down a column. Since there is more shielding due to additional filled orbitals of electrons, the valence electrons are not as tightly held and the atomic radius increases. Choice **(D)** is, therefore, correct.

15. (A)

The electronic configuration of sodium metal is $1s^2 2s^2 2p^6 3s^1$. It will react in favor of losing its $3s$ electron in order to form a noble gas configuration. Na will, therefore, react with species that act as electron acceptors. Because dimethyl ether, choice **(A)**, is a weak electron donor, it will not readily react with sodium metal. Choices **(B)**, **(C)**, and **(D)** are all acids that can accept electrons.

16. (D)

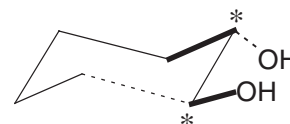
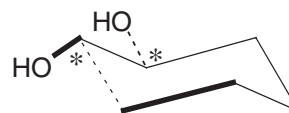
Glucose, the primary source of energy in the human body, is a typical carbohydrate whose structure is shown below. From this structure, it is evident that glucose is a monosaccharide. Therefore, choice **(D)** is incorrect.

**17. (D)**

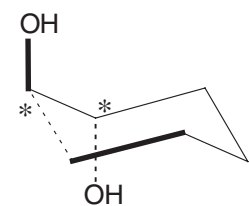
When carbon forms four single bonds, its hybridization is sp^3 . When carbon forms one double bond and two single bonds, it is sp^2 . Carbon atoms that are sp hybridized can form either one single bond and one triple bond, or two double bonds. The carbonyl carbon in acetamide is sp^2 because it forms a double bond with oxygen and single bonds with nitrogen and carbon. The nitrile carbon atom in acetonitrile is sp because it forms a triple bond with nitrogen and a single bond with carbon.

18. (A)

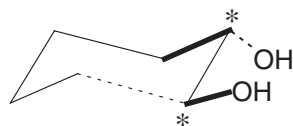
The first step in solving this problem is to determine whether the connectivity is the same in the two compounds. They are both 1,2-dihydroxy cyclohexane. Therefore, they are definitely not constitutional isomers [thus eliminate choice **(B)**]. Visual assessment tells us that cyclohexane is in the chair conformation in each compound.



Each molecule contains two chiral centers (*), so that choices **(A)**, **(C)**, and **(D)** are possible answers. Examination of the positions of the hydroxyl groups, however, tells us that the molecules are identical. Choice **(A)** is, therefore, correct. In each case, both hydroxyl groups are in the equatorial positions (note the parallel dashes and bold lines). If any of the hydroxyls were in axial positions, they would be pointed downward and upward instead of parallel to the C–C bond “once removed.”



Axial OH Groups



Equatorial OH Groups

19. (D)

This question requires us to translate Avogadro's number, N_A , into a variety of forms. Recall that N_A is the number of particles in one mole of anything and is equal to 6.022×10^{23} (particles per mole). Choice **(A)** is equivalent to N_A since 11.2 liters of oxygen at STP, safely assumed to behave as an ideal gas, will consist of a half a mole of oxygen molecules and, since oxygen is diatomic, half a mole of oxygen molecules will contain one mole of oxygen atoms. Choice **(B)** is also equivalent to N_A since helium, unlike oxygen, is a monatomic gas, and one mole of helium is thus composed of one mole of atoms. Choice **(C)** is also an expression of N_A since 500 mL is one half of a liter, and since 1 M H_2SO_4 will have one half a mole of H_2SO_4 in one half of a liter; each formula of H_2SO_4 has 2 protons (H^+), therefore there will be one mole of protons in this half liter of 1 M solution. Choice **(D)**, in contrast to choice **(C)**, is not equivalent to N_A . A 1 N solution of H_2SO_4 will have one mole of protons per liter of solution, but, since there is one sulfate anion for every two protons, there will only be half a mole of sulfate ions in that same one liter solution.

20. (A)

In this case, the pressure and temperature are held constant and we are asked to find the change in volume as the reaction proceeds. Since complete reaction means that 3 moles becomes 1 mole, and since volume is proportional to the number of moles (Avogadro's law), it follows that the volume will be one third as large after the reaction as it was before the reaction. Thus 30 liters becomes 10 liters, and choice **(A)** is indeed correct.

21. (B)

This reaction is an example of electrophilic addition of a halogen to an alkene. When chlorine approaches the double bond of propene, the halogen becomes polarized so that one region is electrophilic—it carries a slight positive charge and part of the molecule is nucleophilic—it carries a slight negative charge. The π bond is broken, and electron density is donated to form a bond to the electrophilic carbon; the result is the formation of a three-membered chloronium ion. The nucleophilic portion of the halogen molecule can then add to the ion from the opposite face of the molecule, that is, in an *anti* mechanism. The result is the formation of 1,2-dichloropropane, shown in choice **(B)**. Choice **(A)** is incorrect since this molecule would be the result of Markovnikov addition of hydrogen chloride to propene, and choice **(C)** is incorrect since this would be the result of anti-Markovnikov addition of hydrogen chloride to propene. Choice **(D)** can be discarded since this molecule would be the result of a free-radical substitution reaction, which is initiated by ultraviolet light or high temperatures. Since the reaction temperature is low and no free-radical initiators are present, electrophilic addition rather than free-radical substitution will occur.

22. (C)

The halide in free radical halogenation reactions always adds to the most substituted carbon. The most substituted carbon is the tertiary carbon connecting the isopropyl group to the benzene ring, making choice **(C)** the only possibility.

Choices **(A)**, **(B)**, and **(D)** are incorrect because the free-radical reaction will not involve the benzene ring (don't confuse this with a halogenation reaction, which requires a Lewis acid catalyst).

23. (C)

In following the IUPAC naming procedure, we start by identifying the longest carbon chain, here being 9. This molecule is a hydrocarbon with no double bonds, so we call it nonane. Next, the carbons must be numbered such that the substituents receive the lowest numbers possible, so this molecule gets numbered left to right. Finally, attached to carbon 3 is an ethyl group, and to carbon 5 are two methyl groups. Putting this together we get answer choice C.

(A) Distortion. It is a nonane; however the numbering is incorrect.

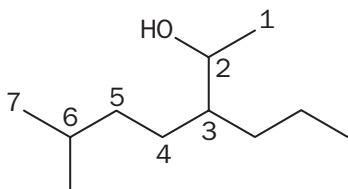
(B) Distortion. The longest continuous chain of carbon atoms is nine, so it cannot be an octane.

(D) Distortion. The longest continuous chain of carbon atoms is nine, so it cannot be an octane. Carbon must be numbered to produce the lowest possible numbers for the substituents.

24. (C)

When assigning a systematic (IUPAC) name to an alcohol, be sure to choose the longest chain of carbon atoms *that contains the -OH group*. Number that chain from the end closest to the -OH group. Alkyl substituents are included in the name in alphabetical order.

In the structure shown, the -OH group is on C-2 of a seven-carbon chain, with a methyl group on C-6 and a propyl group on C-3 (choice (C)).



(A) Distortion. This does not include the -OH group in the longest chain.

(B) Distortion. This was not numbered beginning at the chain from the end closest to the -OH group.

(D) Distortion. This does not include the longest chain in the name.

READING COMPREHENSION ANSWER KEY

- | | | |
|------|-------|-------|
| 1. D | 9. B | 17. D |
| 2. B | 10. D | 18. B |
| 3. D | 11. D | 19. A |
| 4. A | 12. B | 20. C |
| 5. B | 13. A | 21. D |
| 6. A | 14. D | 22. A |
| 7. D | 15. B | 23. B |
| 8. C | 16. C | 24. C |

READING COMPREHENSION ANSWERS AND EXPLANATIONS

1. (D)

In MG, autoantibodies bind the active site of the AChR where ACh normally binds (competitive binding). They do not bind the ion channel.

2. (B)

MG is an autoimmune disease and, as such, could theoretically be treated by suppressing the level of activation of the immune system. Increasing the outflow of calcium pre-synaptically would not address the main problem in MG; furthermore, it might decrease the release of ACh from vesicles in the motor neuron. You could increase the transcription (production) of AChR in the hopes of expressing more AChR, but this would not best address the immune dysregulation in MG; the AChR and the post-synaptic membrane would still be attacked. Also, the passage mentions that there already exists a high-density of AChR on the membrane. Increasing the activity of acetylcholinesterase would only work to decrease the amount of ACh available at the NMJ. Finally, increasing the threshold for action potential at the motor endplate would make it harder for signals to be transmitted under any condition.

3. (D)

Transmission of signals at the NMJ is *always* blocked in MG, for this is the defining characteristic of the disease. The other choices may or may not be features of the disease. The passage states that autoantibodies are present in the serum of *most* patients. Progression of the disease may be slow or fast; some patients do not have rapid involvement of the respiratory muscles. The passage states that 75% of the individuals with MG also have disease of the thymus. Lastly, while the disease often does start with ocular abnormalities, it may present with different symptoms as well.

4. (A)

The order of the events is as follows: (1) propagation of action potential in the motor neuron, (2) calcium influx, (3) vesicle fusion, (4) release of ACh with diffusion across the synapse, (5) binding of ACh to its receptor with ensuing opening of Na channels in the receptor, leading to (6) membrane depolarization.

5. (B)

T cells mature in the thymus. Privileged sites harbor cryptic antigens and ignorant lymphocytes and try to keep activated immune cells out. As mentioned in the

passage, examples of such sites are the brain and the testicals.

6. (A)

According to the passage, the bungarotoxin studies helped to demonstrate the high density of AChR on the post-synaptic membrane.

7. (D)

The passage says that the antibodies demonstrated at the NMJ are IgG type, not IgM. The other options all list ways in which the number of AChRs is reduced on the post-synaptic membrane.

8. (C)

Electron microscopic immunocytochemistry demonstrated the presence of both IgG and the complementary “attack complex” at the NMJ.

9. (B)

James Cleaver cultured cells from people with XP, a disease characterized by exquisite sensitivity to UV rays, i.e., sunlight.

10. (D)

Photoreactivation is a method of direct reversal of dimerization due to UV radiation. It is common to yeast, *E. coli*, and some species of plants and animals but is not found in humans.

11. (D)

Damage to DNA often distorts the DNA strand such that further replication and transcription are hindered if there is no repair. When damage is so severe that repair is ineffective, a cell may initiate the process of programmed cell death to protect against the accrual of dangerous mutations. Otherwise, an unrepaired mutation may lead to accumulation of other mutations that result in the deregulation of the cell cycle, which then leads to cancer. Conversely, proper repair of DNA preserves the integrity of the genome.

12. (B)

The cyclobutane ring joins pyrimidines that are adjacent on the same strand of DNA when cells are exposed to UV radiation. The cyclobutane ring results from UV light exposure but is not a component of UV light. Photoreactivation is the mechanism for reversing this type of damage in yeast and *E. coli*;

there is a different mechanism employed by humans. However, the damage is the same in all cell types (dimerization), regardless of the repair mechanism. Individuals with XP are extraordinarily susceptible to the damaging effect of UV radiation due to mutations in the genes normally involved in repairing pyrimidine dimers; XP is not due to mutation of cyclobutane itself.

13. (A)

The first sentence of the second paragraph states that the most efficient method of repair of common types of damage is direct reversal of the damage. The passage then gives two examples of such reversible damage: pyrimidine dimers and guanine methylation. Methylation of a guanine residue results in damage to a single base and can be directly repaired using the enzyme methylguanine methyltransferase.

14. (D)

Cleavage of pyrimidine dimers is the mechanism of direct repair known as photoreactivation. Photoreactivation never occurs in humans. Rather, human repair of pyrimidine dimers involves: the XP proteins that participate in dimer recognition; DNA unwinding; DNA cleavage; and excision of an oligonucleotide.

15. (B)

In the discussion of mismatch repair, the passage mentions that *E. coli* are able to distinguish the new DNA strand from the parental strand by the presence of methylated adenine residues within the parental strand. When there is a mismatch, it is the aim of the repair system to correct the mistake in the newly synthesized strand, which is represented by the unmethylated strand in *E. coli*.

16. (C)

Coupling of nucleotide-excision repair (not base-excision repair) with transcription was demonstrated in experiments involving both mammalian cells and *E. coli*. These experiments revealed that DNA being actively transcribed is repaired more quickly than non-transcribed DNA. In *E. coli* alone, this was found to involve RNA polymerase recognition. Nowhere does the passage state that repair actually initiates DNA transcription; it merely states that the two processes are connected. Earlier in the passage, the ability of *E. coli* to reverse UV-induced pyrimidine dimers is discussed, but this mechanism is not found in mammalian cells.

17. (D)

(A) This global question requires an answer which characterized both the entire passage and the author's point of view. The word "advocate" suggests that there is an author point of view about Problematica. In reality, the author doesn't support either side and does not give us a point of view.

(B) Same problem as "A."

(C) The author reviews two theories, but does not offer any theory combining the ideas of revisionists and conventional thinkers.

(D) This answer encompasses the entire paragraph and accurately reflects the author's neutral purpose. Note the neutral verb "present," giving a clue to the correct answer.

18. (B)

(A) The last sentence of the passage tells us that the Problematica were gone by early in the Mesozoic era, thus would not even have been around at the close.

(B) In paragraph 2, the two examples of Problematica (Tillimonstrum and Hallucigenia) are representative of creatures which are morphologically distinct. Ediacaran fauna had an approach to life different from nearly all modern animals and, by inference, distinct from that of Tillimonstrum and the Hallucigenia. Thus all three were unique in their approaches to life.

(C) Paragraph one describes the Problematic as "mainly: Paleozoic, but the Ediacaran fauna were pre-Paleozoic (paragraph two) and some Problematic survived into the early Mesozoic (last paragraph).

(D) Neither the revisionists nor the conventional theorists think that all Problematica belong to one phylum.

19. (A)

(A) Revisionist paleontologists believe that the current system of taxonomic classification reflects the prejudice that all fossils may be grouped within current taxonomic categories. They argue that some extinct forms fit poorly, if at all, into current categories, and would therefore see traditional classification as biased toward present-day life forms.

(B) The revisionists do not dismiss conventional evolutionary theory (paragraph four states that both revisionists and traditionalists agree that modern marine species are products of natural selection) but see it as a mechanism which eliminated entire categories of organisms as well as separate species.

- (C) This is never suggested in the passage
 (D) This is also not reflected in the passage, and suggest an author point of view which is not valid.

20. (C)

(A) Both revisionists and traditionalists agree that most extant animal phyla evolved during the Cambrian era and enormous diversification subsequently took place within these phyla (end of paragraph four).

(B) True, the existing fossil record is imperfect, but that hasn't stopped both traditionalists and revisionists from drawing conclusions from it.

(C) Traditionalists regard extinction as involving "species...or groups of species within...basically viable phyla." Revisionists, however, argue that Problematica were distinct unsuccessful phyla, not variations on other phyla. Thus they would say that natural selection operated on entire approaches to survival as well as particular aspects of each approach, implying that conventional theorists distort a major aspect of natural selection.

(D) Nothing in the passage refers to how any theorists viewed evolution before the Cambrian explosion.

21. (D)

(A) Paragraph four states that by the Cambrian period, the number of phyla had fallen while the number of species had grown. If the new fossil evidence were true, the number of phyla would have increased, at least by one.

(B) There would be no need for a new phylum. The fossils, though refined, would still be those of Ediacaran fauna, just as modern animal phyla evolved from those existing in the Cambrian era.

(C) Duplication of the body plan would produce new Ediacaran fauna with exactly the same body plan as the old. The new evidence, however, shows evolutionary refinement, thus the body plan would be at least slightly different.

(D) The last paragraph states that these fauna became extinct before having the opportunity to undergo speciation and evolutionary refinement. New fossil findings would indicate a longer period of existence during which evolutionary changes took place.

22. (A)

(A) Paragraph three refers to the Cambrian explosion of basic phyla which reduced a large number of organisms into a small number of "body plans," or approaches to survival.

Paragraph four characterizes these as "separate experiments in basic design."

(B) "Body plan" refers to both successful (those phyla remaining at the end of the Cambrian) and unsuccessful morphology (Problematica) supporting respiration and absorption, which ensure survival.

(C) The words "body plan" are not used as proof of anything but only as a catch phrase for different body approaches to survival,

(D) The words are not specific to Tullimonstrum or extinction of this phylum.

23. (B)

(A) There is disagreement over the taxonomic classification of Problematica, but no indication that the two factions disagree about classification of other organisms.

(B) The first sentence of paragraph three says exactly what B indicates.

(C) Not only does the author make no such assertion or inference, but logic would suggest that debate furthers progress.

(D) Traditionalists might take this view, but the author does not give his opinion on the proper classification of Problematica.

24. (C)

(A), (B), and (D) are incorrect because the passage gives us no information about theories of plant evolution except to say that the phyla appeared more slowly than those of animals (paragraph three, lines 49-50). Given this lack of information, we cannot make any inferences about how different theorists would view natural selection in the plant world.

QUANTITATIVE ABILITY ANSWER KEY

- | | | |
|------|-------|-------|
| 1. D | 9. B | 17. D |
| 2. D | 10. C | 18. C |
| 3. D | 11. D | 19. B |
| 4. C | 12. D | 20. B |
| 5. B | 13. D | 21. B |
| 6. D | 14. A | 22. B |
| 7. D | 15. C | 23. B |
| 8. D | 16. D | 24. B |

QUANTITATIVE ABILITY ANSWERS AND EXPLANATIONS

1. (D)

To find the average of any group of consecutive numbers, simply add the smallest and largest number and divide by 2. Here, that gives you 15.5.

2. (D)

First, translate everything into powers of 2. Thus $4 = 2^2$, so $4^4 = (2^2)^4 = 2^8$ and $4^5 = (2^2)^5 = 2^{10}$.

So, $\frac{2^{21}}{4^4(4^4 + 4^5)} = \frac{2^{21}}{2^8(2^8 + 2^{10})}$. Now, $2^{21} = 2^8 2^{13}$, so you can cancel 2^8 from the numerator and denominator to get $\frac{2^{13}}{2^8 + 2^{10}}$. Cancelling out a power of 2^8 gives $\frac{2^5}{1 + 2^2} = \frac{2^5}{5}$.

3. (D)

Do not be concerned that you have not seen the term “factor-rich” before; the PCAT often makes up its own terms. These are always clearly defined, so do not panic if you see something unusual. Go through the answer choices one at a time, looking for the number that fits the definition. 6 has factors of 1, 2, 3, and 6. $1 + 2 + 3 = 6$, which is not greater than 6, so 6 is not factor-rich. 8 has factors of 1, 2, 4, and 8. $1 + 2 + 4 = 7$, which is less than 8, so 8 is not factor-rich. 9 has factors of 1, 3, and 9. $1 + 3 < 9$, so 9 is not factor-rich. 12 has factors of 1, 2, 3, 4, and 6. $1 + 2 + 3 + 4 + 6 = 16$, so 12 is factor-rich and, therefore, the correct answer.

4. (C)

If 6 men take public transportation, this means that the other 19 men drive to work. If 29 people drive to work, and 19 of them are men, this means that the other 10 people who drive to work are women.

5. (B)

This question asks you to pick numbers, which will make the math a whole lot easier. Say that 100 people were polled. Then, 80%, or 80 people, were registered voters. 75% of these, $\frac{3}{4}$, voted in the last election, so $\frac{1}{4}$ of them did not vote in the last election. $\frac{1}{4}$ of 80 is 20, so 20 of the 100 people polled were registered

voters who did not vote in the last election. As a fraction, that is $\frac{20}{100}$ or $\frac{1}{5}$.

6. (D)

$x = 2$, so $x^4 = (2)^4 = 2 \times 2 \times 2 \times 2 = 16$. $\frac{1}{y} = 2$, so $y = \frac{1}{2}$. In that case, $y^4 = \left(\frac{1}{2}\right)^4 = \left(\frac{1}{2}\right)^4 = \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} \times \frac{1}{2} = \frac{1}{16}$.

So the ratio of x^4 to $y^4 = \frac{16}{\frac{1}{16}} = 16 \times \frac{16}{1} = \frac{256}{1}$.

7. (D)

Let's go through the answer choices, trying to disprove each incorrect choice until we find a choice that must be true.

The first choice says that r is a prime number. If r is 9, then r is odd and not a prime number because $9 = 3 \times 3$. Discard this choice. The second choice says that r^2 is an even integer. If r is odd, then r^2 must be odd because an odd number multiplied by an odd number must always be odd. For example, if $r = 5$, which is odd, then $r^2 = 5^2 = 5 \times 5 = 25$, which is odd. Discard this choice.

The third choice says that rs is an odd integer. If r is odd and s is even, then rs must be even, because any integer multiplied by an even integer must result in an even integer. For example, if $r = 3$ and $s = 4$, then $rs = 3 \times 4 = 12$, which is even. Discard this choice.

At this point we have eliminated all three incorrect answer choices, so we know that the final choice must be correct. Just for the sake of discussion, let's look at this choice.

The final choice says that s is not a factor of r . If r is odd and s is even, then r does not contain a factor of 2, whereas s does contain a factor of 2; thus s cannot be a factor of r . For example, if $r = 27$ and $s = 4$, s is not a factor of r . We see that it must be true that s is not a factor of r .

8. (D)

Plug the numbers into the expression, and then use PEMDAS to calculate its value. If $x = 4$ and $y = 3$, then $2x^2 + (3y)^2 = 2(4)^2 + (3 \times 3)^2 = 2(4)^2 + (9)^2 = 2 \times 16 + 81 = 32 + 81 = 113$.

9. (B)

1 percent = $\frac{1}{100}$, so 0.3 percent = $\frac{0.3}{100}$. Next,
 0.3 percent of 3,000 = $\frac{0.3}{100} \times 3,000 = 0.3 \times 30 = 9$.

10. (C)

You can solve this by using a little logic. If $x + y = c + d$, and $x < c$, then for the equation to balance out, y must be greater than d . (For instance, if $x = 1$ and $c = 4$, then $1 + y = 4 + d$, or $y = d + 3$. That is, d is 3 less than y .) So, $y > d$.

11. (D)

First, break 192 down into its prime factorization, because from the prime factorization you can get every other possible factor. The prime factorization of 192 is: $3 \times 2 \times 2 \times 2 \times 2 \times 2 \times 2$. If we multiply 3 by 2, we get 6, so 6 is a factor of 192, which is also a multiple of 6. Furthermore, for every additional time we multiply $3 \times 2 = 6$ by 2 we get another divisor of 192, which is also a multiple of 6. So, the divisors of 192 that are also multiples of 6 are 6, 12, 24, 48, 96, and 192; thus there are 6 such factors.

12. (D)

If xy is negative, this means that either x is positive and y is negative or that x is negative and y is positive. Try to find numbers that will make the answer choices negative. If $x = 1$ and $y = -1$, then xy is negative and $y - x = -2$; thus answer choice **(A)** can be negative, and so you can discard it.

Similarly, if $x = -1$ and $y = 1$, then xy is negative and $x - y = -2$, so you can discard answer choice **(B)**. If $x = 1$ and $y = -1$, then xy is negative and $x^2y = -1$, so you can discard answer choice **(C)**.

This means that the final answer, choice **(D)**, must be correct. You can see that this is so if you think of what happens when you square any non-zero number. Any non-zero number squared is positive. Since $xy < 0$, $x \neq 0$ and $y \neq 0$, so x^2 and y^2 must be positive and x^2y^2 must also be positive.

13. (D)

If $f(x) \geq 0$, the area under the curve $y = f(x)$, $x = a$, $x = b$, and the x -axis is the definite integral $\int_a^b f(x)dx$ of the function describing the curve. Evaluate:

$$\begin{aligned} & \int_1^2 (-x^3 + 5x^2 + 4)dx \\ & \int_1^2 (-x^3 + 5x^2 + 4)dx = -\frac{x^4}{4} + 5\frac{x^3}{3} + 4\frac{x^1}{1} \Big|_1^2 \\ & = -\frac{1}{4}x^4 + \frac{5}{3}x^3 + 4x \Big|_1^2 \\ & = \left[-\frac{1}{4}(2^4) + \frac{5}{3}(2^3) + 4(2) \right] - \left[-\frac{1}{4}(1^4) + \frac{5}{3}(1) + 4(1) \right] \\ & \quad \left[-\frac{1}{4}(16) + \frac{5}{3}(8) + 8 \right] - \left[-\frac{1}{4}(1) + \frac{5}{3}(1) + 4 \right] \\ & = \left[-4 + \frac{40}{3} + 8 \right] - \left[-\frac{1}{4} + \frac{5}{3} + 4 \right] = \left[\frac{52}{3} \right] - \left[\frac{65}{12} \right] \\ & = \frac{208}{12} - \frac{65}{12} = \frac{143}{12} \end{aligned}$$

14. (A)

As x approaches -3 from the left, $f(x)$ is equal to $3x + 4$. You can simply plug in $x = -3$:

$$\lim_{x \rightarrow -3^-} f(x) = 3(-3) + 4 = -5.$$

So expression I is equal to -5 . Option I will be part of the correct answer.

As x approaches -3 from the right, $f(x)$ is equal to $2x + 2$. Plug in $x = -3$:

$$\lim_{x \rightarrow -3^+} f(x) = 2(-3) + 2 = -6 + 2 = -4.$$

Expression II does not equal -5 . In order for a limit to exist at a point, the right-side and left-side limits must both exist and have the same value. Since they do not, expression III does not equal -5 .

15. (C)

The slope of a function is given by the derivative of the function. Find the derivative of the function then plug in $x = 2$. To find the derivative, use the chain rule, but first rewrite the function:

$$\begin{aligned} f(x) &= \frac{1}{x+3} = (x+3)^{-1} \\ f'(x) &= -1(x+3)^{-2} = \frac{-1}{(x+3)^2} \end{aligned}$$

Now plug in $x = 2$:

$$f'(2) = \frac{-1}{(2+3)^2} = \frac{-1}{(5)^2} = -\frac{1}{25}.$$

16. (D)

Since $f(x) \geq 0$ for $1 \leq x \leq 3$, find the definite integral of the function from $x = 1$ to $x = 3$:

$$\begin{aligned}\int_1^3 \frac{1}{2x^2} dx &= \int_1^3 \frac{1}{2} x^{-2} dx = -\frac{1}{2} x^{-1} \Big|_1^3 = -\frac{1}{2x} \Big|_1^3 \\ &= -\frac{1}{6} - \left(-\frac{1}{2}\right) = -\frac{1}{6} + \frac{3}{6} = \frac{2}{6} = \frac{1}{3}.\end{aligned}$$

17. (D)

To determine which function increases fastest, you need to look at the derivative of each of the functions. The derivative gives the slope of the function, which describes how fast the function increases. Look at each choice:

For choice **(A)**, factor the numerator first to make the calculation easier:

$$\frac{x^2 + 2x + 1}{x + 1} = \frac{(x + 1)^2}{x + 1} = x + 1.$$

The derivative of this function is 1.

For choice **(B)**, the derivative is $3x^2$.

For choice **(C)**:

$$f(x) = \frac{1}{(x + 2)^2} = (x + 2)^{-2}, \text{ so}$$

$$f'(x) = -2(x + 2)^{-3} = \frac{-2}{(x + 2)^3}.$$

For choice **(D)**, the derivative is:

$$f'(x) = 2(x^3 + 2)^1(3x^2) = 6x^2(x^3 + 2) = 6x^5 + 12x^2.$$

$6x^5 + 12x^2$ is larger than all the other functions as x gets very large. This is the correct answer.

18. (C)

Calculate the indefinite integral of $f'(x)$:

$$\begin{aligned}f(x) &= \int f'(x) dx = \int (1 + e^{2x}) dx \\ &= \int 1 dx + \int e^{2x} dx \\ &= \int 1 dx + \frac{1}{2} \int e^{2x} 2 dx \\ &= x + \frac{1}{2} e^{2x} + C\end{aligned}$$

Since we do not have any more information, we cannot determine the value of C . However, this is all you need to know to pick the correct answer. Choice **(C)** correctly has $x + \frac{1}{2}e^{2x}$ plus a constant term of 3.

19. (B)

A simple and straightforward fractions problem. Every 8 pounds of the alloy contains 6 pounds of copper and 2 pounds of tin, so tin represents $\frac{2}{8}$ or $\frac{1}{4}$ of the alloy.

If 200 pounds of the alloy are made, $\frac{1}{4} \times 200 = 50$ pounds of tin are required.

20. B

Note that simple substitution cannot be applied here because the denominator would then equal 0. However, because the numerator would also equal 0 on simple substitution, we must factor both numerator and denominator of the expression to see if some cancellation can take place.

$$\frac{x^2 + 2x - 35}{x^2 - 25} = \frac{(x - 5)(x + 7)}{(x - 5)(x + 5)} = \frac{x + 7}{x + 5}$$

With the factors of now removed from both numerator and denominator, we can now apply simple substitution to obtain the limit:

$$\begin{aligned}\lim_{x \rightarrow 5} \frac{x^2 + 2x - 35}{x^2 - 25} &= \lim_{x \rightarrow 5} \frac{x + 7}{x + 5} \\ &= \frac{5 + 7}{5 + 5} \\ &= \frac{12}{10} \\ &= \frac{6}{5}\end{aligned}$$

21. B

You are given an expression that tells you that a function is continuous at a given point, and that the limit of the function at that point is L . Since the expression has two pieces, you can break it down and analyze each part separately. The part about continuity is intuitive: If the function is continuous at $x = a$, then it will look continuous there. So, you can eliminate (D). You might notice as you are perusing the answer choices, that some of them have $x = a$ appearing along the x -axis, while others have $y = a$ along the y -axis. Those latter choices can't be right! So you can eliminate (C) as well. Of the remaining two choices, (A) shows a function whose limit is L as x tends to infinity, while (B) correctly illustrates the limit as x tends to a .

Examine the answer choices before trying to solve the problem, and eliminate those which are obviously incorrect.

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22. (B)

You can solve this question by simplifying the expression:

$$\begin{aligned}i\sqrt{-50} + i^2\sqrt{-49} + i^3\sqrt{-48} \\&= i\sqrt{-(25)(2)} + i^2\sqrt{-49} + i^3\sqrt{-(16)(3)} \\&= i(5i)\sqrt{2} + i^2(7i) + i^3(4i)\sqrt{3} \\&= 5i^2\sqrt{2} + 7i^3 + 4i^4\sqrt{3} \\&= -5\sqrt{2} - 7i + 4\sqrt{3}\end{aligned}$$

23. (B)

To solve this question, one needs to use the following trigonometric identities to simplify the equation:

$$\sec(x) = \frac{1}{\cos(x)}, \csc(x) = \frac{1}{\sin(x)} \text{ and}$$

$$\tan(x) = \frac{\sin(x)}{\cos(x)}.$$

$$\begin{aligned}\frac{\sec(x)}{\tan(x)\sin(x)} &= \frac{\frac{1}{\cos(x)}}{\frac{\sin(x)}{\cos(x)}\sin(x)} = \frac{\frac{1}{\cos(x)}}{\frac{\sin^2(x)}{\cos(x)}} \\&= \frac{1}{\sin^2(x)} = \csc^2(x)\end{aligned}$$

24. (B)

If $\arcsin(0.64) = 40$, then $\sin(40) = 0.64$. If $\arccos(0.77) = 40$, then $\cos(40) = 0.77$. Therefore:

$$\cot(40) = \frac{\cos(40)}{\sin(40)} = \frac{0.77}{0.64} = 1.20$$



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