BASH



Round Robin 4

TOSS-UP

1. Energy *Multiple Choice* Students at Amador Valley High School have recently learned about isoelectronic atoms, which have the same number of electrons. Currently, they have a sample of Al, which they want to turn into a species that is isoelectronic with Na^+. Which of the following identifies how many electrons they need to remove to achieve this?

W) 1
X) 2
Y) 3
Z) 4

ANSWER: Y) 3

BONUS

1. Energy *Multiple Choice* Students at Montgomery Blair witness the night sky for the first time with their telescopes. Which of the following is NOT an advantage of reflecting telescopes over refracting telescopes?

W) Reflecting telescopes do not suffer from chromatic aberration
X) Reflecting telescopes have only one surface to polish
Y) Reflecting telescopes are not obstructed by secondary mirrors
Z) Reflecting telescopes can be supported from the back

Y) REFLECTING TELESCOPES ARE NOT OBSTRUCTED BY SECONDARY MIRRORS

TOSS-UP

2. Earth and Space *Short Answer* Caldera lakes often have low pH because volcanic fumes react with the water to form what acid?

ANSWER: SULFURIC ACID

BONUS

2. Earth and Space *Short Answer* What is the minimum number of glacial valleys needed to delineate a horn?

ANSWER: 3

TOSS-UP

3. Chemistry *Short Answer* What are the formal charges on the carbon and oxygen, respectively, in the Lewis structure of carbon monoxide?

ANSWER: -1 AND +1

BONUS

3. Chemistry *Short Answer* Order the following three ionic solids by increasing lattice energy:

1) Potassium iodide
2) Sodium chloride
3) Magnesium chloride

ANSWER: 1, 2, 3

TOSS-UP

4. Physics *Multiple Choice* When a square loop of wire rotates in the presence of a constant magnetic field, a current is induced in the loop. Which physical law does this best demonstrate?

W) Gauss' Law for Electricity

X) Gauss' Law for Magnetism

Y) Ampere's Law

Z) Faraday's Law

ANSWER: Z) FARADAY'S LAW

BONUS

4. Physics *Multiple Choice* Which of the following fundamental forces do quarks, but not leptons, interact with?

W) Gravity

X) Electromagnetic force

Y) Strong force

Z) Weak force

ANSWER: Y) STRONG FORCE

TOSS-UP

5. Math *Short Answer* In a quadruple elimination tournament, what is the difference between the maximum and minimum possible number of games played when there are 30 teams?

ANSWER: 3

BONUS

5. Math *Short Answer* How many of the first 200 positive integers are not divisible by 3 or 11?

ANSWER: 122

TOSS-UP

6. Biology *Short Answer* Identify all of the following three pairs of sugars that are structural isomers:

1) Glucose and fructose
2) G3P and DHAP
3) Galactose and ribulose

ANSWER: 1 AND 2

BONUS

6. Biology *Short Answer* The MyoD **[My-oh-D]** protein is a crucial transcription factor that regulates skeletal muscle differentiation. Identify all of the following three genes that it would activate:

1) Genes encoding cyclins
2) Genes encoding myosin subunits
3) Gene encoding MyoD protein

ANSWER: 2 AND 3

TOSS-UP

7. Earth and Space *Multiple Choice* Which of the following parts of the Milky Way is the youngest?

W) Galactic halo
X) Central bulge
Y) Spiral arms
Z) Globular clusters

ANSWER: Y) SPIRAL ARMS

BONUS

7. Earth and Space *Short Answer* The 21-centimeter spectral line is caused by a spin-flip transition in an electron of what element?

ANSWER: HYDROGEN

TOSS-UP

8. Chemistry *Multiple Choice* Which of the following one-carbon molecules has the highest boiling point?

W) Methane

X) Methanol

Y) Formic acid

Z) Formaldehyde

ANSWER: Y) FORMIC ACID

BONUS

8. Chemistry *Short Answer* At a certain temperature, oxygen gas has root mean square velocity v. What molar mass would be required for a gas to have root mean square velocity 4v at the same temperature?

ANSWER: 2

TOSS-UP

9. Physics *Short Answer* What term best describes an ideal gas process in which no heat is exchanged with the surroundings?

ANSWER: ADIABATIC

BONUS

9. Physics *Short Answer* A ball travels in the xy plane with coordinates described by the parametric functions $x = 7t - 3$ and $y = 6t^2 + 8$. What is the speed of the ball at $t = 2$?

ANSWER: 25

TOSS-UP

10. Math *Short Answer* Convert 1331 **[one three three one]** in base 11 to base 10.

ANSWER: 1728

BONUS

10. Math *Short Answer* How many pairs of integers (x,y) satisfy the equation $x^2 + y^2 = 65$?

ANSWER: 16

TOSS-UP

11. Biology *Short Answer* What pectin-rich layer, found between the primary cell walls of neighboring plant cells, acts as a glue that holds plant tissues together?

ANSWER: MIDDLE LAMELLA

BONUS

11. Biology *Multiple Choice* If the sodium potassium pump becomes overactive in a motor neuron, which of the following outcomes is most likely when the neuron is stimulated, assuming the strength and frequency of the stimulus remain unchanged?

W) Increased frequency of action potentials
X) Decreased frequency of action potentials
Y) Increased amplitude of action potentials
Z) Decreased amplitude of action potentials

ANSWER: X) DECREASED FREQUENCY OF ACTION POTENTIALS

TOSS-UP

12. Energy *Multiple Choice* Students at Amador Valley High School are studying the Haber process. Which of the following best describes how the oxidation number of nitrogen changes during this reaction?

W) 0 to +1

X) 0 to -1

Y) 0 to -2

Z) 0 to -3

ANSWER: Z) 0 TO -3

BONUS

12. Energy *Multiple Choice* Students at Amador Valley are studying clustering algorithms. Which of the following clustering algorithms partitions data into Voronoi regions by iteratively assigning points to the nearest centroids?

W) DBSCAN

X) K-means

Y) Spectral clustering

Z) Gaussian Mixture Models

ANSWER: X) K-MEANS

TOSS-UP

13. Earth and Space *Short Answer* The tops of cumulonimbus clouds spread out into anvils because air struggles to rise beyond what atmospheric boundary, above which temperature begins to increase with altitude?

ANSWER: TROPOPAUSE

BONUS

13. Earth and Space *Multiple Choice* Which of the following metamorphic rocks typically has an igneous parent?

W) Quartzite
X) Slate
Y) Marble
Z) Soapstone

ANSWER: Z) SOAPSTONE

TOSS-UP

14. Chemistry *Short Answer* Identify all of the following three elements that have multiple naturally-existing allotropes:

1) Carbon

2) Oxygen

3) Gold

ANSWER: 1 AND 2

BONUS

14. Chemistry *Short Answer* In the balanced chemical reaction for the dissolution of silver chloride, the equilibrium constant depends on the concentration of silver chloride raised to what power?

ANSWER: 0

TOSS-UP

15. Physics *Short Answer* When an observer views a spaceship traveling at relativistic speeds, its length will appear contracted. The contracted length and proper length are related to each other by what physical, velocity-dependent factor?

ANSWER: LORENTZ FACTOR

BONUS

15. Physics *Short Answer* Three blocks are moving towards each other. Block 1 has a mass of 1 kilogram and is moving at 30 meters per second in the positive x direction. Block 2 has a mass of 2 kilograms and is moving at 15 meters per second in the positive y direction. Block 3 has a mass of 3 kilograms and is moving at 10 meters per second in the positive z direction. If all three masses collide simultaneously and stick together, then in meters per second, what is the final speed of the combined mass?

ANSWER: 5sqrt3

TOSS-UP

16. Math *Short Answer* In a 5 by 5 grid of lattice points, how many unit-length segments connect two adjacent points?

ANSWER: 40

BONUS

16. Math *Short Answer* A bag has 5 red, 4 blue, and 3 green balls. Two balls are drawn at random without replacement. What is the probability they are the same color?

ANSWER: 19/66

TOSS-UP

17. Biology *Multiple Choice* Which of the following amino acids is encoded by only a singular codon?

W) Glycine

X) Methionine

Y) Alanine

Z) Serine

ANSWER: X) METHIONINE

BONUS

17. Biology *Multiple Choice* The secretion of which of the following substances by the roots would be most beneficial for cation exchange?

W) Nitrate

X) Bicarbonate

Y) Carbon dioxide

Z) Water

ANSWER: Y) CARBON DIOXIDE

TOSS-UP

18. Earth and Space *Short Answer* The rings of the Jovian planets lie within what boundary, inside which a moon would be torn apart by tidal forces?

ANSWER: ROCHE LIMIT

BONUS

18. Earth and Space *Short Answer* Order the following three rings of Saturn from innermost to outermost:

1) C ring
2) D ring
3) E ring

ANSWER: 2, 1, 3

TOSS-UP

19. Chemistry *Short Answer* Two solutions are prepared, one with 6 molar sodium fluoride, and another with an unknown concentration of sodium carbonate. In molar, what concentration of sodium carbonate would be needed to ensure both solutions have the same boiling point?

ANSWER: 4

BONUS

19. Chemistry *Short Answer* Evan just synthesized one mole of mercury (I) nitrate using his amazing chemistry skills. How many moles of oxygen are found in this one mole sample?

ANSWER: 6

TOSS-UP

20. Physics *Short Answer* If the radius of curvature for a convex mirror is 50 centimeters, then in centimeters, what is its focal length?

ANSWER: 25

BONUS

20. Physics *Multiple Choice* Rohan launches a ball at a 30-degree angle to the horizontal across flat ground. Edwin launches another ball at the same velocity but at a different angle such that it travels the same horizontal distance as Rohan's ball. In degrees, at what angle to the horizontal was Edwin's ball launched?

W) 15

X) 45

Y) 60

Z) 75

Answer: Y) 60

TOSS-UP

21. Math *Short Answer* What is the sum of the digits of the sum of the first 1000 positive integers?

ANSWER: 10

BONUS

21. Math *Short Answer* How many odd 3-digit numbers have all digits distinct?

ANSWER: 320

TOSS-UP

22. Biology *Multiple Choice* Which of the following best explains the mechanism of inhalation in humans?

W) Diaphragm contracts, decreasing air pressure in the lungs

X) Diaphragm contracts, increasing air pressure in the lungs

Y) Diaphragm relaxes, decreasing air pressure in the lungs

Z) Diaphragm relaxes, increasing air pressure in the lungs

ANSWER: W) DIAPHRAGM CONTRACTS, DECREASING AIR PRESSURE IN THE LUNGS

BONUS

22. Biology *Short Answer* Which of the following would increase the realized niche of a species?

W) Increased intraspecies **[in-TRAspecies]** competition, increased interspecies **[in-TERspecies]** competition

X) Increased intraspecies **[in-TRAspecies]** competition, decreased interspecies **[in-TERspecies]** competition

Y) Decreased intraspecies **[in-TRAspecies]** competition, increased interspecies **[in-TERspecies]** competition

Z) Decreased intraspecies **[in-TRAspecies]** competition, decreased interspecies **[in-TERspecies]** competition

ANSWER: Y) DECREASED INTRASPECIES **[IN-TRASPECIES]** COMPETITION, INCREASED INTERSPECIES **[IN-TERSPECIES]** COMPETITION

TOSS-UP

23. Energy *Multiple Choice* Students at Montgomery Blair are studying projectiles. The maximum range of a projectile, given its launch speed, is proportional to what power of the surface gravitational acceleration?

W) -2

X) -1

Y) 0

Z) 1

ANSWER: X) -1

BONUS

23. Synergy *Multiple Choice* Which of the following ions has the smallest ionic radius?

W) The ion in the center of chlorophyll

X) The primary cation in the mineral anhydrite

Y) The most common ion formed by the element whose atomic number is the magnitude of the complex number (i+sqrt3)^3

Z) The cation immediately formed upon the decay of a lithium-8 atom

ANSWER: Z) THE CATION IMMEDIATELY FORMED UPON THE DECAY OF A LITHIUM-8 ATOM
