BASH

Round Robin 2

TOSS-UP

1. Energy *Multiple Choice* Students at Johns Hopkins University are running a galvanic cell using iron metal at the cathode and magnesium metal at the anode. They decide to add some magnesium chloride to the Mg^{2+} half cell. Which of the following best identifies how they should expect to see the voltage of the cell change?

W) Increases
X) Decreases
Y) Remains the same
Z) Not enough information is provided

ANSWER: X) DECREASES

BONUS

1. Energy *Short Answer* Students at Montgomery Blair want to become quants in the future, so they solve math problems. Let the function y = f(x) be the curve of the standard normal probability distribution with maximum at x = 0 and standard deviation of 1 with a domain of all real numbers. Rounding your answer to 2 significant figures, compute the integral from 1 to infinity of f(x) dx.

ANSWER: 0.16

TOSS-UP

2. Earth and Space *Short Answer* The boundary layer is distinguished from upper layers of the atmosphere by the presence of what force?

ANSWER: FRICTION

BONUS

2. Earth and Space *Multiple Choice* Which of the following statements about glacial sediments is true?

W) A glacier can only have one terminal moraine
X) Moraines are strictly erosional features
Y) Most glacial erratics are transported by meltwater streams, not by the ice itself
Z) Ground moraines are typically well-sorted

ANSWER: W) A GLACIER CAN ONLY HAVE ONE TERMINAL MORAINE

TOSS-UP

3. Chemistry *Multiple Choice* Which of the following acids has the lowest pKa?

W) Acetic acid

X) Fluoroacetic acid

Y) Difluoroacetic acid

Z) Trifluoroacetic acid

ANSWER: Z) TRIFLUOROACETIC ACID

BONUS

3. Chemistry *Short Answer* Yunyi is performing gravimetry on a sample of calcium carbonate in his lab. He notices that as he heats the sample to high temperatures, carbon dioxide gas is driven off, leaving behind what solid?

ANSWER: CALCIUM OXIDE

TOSS-UP

4. Physics *Short Answer* What is the name of the phenomenon caused by variations in the angle of refraction with different wavelengths of light, leading to distortion of the image?

ANSWER: CHROMATIC ABERRATION

BONUS

4. Physics *Short Answer* Identify all of the following 3 particles that have integer spin:

1) Quark

2) Gluon

3) Photon

ANSWER: 2 AND 3

TOSS-UP

5. Math *Short Answer* What is the ratio of the volume of the solid formed when rotating a 3-4-5 right triangle around its shorter side to the volume when rotating it around its longer side?

ANSWER: 4/3

BONUS

5. Math *Short Answer* A triangle with sides of length 5, 5, and 6 has the same area as a triangle with sides of length 5, 5, and x for some x not equal to 6. What is the value of x?

ANSWER: 8

TOSS-UP

6. Biology *Short Answer* Order the following three marine organisms from lowest to highest in terms of how much they are affected by biomagnification:

1) Killer whale

2) Cyanobacteria

3) Tuna

ANSWER: 2, 3, 1

BONUS

6. Biology *Short Answer* Order the following three cellular organelles in order of their sedimentation during centrifugation:

1) Lysosome

2) Ribosome

3) Nucleus

ANSWER: 3, 1, 2

TOSS-UP

7. Earth and Space *Short Answer* Mars' permafrost is mostly composed of water ice and what other compound?

ANSWER: CARBON DIOXIDE

BONUS

7. Earth and Space *Short Answer* Yunyi is staring at the night sky and sees a full moon. A few weeks later, he goes outside and sees a full moon again. What is the specific name for the time that has passed between the two full moons?

ANSWER: SYNODIC PERIOD (ACCEPT: SYNODIC MONTH)

TOSS-UP

8. Chemistry *Multiple Choice* Evan is playing with a sample of phosphorus-32 when he realizes it is actively decaying. Which of the following best describes this decay process?

W) Beta plus decay because P-32 is neutron poor

X) Beta plus decay because P-32 is neutron rich

Y) Beta minus decay because P-32 is neutron poor

Z) Beta minus decay because P-32 is neutron rich

ANSWER: Z) BETA MINUS DECAY BECAUSE P-32 IS NEUTRON RICH

BONUS

8. Chemistry *Multiple Choice* Which of the following compounds has the most pi bonds?

W) Carbon dioxide

X) Sulfur trioxide

Y) Sulfuric acid

Z) Propene

ANSWER: X) SULFUR TRIOXIDE

TOSS-UP

9. Physics *Multiple Choice* If the electric potential on the surface of a conducting spherical shell is 10 volts, then in volts, what is the electric potential at the center of the sphere?

W) -10

X) 0

Y) 10

Z) Infinite

ANSWER: Y) 10

BONUS

9. Physics *Multiple Choice* Cart 1 is moving to the right towards a stationary cart 2 at a constant velocity. The two carts collide elastically. Which of the following could not describe what happens after the collision?

W) Cart 1 is stationary and cart 2 is moving to the right

X) Both carts are moving to the right, at different speeds

Y) Cart 1 is moving to the left and cart 2 is moving to the right, at different speeds

Z) Cart 1 is moving to the left and cart 2 remains stationary

ANSWER: Z) CART 1 IS MOVING TO THE LEFT AND CART 2 REMAINS STATIONARY

TOSS-UP

10. Math *Short Answer* Edwin has infinitely many packets containing either 6, 12, and 13 coins. What is the maximum number of coins he cannot make by some combination of bags?

ANSWER: 59

BONUS

10. Math *Short Answer* Two real numbers x,y exist such that xy = 2 and (2x+1)(2y+1) = 37 [READ: open parentheses 2x+1 close parentheses times open parentheses 2y+1 close parentheses equals 37]. What is the sum of x and y?

ANSWER: 14

TOSS-UP

11. Biology *Short Answer* Complex II of the electron transport chain binds to what electron carrier that is produced from the conversion of succinate **[SUK-sin-ate]** to fumarate **[FYOOM-uh-rate]** in the citric acid cycle?

ANSWER: FADH2 (ACCEPT: FAD and FAD+) (DO NOT ACCEPT: FADH)

BONUS

11. Biology *Short Answer* Order the following three vertebrate groups by increasing forebrain size relative to their midbrain size:

1) Sharks
2) Lampreys
3) Mammals

ANSWER: 2, 1, 3

TOSS-UP

12. Energy *Multiple Choice* Students at Amador Valley are doing some wacky computer stuff. Which of the following activation functions outputs exactly zero for any negative input and grows linearly for positive inputs to avoid saturation in neural networks?

W) Sigmoid

X) Hyperbolic tangent

Y) Softplus

Z) ReLU

ANSWER: Z) RELU

BONUS

12. Energy *Short Answer* Students at Amador Valley are analyzing polymers of glucose in animals and plants. Order the following three polymers in order from least branched to most branched:

1) Cellulose

2) Glycogen

3) Amylose

ANSWER: 1, 3, 2

TOSS-UP

13. Earth and Space *Short Answer* The continuous branch of Bowen's reaction series describes the crystallization of what type of feldspar?

ANSWER: PLAGIOCLASE

BONUS

13. Earth and Space *Multiple Choice* Jason is scattering grass seeds along the beach. In a couple months, when grass clumps grow and blowouts form around them, which of the following dune types should Jason expect to see?

W) Star
X) Parabolic
Y) Barchan
Z) Transverse

ANSWER: X) PARABOLIC

TOSS-UP

14. Chemistry *Multiple Choice* Which of the following correctly describes the signs of delta H and delta S, respectively, for a reaction that is spontaneous at all temperatures?

W) Positive, positive

X) Positive, negative

Y) Negative, positive

Z) Negative, negative

ANSWER: Y) NEGATIVE, POSITIVE

BONUS

14. Chemistry *Short Answer* Identify all of the following three compounds that are network solids:

1) Diamond

2) Carbon dioxide

3) Silicon dioxide

ANSWER: 1 AND 3

TOSS-UP

15. Physics *Multiple Choice* In 3-dimensional space, which of the following shapes describes the path that a flash of light, from a single event and traveling in all directions, would take?

W) Cone

X) Plane

Y) Line

Z) Sphere

ANSWER: Z) SPHERE

BONUS

15. Physics *Short Answer* A capacitor of capacitance 2 farads has a charge of 1 coulomb. In joules, how much energy is stored in the capacitor?

ANSWER: 0.25

TOSS-UP

16. Math *Short Answer* In a circle with 20 people, each person either tells the truth or lies. They all say "the person to my right is a liar". How many liars are in the group?

ANSWER: 10

BONUS

16. Math *Short Answer* Two regular hexagons exist such that the side length of the first hexagon is the length of the longest diagonal of the second hexagon. What is the ratio of the area of the first hexagon to the area of the second hexagon?

ANSWER: 4

TOSS-UP

17. Biology *Short Answer* A special restriction enzyme recognizes and cuts at the sequence 5 prime—GGCC—3 prime, but the specific location of the excision is unknown. If the enzyme yields sticky ends, identify all of the following three locations in the sequence where the enzyme could cut:

1) After the first nucleotide
2) After the second nucleotide
3) After the third nucleotide.

ANSWER: 1 AND 3

BONUS

17. Biology *Multiple Choice* Which of the following types of white blood cell is not commonly phagocytic?

W) Monocyte
X) Lymphocyte
Y) Dendritic cell
Z) Neutrophil

ANSWER: X) LYMPHOCYTE

TOSS-UP

18. Earth and Space *Short Answer* The Sun primarily generates energy through what nuclear fusion process?

ANSWER: PROTON-PROTON CHAIN (ACCEPT: PP CHAIN)

BONUS

18. Earth and Space *Multiple Choice* Which of the following best describes the origins of Mars' two moons Phobos and Deimos?

W) Collision with a planetesimal
X) Condensation from the solar disk
Y) Captured asteroids
Z) Volcanic ejecta

ANSWER: Y) CAPTURED ASTEROIDS

TOSS-UP

19. Chemistry *Short Answer* Kian is electroplating copper from a solution of copper (II) chloride. What constant, which equals the charge of a mole of electrons, does he need to use to calculate his yield?

ANSWER: FARADAY'S CONSTANT

BONUS

19. Chemistry *Multiple Choice* Which of the following quantities is NOT included in the Born-Haber cycle for finding the lattice enthalpy of cesium chloride?

W) First ionization energy of cesium

X) First ionization energy of chlorine

Y) Enthalpy of sublimation of cesium

Z) Bond dissociation energy of diatomic chlorine

ANSWER: X) FIRST IONIZATION ENERGY OF CHLORINE

TOSS-UP

20. Physics *Multiple Choice* Bernoulli's principle is derived from the conservation of what quantity?

W) Mass

X) Momentum

Y) Energy

Z) Pressure

Answer: Y) ENERGY

BONUS

20. Physics *Short Answer* A rock of mass 0.5 kilograms travelling at 4 meters per second crashes through a window. Immediately after it crashes through the window, it is travelling at 1 meters per second. Assuming the rock did not lose any height during its flight, how much energy, in joules, was lost when it crashed into the window?

ANSWER: 15/4

TOSS-UP

21. Math *Short Answer* The altitude of a right triangle splits the hypotenuse into segments of length 3 and 6. In a different right triangle, the altitude splits the hypotenuse into segments of length 3 and 12. What is the ratio of the length of the altitude in the first triangle to the length of the altitude in the second triangle?

ANSWER: SQRT2 TO 2

BONUS

21. Math *Multiple Choice* A polynomial P(x) of degree at most 3 satisfies P(1) = 10, P(2) = 20, P(3) = 30, and P(4) = 40. What is P(5)?

W) 45

X) 50

Y) 60

Z) 70

ANSWER: X) 50

TOSS-UP

22. Biology *Short Answer* Whereas cilia are supported by central bundles of microtubules, villi are supported by central bundles of what other cytoskeletal element?

ANSWER: MICROFILAMENTS (ACCEPT: ACTIN)

BONUS

22. Biology *Short Answer* Order the following three plant cells by increasing ploidy:

1) Microsporocyte

2) Synergid

3) Endosperm

ANSWER: 2, 1, 3

TOSS-UP

23. Energy *Short Answer* Students at Amador Valley are doping silicon semiconductors. Identify all of the following three elements that can be used to create a p-type semiconductor:

1) Boron

2) Aluminum

3) Phosphorus

ANSWER: 1 AND 2

BONUS

23. Synergy *Short Answer* In a theoretical molecule, there are 3 atoms. Each pair of atoms is bonded, and the number of bonds between the pair of atoms is chosen from 1 to 3 uniformly at random. What is the expected number of sigma and pi bonds respectively?

ANSWER: 3 AND 3
