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Topic Break Down

Topic	No. of Questions
Topic 1, Survey of the Natural Sciences	157
Topic 2, Physics	70
Topic 3, Reading Comprehension	18
Topic 4, Quantitative Reasoning	48
Total	293

QUESTION NO: 1

Jellyfish possess what type of circulatory system?

A. Closed circulatory system

B. Open circulatory system

C. Dorsal vessel

D. Double circulatory system

E. It has no circulatory system

ANSWER: E

Explanation:

It has no circulatory system is correct. Jellyfish are cnidarians, animals with a relatively simple body plan consisting mainly of two thin tissue layers separated by a gelatinous mesoglea. They do not have a heart, blood, blood vessels, or a specialized system for transporting oxygen, nutrients, and wastes. Instead, because their tissues are thin and most cells are close to either the surrounding water or the internal gastrovascular cavity, materials move primarily by diffusion. The gastrovascular cavity also distributes partially digested nutrients through the animal's body and serves digestive functions. Water movement and the jellyfish's body motions can help exchange materials, but this does not constitute a circulatory system. This arrangement is sufficient because jellyfish have a high surface-area-to-volume relationship and comparatively low metabolic demands. In contrast, more complex animals require specialized circulatory structures to move substances efficiently across greater internal distances. For an overview of cnidarian body organization and the gastrovascular cavity, see UC Museum of Paleontology: Cnidaria. Additional zoological context is available from OpenStax Biology: Phyla Cnidaria and Ctenophora.

QUESTION NO: 2

Which of the following arises from the mesoderm?

A. Pancreas

B. Lining of digestive system

C. Skin

D. Skeletal muscles

E. Nervous system

ANSWER: D

Explanation:

Skeletal muscles arise from the mesoderm, specifically the paraxial mesoderm. During early embryonic development, paraxial mesoderm segments into somites. Cells from the myotome portion of each somite differentiate into skeletal muscle precursors, which migrate and mature to form voluntary muscles of the trunk, limbs, and much of the head and neck. This germ-layer origin is a core developmental-biology principle: mesoderm broadly forms musculoskeletal tissues, including muscle and bone, as well as connective tissues and components of the cardiovascular and urogenital systems. Skeletal muscle is recognized histologically by its long, multinucleated fibers and is responsible for voluntary movement, posture, and heat generation. The developmental connection between somites and skeletal musculature also helps explain the segmental organization of many muscles and their associated spinal nerves. For a concise overview of embryonic germ-layer derivatives, see StatPearls: Embryology, Germ Layers. Additional detail on somite formation and differentiation is available from UNSW Embryology: Somite Development.

QUESTION NO: 3

Two guys are sitting on a playground Merry-Go-Round. Which of the following statements is correct?



A. Guy 1 will make a full circle before Guy 2.

B. Guy 1 will travel at a higher velocity.

C. Guy 1 and Guy 2 will travel at equal velocity.

D. Guy 2 will travel at higher velocity.

E. Guy 2 will make a full circle before Guy 1.

ANSWER: D

Explanation:

Guy 2 will travel at higher velocity. A merry-go-round rotates as a rigid body, so every rider shares the same angular displacement during any time interval and therefore has the same angular velocity and period. In particular, both riders complete each revolution at the same time. Their linear, or tangential, velocities are not necessarily equal, however. Tangential speed depends on distance from the axis of rotation according to $v = r\omega$, where r is the rider's distance from the center and ω is the common angular velocity. The diagram places Guy 2 farther from the center than Guy 1, so Guy 2 has the larger radius. Since both radii rotate with the same angular velocity, the larger radius corresponds directly to a greater tangential speed. Physically, during one full revolution Guy 2 follows a longer circular path—its circumference is larger—while taking the same amount of time as Guy 1. Dividing that greater distance by the same time gives Guy 2 a higher velocity magnitude. This distinction between shared angular motion and radius-dependent tangential motion is a central idea in rotational kinematics. See OpenStax Physics: Rotational Variables and OpenStax College Physics: Kinematics of Rotational Motion.

QUESTION NO: 4

A lead sphere 10 centimeters in diameter is attached to a 10-meter wire and suspended from a beam in a large warehouse. A lead sphere 1 meter in diameter is hung next to the smaller sphere, almost touching. Ignoring friction, which statement is true?

A. The small sphere will move slightly towards the big sphere, but the big sphere will not move.

B. The big sphere will move slightly toward the small sphere, but the small sphere will not move.

C. Neither sphere will move.

D. Both spheres will move slightly towards each other.

ANSWER: D

Explanation:

Both spheres will move slightly towards each other.

is correct because every object with mass produces a gravitational field and attracts every other mass. The magnitude of the mutual attraction is described by Newton's law of universal gravitation: $F = Gm_1m_2/r^2$, where the force depends on the two

masses and the distance between their centers. Since the spheres are close together and made of lead, each exerts a small horizontal gravitational pull on the other.

By Newton's third law, the gravitational force exerted by one sphere on the other is equal in magnitude and opposite in direction to the force exerted back on it. Thus, neither sphere is exempt from the interaction. Each suspended sphere experiences a horizontal component of force toward the other, causing its wire to deflect slightly from vertical and allowing the sphere to move inward. Their accelerations need not be equal because acceleration also depends on mass through Newton's second law, but both objects respond to the same mutual gravitational interaction. In the absence of friction or damping, this attraction produces motion toward one another. See NASA's overview of Newton's laws of motion and Encyclopaedia Britannica's description of Newton's law of gravitation.

QUESTION NO: 5

Which of the following is NOT a natural dispersal process that would lead to species colonization on an island?

A. Mussels carried into a lake on the hull of a ship

B. Drought connecting an island to other land

C. Floating seeds

D. Animals swimming long distances

E. Birds adapted to flying long distances

ANSWER: A

Explanation:

Mussels carried into a lake on the hull of a ship is the correct answer because attachment to a ship hull is a form of human-mediated transport rather than a natural mechanism of dispersal. Organisms that travel this way are moved beyond the geographic limits they could ordinarily reach through their own movement or environmental processes. Hull fouling is a well-recognized pathway by which aquatic species, including mussels and other sessile organisms, are introduced into new waters when vessels move between locations. Once released or detached in a suitable habitat, these organisms may establish a new population, but their arrival resulted from shipping activity rather than natural colonization.

Natural colonization occurs when organisms reach new habitats through processes operating without deliberate or incidental human transport. Such processes can include movement through water, flight, swimming, or temporary changes in land connections. In contrast, vessel hulls provide an artificial mobile surface that can carry attached organisms across otherwise substantial barriers. The U.S. National Oceanic and Atmospheric Administration identifies biofouling on vessel hulls as an important vector for the spread of non-native marine species. The U.S. Environmental Protection Agency likewise describes hull fouling as a pathway for aquatic invasive species. See NOAA Ocean Service: invasive species and EPA: ballast water and hull fouling.

QUESTION NO: 6

Which of the following is an example of keto-enol tautomerism? A.

B.

C.

D.

E. B & C

Answer: E

Explanation:

Keto-enol tautomerism is the equilibrium between a keto form and an enol form (alcohol) of a chemical. In this scenario, both answer choices B and C are applicable keto-enol tautomers, although the frequency of one form compared to another may be shifted.

A. B & C

ANSWER: A

Explanation:

B & C is correct because the supplied question explanation identifies both referenced structures as keto-enol tautomeric systems. Keto-enol tautomerism is a dynamic constitutional-isomer equilibrium in which a proton changes position while a carbonyl π bond is reorganized to give an alkene bearing a hydroxyl group. The keto member contains a carbonyl group, C=O, whereas the enol member contains a C=C bond and an –OH group attached to one of the alkene carbons. These forms interconvert through proton transfer and electron redistribution, commonly under acid- or base-catalyzed conditions. The relative amount of each tautomer depends on structural factors such as carbonyl stability, alkene substitution, conjugation, aromaticity, and intramolecular hydrogen bonding; therefore, one member may be present only in a small amount without ceasing to be a valid tautomer. Since both B and C meet the stated keto/enol relationship, the combined response is the single correct selection. See the IUPAC Gold Book definition of tautomerism and Chemistry LibreTexts' discussion of keto-enol tautomerism.

QUESTION NO: 7

What corresponds to the amplitude of a sound wave?

A. loudness

B. pressure differential of fluctuations

C. magnitude of motion of air molecules

D. power

ANSWER: B

Explanation:

The correct answer is **pressure differential of fluctuations**. Sound traveling through air is a longitudinal pressure wave: air molecules oscillate about their equilibrium positions and create alternating compressions, where pressure is higher than ambient, and rarefactions, where pressure is lower than ambient. The acoustic amplitude can be expressed as the greatest pressure departure from the equilibrium (ambient) pressure. Equivalently, if the pressure difference between a compression peak and a rarefaction trough is described, the amplitude is one-half of that peak-to-peak pressure difference.

This pressure variation is a physically meaningful measure of the strength of the sound wave at a location. A larger pressure amplitude represents a stronger acoustic disturbance and is associated with greater sound intensity. For a plane progressive sound wave, intensity is proportional to the square of the pressure amplitude, which is why changes in pressure amplitude have an important effect on the sound's measurable energy and perceived level. The National Institute of Standards and Technology describes sound pressure as the fluctuating pressure superimposed on static atmospheric pressure, while OpenStax explains the relation between sound-wave pressure variations and wave intensity. See NIST's acoustics and SI-units guidance and OpenStax: Sound Intensity and Sound Level.

QUESTION NO: 8

A 3 kg object is accelerated by a net force of 15 N. What is the acceleration of the object?

A. 0.2 m/s^2

B. 3 m/s^2

C. 5 m/s^2

D. 12 m/s^2

E. 45 m/s^2

ANSWER: C

Explanation:

5 m/s^2 is correct. Newton's second law states that the net force on an object equals its mass times its acceleration: $F = ma$. Solving for acceleration gives $a = F/m$.

Substituting the values gives $a = 15\ N/3\ kg = 5\ m/s^2$. The net force, rather than any individual force acting on the object, determines its acceleration. See OpenStax: Newton's Laws of Motion.

QUESTION NO: 9

A white rabbit mates with a black rabbit, resulting in a mix of black and white offspring. This is an example of:

A. Epistasis

B. Incomplete Dominance

C. Complete Dominance

D. Co-dominance

E. Pleiotropy

ANSWER: D

Explanation:

Co-dominance is correct because it describes inheritance in which both alleles are fully and distinctly expressed in the phenotype of a heterozygous offspring. In the stated example, black and white coat characteristics appear together rather than blending into a single intermediate coat color. Thus, the offspring display both parental traits at the same time, such as visibly black and white fur patches or hairs. This pattern is the defining feature of codominance: neither allele masks the other, and neither trait is diluted into an intermediate appearance. The question's contrast between a mixture of black and white traits and a blended gray phenotype is important; a gray intermediate phenotype would instead reflect partial expression of each allele. Codominant expression is commonly illustrated by phenotypes in which two distinguishable trait forms are simultaneously observable in one individual. For additional background on non-Mendelian inheritance patterns, see OpenStax Biology 2e: Laws of Inheritance and NHGRI: Codominance.

QUESTION NO: 10

With a standard deck, what are the odds of drawing a 8 of hearts followed by a 2 of diamonds, without replacement?

A. 1/2652

B. 1/2704

C. 1/50

D. 1/3042

E. 1/1064

ANSWER: A

Explanation:

The correct answer is **1/2652**. A standard deck contains 52 distinct cards, including exactly one 8 of hearts and exactly one 2 of diamonds. Because the question specifies an ordered sequence—first drawing the 8 of hearts and then drawing the 2 of diamonds—the probability of the first draw must be multiplied by the conditional probability of the second draw. The probability that the first card is the 8 of hearts is 1/52. Since that card is not replaced, 51 cards remain in the deck, and the 2 of diamonds is still among them. Therefore, the probability that the next card is the 2 of diamonds is 1/51. Multiplying these dependent probabilities gives (1/52) × (1/51) = 1/2652. This is an application of the multiplication rule for sequential events without replacement: multiply the probability of the first event by the probability of the next event given that the first event has occurred. For a review of multiplication rules and conditional probability, see OpenStax Introductory Statistics and Khan Academy's dependent probability lesson.

QUESTION NO: 11

A store has a series of sales. In August, all items are reduced to 50%. In September, all items are reduced an additional 30%. If an item was $140 back in July, how much would the item be in September?

A. $49

B. $70

C. $35

D. $30

E. $77

ANSWER: A

Explanation:

$49 is correct because the two discounts are applied sequentially, with the September discount calculated from the already reduced August price rather than from the original July price. A reduction to 50% means the customer pays 50% of the original $140 price: $140 × 0.50 = $70. The additional 30% September reduction is then taken from $70. The discount amount is $70 × 0.30 = $21, leaving $70 − $21 = $49. Equivalently, after the first sale the item retains a factor of 0.50, and after the next sale it retains 70% of that reduced amount, or a factor of 0.70. Thus, the final price is $140 × 0.50 × 0.70 = $49. This reflects the standard percent-change rule that successive percentage discounts are multiplicative: each new percentage is based on the current price. For additional practice with percent calculations and discounts, see Khan Academy's percentage review and OpenStax's percent-application lesson.

QUESTION NO: 12

What is the average of: 15, 25%, 1/2 and sin0?

A. 3.02

B. 3.94

C. 4.20

D. 4.64

E. 5.21

ANSWER: B

Explanation:

The correct answer is **3.94**. To compute an average, first express every quantity in the same numerical form, add the values, and divide the total by the number of values. Here, 25% equals 0.25, 1/2 equals 0.5, and sin 0 equals 0 because the sine of an angle of zero is zero. The four values are therefore 15, 0.25, 0.5, and 0. Their sum is 15.75. Since there are four numbers, the mean is 15.75 ÷ 4, which equals 3.9375. Rounded to the nearest hundredth, this is 3.94. This problem tests efficient conversion among percentages, fractions, and trigonometric values before applying the arithmetic-mean formula.

The general procedure for finding a mean is to divide the sum of the observations by the number of observations, as described in OpenStax Introductory Statistics. The unit-circle trigonometric value sin(0) = 0 is also summarized by this trigonometric-functions reference.

QUESTION NO: 13

How much do you save on a purchase of $47.00 if you shop in a store on a day in which the promotion is that the store will pay the sales tax (and sales tax is 8%)?

A. $2.76

B. $0.37

C. $3.76

D. $4.76

ANSWER: C

Explanation:

The correct answer is **$3.76**. When a store pays the sales tax, the customer saves the amount of tax that would otherwise be added to the purchase price. Sales tax is calculated by multiplying the pre-tax purchase price by the tax rate expressed as a decimal. Here, 8% is equivalent to 0.08, so the tax on a $47.00 purchase is calculated as $47.00 × 0.08 = $3.76. Therefore, the promotion saves the shopper $3.76, and the store effectively covers that amount of tax. The purchase price is the tax base because the question gives $47.00 as the price of the item before the sales tax would be charged. This is a standard percent calculation: convert the percentage to a decimal and multiply it by the original amount. For additional guidance on calculating a percentage of a number, see Khan Academy's percentage example. The Internal Revenue Service also distinguishes sales tax from an item's purchase price in its Sales Tax guidance.

QUESTION NO: 14

If 500 mL of 0.5M HBr is diluted to 0.4M HBr, what is the final volume?

A. (500) (0.4 / 0.5)

B. (500) (0.5 / 0.4)

C. (0.5 / 500) (0.4)

D. (500) (0.20)

E. (500 − 0.4) (0.5)

ANSWER: B

Explanation:

The correct calculation is **(500) (0.5 / 0.4)**, which gives a final volume of **625 mL**. Dilution changes the solution's volume and concentration, but it does not change the number of moles of dissolved HBr, provided no solute is added, removed, or reacts. Therefore, the dilution relationship is $M_1V_1 = M_2V_2$. Substituting the given values gives (0.5 mol/L)(500 mL) = (0.4 mol/L)(V_2). Solving for V_2 requires dividing by the final concentration: V_2 = 500 mL × (0.5/0.4) = 625 mL. The final volume is larger than the initial 500 mL because water was added to lower the HBr concentration from 0.5 M to 0.4 M. The calculation may use milliliters on both sides because the volume units cancel in the concentration ratio; the resulting volume remains in milliliters. This is the standard molarity-dilution method described in LibreTexts' molarity guidance and its discussion of dilutions.

QUESTION NO: 15

A 2.0 m long pendulum is moved to a location where gravitational acceleration is smaller. What happens to its period?

A. The period decreases.

B. The period increases.

C. The period remains the same.

D. The period becomes zero.

E. There is not enough information.

ANSWER: B

Explanation:

The correct answer is **The period increases.** For a simple pendulum undergoing small oscillations, the period is given by $T = 2\pi\sqrt{(L/g)}$. The pendulum length L remains constant, but a smaller gravitational acceleration g makes the quantity L/g larger. Therefore, the period becomes longer.

Physically, weaker gravity provides a smaller restoring force, so the pendulum swings back and forth more slowly. The mass of the pendulum bob does not affect the ideal simple-pendulum period. See OpenStax: Pendulums.

QUESTION NO: 16

A circuit contains a 2Ω and a 5Ω resistor, connected in parallel to each other. What is the equivalent resistance in this circuit?

A. 7Ω

B. 10Ω

C. 0.7Ω

D. 10/7Ω

E. 5/2Ω

ANSWER: D

Explanation:

The equivalent resistance is **10/7Ω**, or approximately 1.43Ω. For two resistors connected in parallel, the reciprocal of the equivalent resistance equals the sum of their reciprocal resistances: $1/R_{eq} = 1/R_1 + 1/R_2$. Substituting the resistor values gives $1/R_{eq} = 1/2 + 1/5$. Using a common denominator of 10, this becomes 5/10 + 2/10 = 7/10. Therefore, $1/R_{eq} = 7/10$, and taking the reciprocal yields $R_{eq} = 10/7\Omega$. This result is physically consistent with a parallel circuit: adding another conducting branch provides an additional path for charge flow, so the total resistance must be less than the smallest individual branch resistance, which here is 2Ω. The general relationship for resistors in parallel and its reciprocal-resistance calculation are described by OpenStax College Physics: Resistors in Series and Parallel. A concise formula reference is also available from All About Circuits: Series Versus Parallel Circuits.

QUESTION NO: 17

A circle is stretched out and its circumference is increased by 10%. What is the percent increase of the area of that circle?

A. 10%

B. 16%

C. 21%

D. 25%

E. 30%

ANSWER: C

Explanation:

The correct answer is **21%**. A circle's circumference is given by $C = 2\pi r$, so circumference changes in direct proportion to the radius. Therefore, increasing the circumference by 10% multiplies the radius by 1.10. The area is given by $A = \pi r^2$, meaning that area depends on the square of the radius. Consequently, the new area is multiplied by $(1.10)^2 = 1.21$. This represents an area equal to 121% of its original value, so the increase is 121% − 100% = 21%.

For example, if the original radius were 10 units, a 10% circumference increase would correspond to a new radius of 11 units. The original area would be 100π square units and the new area would be 121π square units. The difference, 21π, is 21% of the original 100π. This uses the standard circle circumference and area relationships described by Khan Academy and summarized by Wolfram MathWorld.

QUESTION NO: 18

It is most likely that you have never had diphtheria. You probably don't even know anyone who has suffered from this disease. In fact, you may not even know what diphtheria is. Similarly, diseases like whooping cough, measles, mumps, and rubella may all be unfamiliar to you. In the nineteenth and early twentieth centuries, these illnesses struck hundreds of thousands of people in the United States each year, mostly children, and tens of thousands of people died. The names of these diseases were frightening household words. Today, they are all but forgotten. That change happened largely because of vaccines.

You probably have been vaccinated against diphtheria. You may even have been exposed to the bacterium that causes it, but the vaccine prepared your body to fight off the disease so quickly that you were unaware of the infection. Vaccines take advantage of your body's natural ability to learn how to combat many disease-causing germs, or microbes. What's more, your body remembers how to protect itself from the microbes it has encountered before. Collectively, the parts of your body that remember and repel microbes are called the immune system. Without the proper functioning of the immune system, the simplest illness – even the common cold – could quickly turn deadly.

On average, your immune system needs more than a week to learn how to fight off an unfamiliar microbe. Sometimes, that isn't enough time. Strong microbes can spread through your body faster than the immune system can fend them off. Your body often gains the upper hand after a few weeks, but in the meantime you are sick. Certain microbes are so virulent that they can overwhelm or escape your natural defenses. In those situations, vaccines can make all the difference.

Traditional vaccines contain either parts of microbes or whole microbes that have been altered so that they don't cause disease. When your immune system confronts these harmless versions of the germs, it quickly clears them from your body. In other words, vaccines trick your immune system in order to teach your body important lessons about how to defeat its opponents.

What is the main idea of the passage?

A. The nineteenth and early twentieth centuries were a dark period for medicine.

B. You have probably never had diphtheria.

C. Traditional vaccines contain altered microbes.

D. Vaccines help the immune system function properly.

ANSWER: D

Explanation:

"Vaccines help the immune system function properly." is the best overall summary because the passage consistently explains vaccination as a way of preparing the body's immune defenses before exposure to a dangerous microbe. The author begins by connecting vaccines with the dramatic reduction of once-common diseases, then explains the underlying process: the immune system normally needs time to recognize an unfamiliar germ and develop an effective response. That

delay can allow a serious infection to cause illness or become overwhelming. Vaccines provide a safe advance encounter with a microbe or with components of it, enabling the immune system to recognize the threat and respond rapidly later. Thus, the central message is not merely that vaccines contain altered microbes, but that they use the immune system's capacity for learning and memory to protect people from disease. This account aligns with the Centers for Disease Control and Prevention's explanation that vaccines stimulate an immune response and create immune memory without causing the disease: CDC: Explaining How Vaccines Work. The World Health Organization likewise describes vaccination as training the immune system to recognize and fight pathogens: WHO: How Do Vaccines Work?.

QUESTION NO: 19

You are interested in extracting a specific carboxylic acid only in a mixture containing amines, ketones and phenols. Which of the following can be used to accomplish this?

A. NaOH

B. HCl

C. NaHCO3

D. H2O

E. A & C

ANSWER: C

Explanation:

NaHCO3 is correct because aqueous sodium bicarbonate provides a mild base that selectively converts a carboxylic acid into its water-soluble sodium carboxylate salt. Carboxylic acids typically have pKa values around 4–5, whereas bicarbonate is sufficiently basic to deprotonate them. The ionic carboxylate preferentially partitions into the aqueous layer during a liquid–liquid extraction, while the neutral amines, ketones, and ordinary phenols remain primarily in the organic layer under these basic conditions. This selectivity is especially useful because phenols are substantially less acidic than typical carboxylic acids, commonly having pKa values near 10; bicarbonate therefore does not appreciably convert a typical phenol to a water-soluble phenoxide. After separation of the aqueous layer, acidification regenerates the neutral carboxylic acid, allowing it to be isolated. This acid–base extraction principle is described in LibreTexts' acid-base extraction guide and is consistent with the acidity data summarized by OpenStax Organic Chemistry.

QUESTION NO: 20

Which of the following bonds requires the highest energy to denature in DNA?

A. Adenine – Thymine

B. Guanine – Adenine

C. Cytosine – Guanine

D. Adenine – Uracil

E. All require equal strength

ANSWER: C

Explanation:

Cytosine – Guanine is correct because a guanine–cytosine base pair in standard double-stranded DNA is held together by three hydrogen bonds. Specifically, guanine and cytosine have complementary donor and acceptor positions that permit three hydrogen-bonding interactions across the two DNA strands. Separating this pair therefore requires disruption of three such interactions, whereas an adenine–thymine base pair contains two hydrogen bonds. In the conventional comparison of DNA base-pair hydrogen bonding used in introductory biology and admissions-test questions, guanine–cytosine pairs consequently require more energy to separate and contribute to greater DNA duplex stability. DNA regions with a larger

proportion of guanine–cytosine base pairs generally have higher melting temperatures than regions with less GC content, although real DNA melting behavior is also influenced by neighboring-base stacking interactions, salt concentration, and strand length. The fundamental base-pairing pattern and hydrogen-bond counts are described by the NCBI Bookshelf overview of DNA structure. A discussion of how base composition affects duplex melting temperature is available from Molecular Biology of the Cell via NCBI Bookshelf.

QUESTION NO: 21

A lens forms an upright image 19 cm from a lens of an object 49 cm from the lens. The object and image are on the same side of the lens. What is the magnification of the image?

A. 0.39

B. 2.6

C. 13.7

D. 31.2

ANSWER: A

Explanation:

The correct magnification is 0.39. Lateral magnification for a thin lens is calculated using the signed-distance relationship $m = -d_i/d_o$. The object is 49 cm from the lens, so its object distance is positive: $d_o = +49\ cm$. Because the image is upright and located on the same side of the lens as the object, it is a virtual image; therefore, its signed image distance is negative: $d_i = -19\ cm$. Substitution gives $m = -(-19\ cm)/(49\ cm) = 19/49 = 0.3878...$, which rounds to 0.39.

The positive sign is physically meaningful: positive magnification denotes an upright image. Its magnitude, less than 1, shows that the image is reduced relative to the object, consistent with an upright virtual image formed by a diverging lens or by a converging lens when the object is inside the focal length. The distances must be used with their signs rather than simply treated as unsigned lengths; doing so preserves the image orientation specified in the question. See OpenStax's discussion of the thin-lens and magnification equations and the sign conventions summarized by LibreTexts.

QUESTION NO: 22

A 120 Hz sound wave travels through air at 360 m/s. What is the wavelength of the sound wave?

A. 0.33 m

B. 3 m

C. 120 m

D. 240 m

E. 43,200 m

ANSWER: B

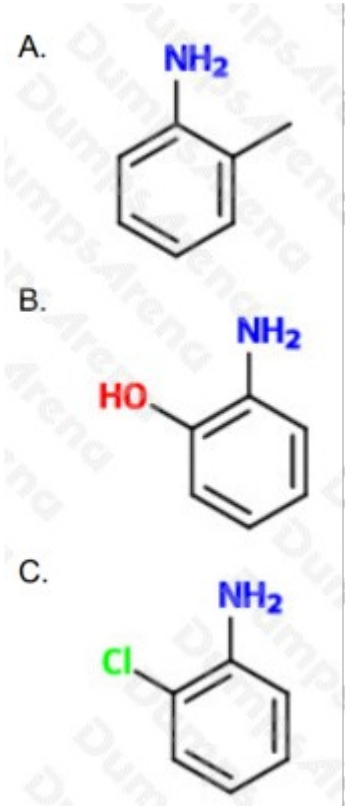
Explanation:

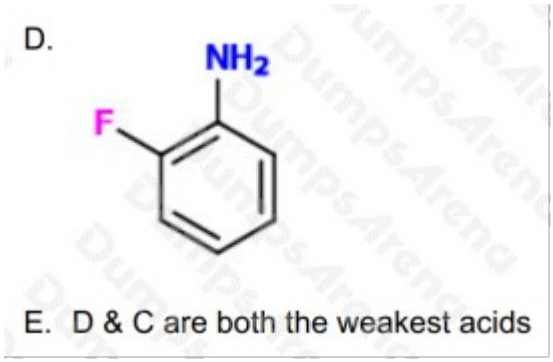
The correct answer is **3 m**. Wave speed is related to frequency and wavelength by v = fλ. Solving for wavelength gives λ = v/f. Substitution gives λ = 360 m/s ÷ 120 Hz = 3 m.

Frequency in hertz is equivalent to cycles per second, so the seconds cancel appropriately in the calculation. A higher-frequency sound traveling at the same speed would have a shorter wavelength. See OpenStax: Mathematics of Waves.

QUESTION NO: 23

Which of the following compounds is the weakest acid?





A. Option A

B. Option B

C. Option C

D. Option D

E. Option E

ANSWER: B

Explanation:

The structure shown as **Option B** is the weakest acid because its electron-donating substituent increases electron density at the aromatic amine nitrogen. Acid strength is assessed by the stability of the conjugate base: a weaker acid has a less-stabilized conjugate base. For an aromatic amine, removal of a proton from the nitrogen-containing conjugate acid regenerates the neutral amine; thus, a substituent that makes the nitrogen lone pair more available also makes the amine more basic and its conjugate acid less willing to donate a proton. Hydroxyl substitution donates electron density strongly through resonance when appropriately positioned on the benzene ring. This resonance donation raises the electron density available to the nitrogen-containing system and favors the protonated form relative to deprotonation. Consequently, the

corresponding ammonium species has the lowest acidity, equivalently the highest pKa, among the displayed compounds. The relationship between basicity and the acidity of a conjugate acid follows directly from conjugate acid–base equilibria: stronger bases have weaker conjugate acids. Resonance and inductive effects of aromatic substituents are discussed in LibreTexts' discussion of amine basicity and in OpenStax Organic Chemistry.

QUESTION NO: 24

Which of the following paracrine signaling molecules increases gastric acid production in the stomach?

A. Somatostatin

B. Prostaglandins

C. Histamine

D. GIP

E. None of the above

ANSWER: C

Explanation:

Histamine is correct because it is the key local (paracrine) mediator that stimulates gastric acid secretion. Enterochromaffin-like cells in the gastric mucosa release histamine near parietal cells. Histamine then binds histamine H2 receptors on the parietal cells, activating intracellular signaling that increases activity of the H+/K+-ATPase proton pump. This pump secretes hydrogen ions into the stomach lumen, producing hydrochloric acid. Histamine also works synergistically with acetylcholine from vagal stimulation and gastrin from G cells, allowing strong acid secretion in response to feeding. The clinical relevance of this pathway is demonstrated by H2-receptor antagonists, which reduce gastric acid production by blocking histamine's stimulatory action at parietal cells. For a review of the cellular mechanisms regulating acid secretion, see the NCBI Bookshelf discussion of gastric acid secretion. The physiological role of histamine H2 receptors in acid secretion is also summarized in StatPearls: Histamine H2-Receptor Antagonists.

QUESTION NO: 25

Which of the following are not part of Huckel's criteria for aromaticity?

A. Be cyclic.

B. Have one 2p orbital on each atom of the ring.

C. Be planar.

D. (4n+2)π electrons

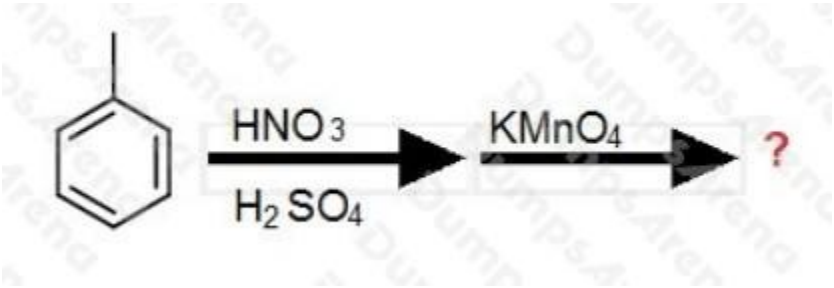
E. All of the above are part of Huckel's criteria.

ANSWER: E

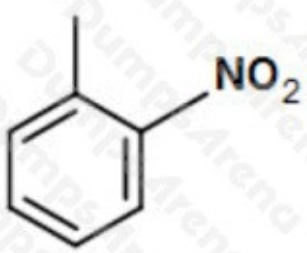
Explanation:

All of the above are part of Huckel's criteria. For a molecule to be aromatic, it must form a cyclic ring and be sufficiently planar for the relevant unhybridized p orbitals to overlap continuously around that ring. The requirement to have one 2p orbital on each atom of the ring describes this continuous conjugation: each participating ring atom supplies a p orbital, allowing π electrons to be delocalized over the entire cyclic system. Finally, Hückel's electron-counting rule requires a planar, cyclic, fully conjugated π system to contain 4n + 2 π electrons, where n is a nonnegative integer. These structural and electron-count requirements work together; aromaticity is not determined by electron count alone. Thus, cyclicity, planarity, continuous p-orbital overlap, and a 4n + 2 π-electron count are all included in the standard criteria used to identify aromatic systems. See the IUPAC Gold Book definition of aromaticity and this Hückel's rule overview from Chemistry LibreTexts.

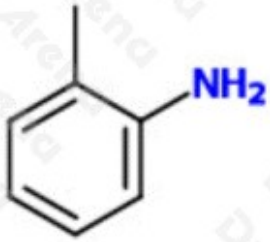
QUESTION NO: 26



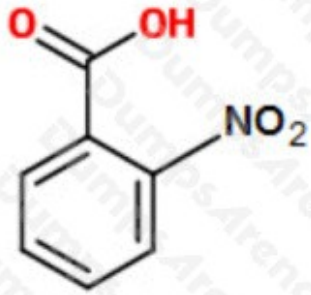
A.



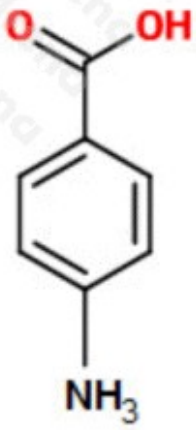
B.



C.



D.



E.



A. Option A

B. Option B

C. Option C

D. Option D

E. Option E

ANSWER: C

Explanation:

The depicted product is correct because the methyl substituent on toluene directs electrophilic aromatic substitution primarily to the ortho and para positions. During nitration, the incoming nitro group is therefore installed adjacent to, or opposite, the methyl group on the aromatic ring. This directing behavior follows from the electron-donating effect of the alkyl substituent, which stabilizes the resonance contributors of the arenium-ion intermediate formed during ortho and para attack.

The subsequent oxidation changes the benzylic methyl side chain into a carboxylic-acid group while preserving the positions of substituents already present on the ring. Thus, the required final structure must retain the nitro group in an ortho or para relationship to the group that has become the carboxylic acid. The product shown has exactly this regiochemical relationship and correctly reflects benzylic oxidation of an alkylbenzene to a benzoic-acid derivative. These two transformations—ortho/para-directed nitration followed by oxidation of the benzylic side chain—lead directly to the depicted nitrobenzoic-acid product. See Chemistry LibreTexts' discussion of substituent effects in electrophilic aromatic substitution and its coverage of oxidation chemistry.

QUESTION NO: 27

A bat uses echolocation to identify objects. A bat is traveling to west emits a sound (also heading towards the west) to a stationary object. Which of the following is most accurate in regards to the Doppler effect?

A. Frequency will be the same.

B. Frequency will be higher than the originally emitted one.

C. Frequency will be lower than the originally emitted one.

D. Frequency will not return.

E. Cannot determine.

ANSWER: B

Explanation:

"Frequency will be higher than the originally emitted one." is correct because the bat is moving toward the stationary object while emitting sound, and it later receives the reflected echo while continuing to move toward that object. This produces a Doppler shift in two stages. First, motion of the bat toward the object causes the sound reaching the object to have a higher frequency than the frequency produced by the bat. The stationary object reflects that sound without changing its received frequency. Second, because the bat is moving toward the returning reflected wave, it encounters wavefronts more frequently and detects an additional increase in frequency. Thus, the echo received by the bat has a frequency greater than the originally emitted sound. This increase is the physical basis by which echolocating animals can obtain information about relative motion from returning sound waves. The conclusion assumes that the object is located west of the bat, consistent with the sound being emitted westward toward it. For an overview of the Doppler effect for sound, see OpenStax Physics: The Doppler Effect. A discussion of bat echolocation and Doppler-shift processing is available from Encyclopaedia Britannica: Bat—Echolocation.

QUESTION NO: 28

A wire of resistance R is about to be replaced with a different wire that is three times as long and having a radius three times as much as the original wire. What is the resistance of this new wire?

A. 1/2

B. 1/4

C. 1/3

D. 1/5

E. The resistance is the same in both wires.

ANSWER: C

Explanation:

The correct answer is **1/3**, meaning that the replacement wire has one-third of the original resistance, assuming both wires are made of the same material and are at the same temperature. Resistance in a uniform cylindrical wire is given by $R = \rho L/(\pi r^2)$, where ρ is the material's resistivity, L is the wire length, and r is its radius. The new wire's length is three times the original length, which by itself would multiply resistance by three. However, its radius is also three times larger. Because the cross-sectional area depends on the square of radius, the new cross-sectional area is $3^2 = 9$ times larger. A ninefold increase in area reduces resistance by a factor of nine. Combining the length and area changes gives a resistance ratio of 3/9, or 1/3. Therefore, the new resistance is R/3. This relationship between resistance, length, and cross-sectional area is described in OpenStax's discussion of electrical resistance: OpenStax College Physics: Resistance and Resistivity. For the cylindrical area relation used here, see OpenStax: Area of a Circle.

QUESTION NO: 29

Cyanide is a poison that binds to the active site of the enzyme cytochrome c and prevents its activity. Cyanide is a(n)

A. Prosthetic group

B. Cofactor

C. Reverse regulator

D. Coenzyme

E. Inhibitor

ANSWER: E

Explanation:

Inhibitor is correct because cyanide decreases enzyme function by binding tightly at or near the catalytic metal-containing site of the cytochrome c oxidase complex in the mitochondrial electron-transport chain. This interaction prevents the enzyme from carrying out its normal role: transferring electrons to molecular oxygen, the terminal electron acceptor. When this step is blocked, oxygen can be present in the blood yet cannot be effectively used by cells for oxidative phosphorylation. Cellular ATP production then falls sharply, particularly in tissues with high energy demands.

In enzyme terminology, a substance that binds an enzyme and reduces or abolishes its catalytic activity is an inhibitor. Cyanide is especially important as an example of a potent, essentially irreversible inhibitor of cytochrome c oxidase under physiologic conditions. Its toxic effect illustrates that enzyme inhibition can disrupt an entire metabolic pathway when the affected enzyme performs an essential step. The stated binding to the enzyme's active site and prevention of activity directly support the classification as an inhibitor. Additional biochemical context is available from NCBI Bookshelf's review of cyanide toxicity and the NCBI Bookshelf overview of oxidative phosphorylation.