

ROUND ROBIN ~ ROUND 7

TOSS UP

1. MATH *Short Answer* Find the number of degrees in the angle of elevation of the Sun when a 10-foot vertical flag pole casts a 10-foot shadow on level ground.

ANSWER: 45°

BONUS

1. MATH *Short Answer* Find the largest possible real range of the function $y = 1 - 2e^{\frac{x}{2}-3}$ [**y equals 1 minus 2 times e to the power of the quantity x over 2 minus 3**].

ANSWER: $y < 1$ (ACCEPT: ALL REAL NUMBERS LESS THAN 1; THE OPEN INTERVAL FROM MINUS INFINITY TO 1)

TOSS UP

2. EARTH AND SPACE *Short Answer* What element gives azurite [**AZ-uh-ryt**] its blue coloring?

ANSWER: COPPER

BONUS

2. EARTH AND SPACE *Multiple Choice* Which of the following minerals is NOT a constituent of basalt?

- W) Anorthite [**an-OHR-thyt**]
- X) Augite [**AW-jyt**]
- Y) Olivine
- Z) Biotite

ANSWER: Z) BIOTITE

TOSS UP

3. BIOLOGY *Multiple Choice* A botanist wishes to prevent self-pollination in bluebells so he can conduct a controlled experiment involving artificial pollination of flowers by hand. How might he go about stopping self-pollination?

- W) Fasten mesh bags around flowers so pollinators cannot approach flowers
- X) Cut off flower sepals
- Y) Cut off flower petals
- Z) Cut off flower anthers

ANSWER: Z) CUT OFF FLOWER ANTHERS

BONUS

3. BIOLOGY *Multiple Choice* Which of the following would be the most direct product of meiosis [*my-OH-sis*] in a typical plant?

- W) Gametophyte [*guh-MEE-tuh-fyt*]
- X) Spore
- Y) Egg
- Z) Sporophyte

ANSWER: X) SPORE

TOSS UP

4. PHYSICS *Multiple Choice* Three resistors are connected to a battery in parallel. The resistors have resistances of 1 ohm, 100 ohms, and 1000 ohms. The equivalent resistance of the circuit is nearest to which of the following values in ohms?

- W) 1
- X) 100
- Y) 1000
- Z) 1101

ANSWER: W) 1

BONUS

4. PHYSICS *Short Answer* If it takes 12 seconds total for a ball to travel straight up from the ground and fall back to earth, neglecting air resistance and given g as 10 meters per second squared, what was the maximum height it reached in meters?

ANSWER: 180

TOSS UP

5. ENERGY *Multiple Choice* Which of the following sources of energy produces radioactive waste?

- W) Hydrogen
- X) Geothermal
- Y) Coal
- Z) Oil

ANSWER: Y) COAL

BONUS

5. ENERGY *Multiple Choice* A motor consumes 21 kilowatts at 90% efficiency. Which of the following is closest to the difference in operating costs over 20 years for this motor versus a 95% efficient motor, assuming that the motors are running constantly and that electricity costs \$0.10 per kilowatt-hour.

- W) \$5,000
- X) \$20,000
- Y) \$27,000
- Z) \$30,000

ANSWER: X) \$20,000

TOSS UP

6. CHEMISTRY *Multiple Choice* Which of the following elements has more p electrons than s electrons?

- W) Boron
- X) Magnesium
- Y) Germanium
- Z) Nitrogen

ANSWER: Y) GERMANIUM

BONUS

6. CHEMISTRY *Multiple Choice* Imperfections in solids have a distinct effect on the properties of the materials. Which of the following describes 2D defects?

- W) Pores and cracks
- X) Grain boundaries and surface defects
- Y) Vacancies and interstitials
- Z) Edge and screw dislocations

ANSWER: X) GRAIN BOUNDARIES AND SURFACE DEFECTS

TOSS UP

7. MATH *Short Answer* Find the slant height in units of a regular pyramid whose base is a 10 x 10 square and whose altitude is 12 units in length.

ANSWER: 13

BONUS

7. MATH *Short Answer* What is the 19th derivative of $y = \sin x$?

ANSWER: $-\cos x$

TOSS UP

8. BIOLOGY *Multiple Choice* An example of a negative feedback mechanism is thermoregulation in animals. When an ectotherm begins to feel cold, which of the following typically happens?

- W) It sits in the Sun until it gets warm
- X) It uses metabolic energy to warm
- Y) It goes into torpor
- Z) Its body temperature cools to match the environment

ANSWER: W) IT SITS IN THE SUN UNTIL IT GETS WARM

BONUS

8. BIOLOGY *Multiple Choice* Chloroplasts in green algae have a double membrane, whereas chlorarachniophytes [*klohr-uh-ra-KNEE-oh-fyts*] have chloroplasts with four membranes. Which of the following is a likely explanation for this observation?

- W) Chlorarachniophytes are an example of polyploidy
- X) Chlorarachniophyte chloroplasts are the result of ancient endosymbiosis of green algae with a eukaryote [*yoo-KAR-ee-oh*]
- Y) Chlorarachniophyte chloroplasts are parasitic green algae living within the chlorarachniophyte
- Z) Chlorarachniophyte chloroplasts are the result of phagocytosis of cyanobacteria [*fag-uh-sy-TOH-sis* of *sy-uh-noh-bak-TEER-ee-uh*]

ANSWER: X) CHLORARACHNIOPHYTE CHLOROPLASTS ARE THE RESULT OF ANCIENT ENDOSYMBIOSIS OF GREEN ALGAE WITH A EUKARYOTE

TOSS UP

9. EARTH AND SPACE *Short Answer* What type of plate boundary shows primarily tensional stress?

ANSWER: DIVERGENT

BONUS

9. EARTH AND SPACE *Short Answer* What is the name for a small-scale vent on a volcano from which gases escape into the atmosphere?

ANSWER: FUMAROLE

TOSS UP

10. PHYSICS *Short Answer* A solid conducting sphere with a radius of 10 centimeters is charged with a charge of 20 microcoulombs. What is the electric field 5 centimeters from the center of the sphere?

ANSWER: ZERO

BONUS

10. PHYSICS *Short Answer* A boy standing at the top of a tower of height h jumps to the ground. In simplest form, what is the exact expression for the speed with which he touches the ground, given that g stands for the magnitude of the acceleration due to gravity?

ANSWER: $\sqrt{2gh}$

TOSS UP

11. CHEMISTRY *Multiple Choice* Which of the following four substances would have the highest melting point?

- W) C₁₈H₃₈
- X) H₂O
- Y) MgCl₂
- Z) N₂O₅

ANSWER: Y) MgCl₂

BONUS

11. CHEMISTRY *Multiple Choice* Which of the following statements about hydroboration-oxidation is false?

- W) It is a syn addition
- X) The borane acts as the electrophile
- Y) Overall, the reaction converts an alkene to an alcohol
- Z) The common oxidizing agent used is sodium borohydride

ANSWER: Z) THE COMMON OXIDIZING AGENT USED IS SODIUM BOROHYDRIDE

TOSS UP

12. BIOLOGY *Multiple Choice* Which of the following methods is NOT typically used to determine the proportion of guanine [**GWAH-neen**] and cytosine [**SY-tuh-seen**] base pairing in a sample of DNA?

- W) DNA sequencing
- X) Melting point
- Y) X-ray crystallography
- Z) Density gradient centrifugation

ANSWER: Y) X-RAY CRYSTALLOGRAPHY

BONUS

12. BIOLOGY *Multiple Choice* Which of the following populations would be most likely to exhibit logarithmic population growth?

- W) Elephants protected from hunting in a national park
- X) Sparrows that breed on a small island in northern Canada, with alternating mild and very harsh winters
- Y) Yeast growing under controlled laboratory conditions
- Z) Deer living in Yellowstone National Park with wolf predators present

ANSWER: Y) YEAST GROWING IN CONTROLLED LABORATORY CONDITIONS

TOSS UP

13. MATH *Multiple Choice* Which of the following is equivalent to the expression: $(x^2 - 2)^2$ **[open parenthesis x squared minus 2 close parenthesis squared]**?

- W) $x^4 + 4$
- X) $x^4 - 4x + 4$
- Y) $x^4 - 4x^2 + 4$
- Z) $x^4 - 4$

ANSWER: Y) $x^4 - 4x^2 + 4$

BONUS

13. MATH *Multiple Choice* For a recursive sequence a_n defined as follows: $a_1 = 7$, $a_2 = 3$, and $a_n = a_{n-1} - a_{n-2}$ for $n \geq 3$, find a_{1205} **[a sub 1205]**.

- W) -4
- X) -3
- Y) 3
- Z) 4

ANSWER: X) -3

TOSS UP

14. EARTH AND SPACE *Multiple Choice* Which of the following plates is currently subducting off the west coast of Central America?

- W) Juan De Fuca **[WAHN di FEW-kuh]**
- X) Nazca
- Y) Cocos
- Z) Gordo

ANSWER: Y) COCOS

BONUS

14. EARTH AND SPACE *Short Answer* Of the following four factors, by number, identify those that will increase the rate of light attenuation in a natural water body: 1) decreased particulate turbidity, 2) increased concentrations of plankton, 3) decreased chromophoric compounds, 4) increased dissolved organic carbon.

ANSWER: 2, 4

TOSS UP

15. BIOLOGY *Multiple Choice* A mysterious new disease has been discovered. The pathogen responsible for the disease can be easily viewed on a light microscope using a 4x objective with 10x ocular lenses. Studies reveal that the pathogen easily desiccates, moves by changing the consistency of its cytoplasm, and it does not contain peptidoglycan [*pep-TI-doh-GLY-kuhn*]. In which of the following groups will this pathogen likely be classified?

- W) Amoeba [*uh-MEE-buh*]
- X) Fungus
- Y) Bacterium
- Z) Virus

ANSWER: W) AMOEBA

BONUS

15. BIOLOGY *Multiple Choice* A new species of fruit fly has been discovered that has wings of two colors, brown or white. Brown-winged females are allowed to mate with white-winged males. In the F1 generation, half of the females are brown and half of the males are brown. Which of the following is the best explanation for these results?

- W) White wing color is a recessive X-linked trait
- X) Brown wing color is a recessive X-linked trait
- Y) White wing color is a recessive autosomal trait
- Z) White wing color is a lethal mutation

ANSWER: W) WHITE WING COLOR IS A RECESSIVE X-LINKED TRAIT

TOSS UP

16. PHYSICS *Short Answer* A proton is moving to the north when it experiences a uniform magnetic field that is pointing vertically downward. In which cardinal direction should an electric field be applied to keep the proton moving due north?

ANSWER: EAST

BONUS

16. PHYSICS *Short Answer* What is the kinetic energy in joules to two significant figures of a car with a mass of 2000 kilograms moving with a speed 100 kilometers per hour?

ANSWER: 770,000

TOSS UP

17. ENERGY *Multiple Choice* Despite the heat produced from hydrothermal vents on the ocean floor, with temperatures reaching up to 400° Celsius, the surrounding water does not boil. Why not?

- W) The surrounding water is too cold
- X) There is too much pressure at that depth
- Y) The salt concentration is too high
- Z) There is a low concentration of oxygen

ANSWER: X) THERE IS TOO MUCH PRESSURE AT THAT DEPTH

BONUS

17. ENERGY *Multiple Choice* Approximately how many horsepower are generated by a horse pulling with a force of 180 pounds and turning a 24 foot diameter wheel 72 times in one hour?

- W) 1/2
- X) 3/4
- Y) 1
- Z) 5/4

ANSWER: W) 1/2

TOSS UP

18. CHEMISTRY *Multiple Choice* Which of the following statements about phase diagrams is NOT true?

- W) The point at which all three phases coexist is called the critical point
- X) The line separating solid and vapor represents sublimation
- Y) The line separating liquid and vapor represents boiling
- Z) A negatively sloped line between the solid and liquid indicates that the solid will float in the liquid

ANSWER: W) THE POINT AT WHICH ALL THREE PHASES COEXIST IS CALLED THE CRITICAL POINT

BONUS

18. CHEMISTRY *Multiple Choice* Which of the following is a characteristic of an adiabatic gas expansion?

- W) Internal energy increases
- X) Temperature of the working gas decreases
- Y) Kinetic energy increases with average molecular speed
- Z) Work done is inversely proportional to temperature difference between initial and final states

ANSWER: X) TEMPERATURE OF THE WORKING GAS DECREASES

TOSS UP

19. MATH *Short Answer* In the expansion of $(1 - 5x)^3$ [**open parenthesis 1 minus 5x close parenthesis cubed**], what is the coefficient of x^2 ?

ANSWER: 75

BONUS

19. MATH *Short Answer* Evaluate $\lim_{x \rightarrow 1} \frac{-1 + \sqrt[3]{x}}{x-1}$ [**the limit as x approaches 1 of the fraction with numerator negative 1 plus the cube root of x and denominator x minus 1**].

ANSWER: $\frac{1}{3}$

TOSS UP

20. EARTH AND SPACE *Multiple Choice* Which of the following observations was NOT used as evidence for Alfred Wegener's theory of continental drift?

- W) Seafloor bathymetry [**buh-THIM-i-tree**]
- X) Glaciogenic sediments
- Y) Shoreline fit of continents
- Z) Fossil evidence

ANSWER: W) SEAFLOOR BATHYMETRY

BONUS

20. EARTH AND SPACE *Multiple Choice* Which of the following minerals has the highest specific gravity?

- W) Galena [**guh-LEE-nuh**]
- X) Graphite
- Y) Goethite
- Z) Garnet

ANSWER: W) GALENA

TOSS UP

21. BIOLOGY *Multiple Choice* Which of the following populations would be most likely to have a clumped distribution?

- W) Wolves that hunt in packs
- X) Thousands of seagulls nesting on a half-mile stretch of beach
- Y) A planted field of wheat
- Z) Dandelions growing from seeds dispersed by wind

ANSWER: W) WOLVES THAT HUNT IN PACKS

BONUS

21. BIOLOGY *Multiple Choice* Bird wings and airplane wings have a highly similar shape. At the top of the wing, birds have a small feather called the alula, which extends during takeoff and landing. Which of the following is the purpose of the alula?

- W) Acts as a brake by increasing drag
- X) Makes the wing produce less lift
- Y) Reduces turbulence and maintains lift
- Z) Increases thrust

ANSWER: Y) REDUCES TURBULENCE AND MAINTAINS LIFT

TOSS UP

22. PHYSICS *Short Answer* In an electromagnetic wave, the **E** field vector points in the positive x direction and the **B** field vector points in the negative y direction. What is the direction of propagation of the wave?

ANSWER: NEGATIVE Z

BONUS

22. PHYSICS *Multiple Choice* Let g represent the acceleration due to gravity at the surface of the Earth. A planet with one third of the mass of the Earth and one half of the radius of the Earth will have an acceleration due to gravity near its surface that is which of the following?

- W) one third g
- X) two thirds g
- Y) g
- Z) four thirds g

ANSWER: Z) FOUR THIRDS G

TOSS UP

23. ENERGY *Multiple Choice* Photosynthesis accounts for the fixation of about 200 billion tons of carbon. Approximately which of the following percentages of this carbon is fixed by marine plankton alone?

- W) 8%
- X) 24%
- Y) 40%
- Z) 65%

ANSWER: Y) 40%

BONUS

23. ENERGY *Short Answer* Rank the four following forms of coal in order of energy per pound from least to greatest: 1) bituminous [**by-TOO-muh-nuhs**], 2) anthracite [**AN-thruh-syt**], 3) lignite, 4) sub-bituminous.

ANSWER: 3, 4, 1, 2 (ACCEPT: LIGNITE, SUB-BITUMINOUS, BITUMINOUS, ANTHRACITE)

TOSS UP

24. CHEMISTRY *Multiple Choice* Consider the following reaction:

$2\text{C}_2\text{H}_6(\text{g}) + 7\text{O}_2(\text{g}) \rightarrow 4\text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{l})$ in which $\Delta H = -3120$ kilojoules. If 3.00 grams of ethane are burned, how many kilojoules of heat are produced?

- W) 1560
- X) 624
- Y) 312
- Z) 156

ANSWER: Z) 156

[NOTE: (g) = GAS; (l) = LIQUID]

BONUS

24. CHEMISTRY *Multiple Choice* An element's most stable ion forms an ionic compound with iodine having the formula, XI_2 . If the ion of element X has a mass of 89 amu and has 36 electrons, which of the following correctly matches the identity of the element and how many neutrons it has?

- W) Strontium and 51
- X) Krypton and 55
- Y) Selenium and 55
- Z) Krypton and 53

ANSWER: W) STRONTIUM AND 51

TOSS UP

25. BIOLOGY *Short Answer* The population growth rate of a sparrow community at carrying capacity on a small island depends on the number of individuals present. What effect would an increase in population size have on the birth rate of sparrows?

ANSWER: DECREASE

BONUS

25. BIOLOGY *Multiple Choice* On a mountainside, Species A lives at an elevation of 4500-7000 feet. You believe that Species B, which lives and forages at an elevation of 6500-9000 feet, is not an effective competitor against Species A. You decide to implement one of the following choices and then observe Species B for at least one year. Which of the following tests would be most effective in answering your question?

- W) Release 100 pairs of Species B at elevations between 4500 and 5500 feet
- X) Remove all members of Species A living between 5500 and 7000 feet
- Y) Release 100 pairs of Species A at elevations between 7000 and 9000 feet
- Z) Capture one bird of each species and test its physiological adaptations

ANSWER: X) REMOVE ALL MEMBERS OF SPECIES A LIVING BETWEEN 4500 AND 7000 FEET