BASH



Double Elimination 3

TOSS-UP

1. Energy *Multiple Choice* Students at Montgomery Blair are pretending to observe ideal gases. If the constant volume heat capacity of an ideal gas is 25 Joules per mole Kelvin, then which of the following values, in Joules per mole Kelvin, is closest to the constant pressure heat capacity of this gas?

W) 17

X) 25

Y) 33

Z) 41

ANSWER: Y) 33

BONUS

1. Energy *Short Answer* Students at Amador Valley like reading flavor text from a new angle. An angle with a nonzero sine is doubled in value, and this multiplies its sine by 1.5. What is the magnitude of its original sine?

ANSWER: sqrt7/4

TOSS-UP

2. Earth and Space *Multiple Choice* Horsts and grabens are separated by which of the following types of faults?

W) Normal
X) Reverse
Y) Thrust
Z) Transform

ANSWER: W) NORMAL

BONUS

2. Earth and Space *Multiple Choice* Due to budget constraints, Kian's swim team is trying to relocate to a pluvial lake. However, this is probably not feasible because the water in most pluvial lakes comes from which of the following?

W) Glacial meltwater
X) Increased precipitation during ice ages
Y) Seasonal monsoon rains
Z) Water table above ground level

ANSWER: X) INCREASED PRECIPITATION DURING ICE AGES

TOSS-UP

3. Chemistry *Multiple Choice* Which of the following integers is closest to the pH of a solution of 1 molar ammonium acetate, given that ammonium has pKa 9.2 and acetic acid has pKa 4.8?

W) 5

X) 6

Y) 7

Z) 8

ANSWER: Y) 7

BONUS

3. Chemistry *Short Answer* The dimerization of nitrogen dioxide to dinitrogen pentoxide is occurring at 300 Kelvins and has Kp equal to 1. To 2 significant figures, what is the Kc for this reaction at the same temperature?

ANSWER: 25

TOSS-UP

4. Physics *Multiple Choice* Which of the following best describes how a dielectric acts to increase the capacitance of an isolated capacitor?

W) The dielectric polarizes to increase the internal electric field

X) The dielectric polarizes to decrease the internal electric field

Y) The dielectric provides free electrons to increase the capacitor's stored charge

Z) The dielectric provides free electrons to decrease the capacitor's stored charge

ANSWER: X) THE DIELECTRIC POLARIZES TO DECREASE THE INTERNAL ELECTRIC FIELD

BONUS

4. Physics *Short Answer* Identify all of the following three types of mirrors that can show a real image:

1) Plane

2) Concave

3) Convex

Answer: 2 ONLY

TOSS-UP

5. Math *Short Answer* x and y are two odd integers. Identify all of the following three quantities that must be divisible by 4:

1) $x^2 - y^2$

2) $x^2 + y^2$

3) $x^2 + 2xy + y^2$

ANSWER: 1 AND 3

BONUS

5. Math *Short Answer* A number is called good if it has a remainder of 1 when divided by 6. How many ways can 25 indistinguishable marbles be split into 7 distinguishable piles such that each pile has a good number of marbles?

ANSWER: 84

TOSS-UP

6. Biology *Multiple Choice* Glomerular filtration rate would be the highest in which of the following scenarios?

W) Afferent **[AFF-er-ent]** arteriole constriction, efferent **[EFF-er-ent]** arteriole constriction

X) Afferent arteriole dilation, efferent arteriole constriction

Y) Afferent arteriole constriction, efferent arteriole dilation

Z) Afferent arteriole dilation, efferent arteriole dilation

ANSWER: X) AFFERENT ARTERIOLE DILATION, EFFERENT ARTERIOLE CONSTRICTION

BONUS

6. Biology *Multiple Choice* Which of the following microscopy techniques does not visualize 3D images after processing?

W) Confocal microscopy

X) Phase-contrast microscopy

Y) Scanning electron microscopy

Z) Cryo-electron microscopy

ANSWER: X) PHASE-CONTRAST MICROSCOPY

TOSS-UP

7. Earth and Space *Short Answer* The Tully-Fisher relationship compares the luminosity of spiral galaxies with their rotational velocity. What analogous relationship is used for elliptical galaxies?

ANSWER: FABER JACKSON

BONUS

7. Earth and Space *Short Answer* Order the following three ice cloud layers from lowest to highest in the atmospheres of Jupiter and Saturn:

1) Water
2) Ammonia
3) Ammonium hydrosulfide

ANSWER: 1, 3, 2

TOSS-UP

8. Chemistry *Short Answer* Order the following three anions in terms of increasing ionic radius:

1) Hydride

2) Fluoride

3) Chloride

ANSWER: 2, 1, 3

BONUS

8. Chemistry *Multiple Choice* Which of the following describes how the ionization energy and standard reduction potential, respectively, of transition metals change from left to right across a period?

W) Increases, increases

X) Increases, decreases

Y) Decreases, increases

Z) Decreases, decreases

ANSWER: W) INCREASES, INCREASES

TOSS-UP

9. Physics *Multiple Choice* Which of the following shapes CANNOT describe the path of a particle through a region with a uniform magnetic field and no electric field?

W) Straight line

X) Circle

Y) Cycloid

Z) Helix

ANSWER: Y) CYCLOID

BONUS

9. Physics *Short Answer* A rectangular current loop has a width of 2 meters and moves into a magnetic field with magnitude 5 T, which is perpendicular to the plane of the current loop. If the current loop is moving at a constant velocity of 2 meter per seconds and the loop has a resistance of 10 ohms, what is the magnitude of the induced current in the loop?

ANSWER: 2

TOSS-UP

10. Math *Short Answer* If a positive integer has exactly 7 factors, identify all of the following properties the positive integer must have:

1) Perfect square

2) Perfect cube

3) Perfect fourth power

ANSWER: 1 AND 2

BONUS

10. Math *Short Answer* How many paths from (1,1) to (5,5), where each move consisting of moving right one unit or up one unit never hit a point with 2 composite coordinates?

ANSWER: 30

TOSS-UP

11. Biology *Short Answer* Tracheal tubes in grasshoppers don't connect to the outside of the body via a pharynx. Instead, they form little pores on the body surface that can open and close. What are these pores called?

ANSWER: SPIRACLES

BONUS

11. Biology *Short Answer* Identify all of the following three scenarios that would likely lead to the development of a goiter in the thyroid:

1) Addition of antibodies that bind to TSH receptors on the thyroid
2) Large daily injections of TRH
3) Large daily injections of thyroxine

ANSWER: 1 AND 2

TOSS-UP

12. Energy *Multiple Choice* Students at Montgomery Blair are viewing the Ring Nebula to study star evolution. Which of the following best explains the Ring Nebula's colorful emissions?

W) Ionization of surrounding gas by UV radiation
X) Turbulence in the interstellar medium
Y) Scattering of outgoing light by dust specks
Z) Gravitational lensing

ANSWER: W) IONIZATION OF SURROUNDING GAS BY UV RADIATION

BONUS

12. Synergy *Short Answer* Edwin is studying the SN2 reaction between sodium hydroxide and chloromethane. Assuming the central carbon atom remains stationary, if the hydroxide attacks the carbon at 30 meters per second, then to one significant figure, at what speed is the chlorine atom ejected?

ANSWER: 7

TOSS-UP

13. Earth and Space *Short Answer* Order the following 3 types of sediments from most to least uniform particle size:

1) Till
2) Loess
3) Stream bed load

ANSWER: 2, 3, 1

BONUS

13. Earth and Space *Short Answer* Squidward is leaving Bikini Bottom for a party on July 4th, and would like to know the state of the atmosphere outside. Identify all of the following 3 world climate patterns that Squidward will observe that day:

1) Monsoon winds blowing toward the shores of India
2) Northward ITCZ movement
3) Falling CO_2 levels

ANSWER: ALL

TOSS-UP

14. Chemistry *Multiple Choice* Evan obtained a mystery diatomic molecule and observed that it has 8 electrons in bonding molecular orbitals, 2 electrons in antibonding molecular orbitals, and 4 electrons in nonbonding molecular orbitals. What is the bond order of this molecule?

ANSWER: 3

BONUS

14. Chemistry *Multiple Choice* The vapor pressure of liquid A is 300 torr, and the vapor pressure of liquid B is 700 torr. If a mixture of A and B deviates negatively from Raoult's law, then in torr, which of the following is a possible vapor pressure of a solution consisting of half A and half B by mole fraction?

W) 400

X) 500

Y) 600

Z) 700

ANSWER: W) 400

TOSS-UP

15. Physics *Short Answer* Identify all of the following three quantities that are nonzero in the free expansion of an ideal gas:

1) Entropy change
2) Temperature change
3) Heat exchanged

ANSWER: 1 ONLY

BONUS

15. Physics *Short Answer* The center of black holes contains a point where the curvature of spacetime becomes infinite. What is the term for such a point?

ANSWER: SINGULARITY

TOSS-UP

16. Math *Multiple Choice* What is the integral from 0 to 2 of the square root of open parenthesis 2x minus x^2 close parenthesis dx?

W) pi/4

X) pi/2

Y) pi

Z) 2pi

ANSWER: X) PI/2

BONUS

16. Math *Short Answer* What is the ratio of the area of the incircle to the area of the circumcircle of a 6-8-10 triangle?

ANSWER: 4/25

TOSS-UP

17. Biology *Short Answer* Order the following three cytochromes from least to most electronegative:

1) Cytochrome a
2) Cytochrome b
3) Cytochrome c

ANSWER: 2, 3, 1

BONUS

17. Biology *Short Answer* Identify all of the following 3 types of inheritance patterns that can result in a mosaic phenotype in the offspring:

1) Maternal effect
2) X-linked
3) Mitochondrial

ANSWER: 2 AND 3

TOSS-UP

18. Earth and Space *Short Answer* Order the following three astronomical objects in terms of increasing size:

1) Quasar
2) Galactic filament
3) Pulsar

ANSWER: 3, 1, 2

BONUS

18. Earth and Space *Short Answer* Identify all of the following three features that are indicative of star formation:

1) O-B associations
2) Globular clusters
3) H II (H two) regions

ANSWER: 1 AND 3

TOSS-UP

19. Chemistry *Short Answer* Order the following three substituents in terms of increasing activation of an aromatic ring towards electrophilic aromatic substitution:

1) Cyano

2) Amino

3) Fluoro

ANSWER: 1, 3, 2

BONUS

19. Chemistry *Short Answer* If the maximum absorbance of a complex ion solution is 410 nm, then what is the most likely color of the solution?

ANSWER: YELLOW

TOSS-UP

20. Physics *Short Answer* How many different carrier particles are there for the weak force?

ANSWER: 3

BONUS

20. Physics *Short Answer* Bill is singing a note with a frequency of 780 Hertz. If Bill is running away from Sam at 50 meters per second, then in Hertz and taking the speed of sound as 340 meters per second, at what frequency will Sam hear Bill sing?

Answer: 680

TOSS-UP

21. Math *Short Answer* Every diagonal in an octagon is drawn. Assuming no 3 diagonals meet at a common point, how many intersect points are in the interior of the octagon?

ANSWER: 70

BONUS

21. Math *Short Answer* As an avid basher, Rohan loves bashing geometry problems. He wants to find the foot of an altitude in a 3-4-5 triangle so he sets A as (0,3), B as (4,0), and C as (0,0). What are the coordinates of the foot from C onto the side AB?

ANSWER: (36/25, 48/25)

TOSS-UP

22. Biology *Multiple Choice* Which of the following best explains why red blood cells become deformed in sickle cell disease?

W) More ionic bonds in hemoglobin α subunits

X) More ionic bonds in hemoglobin β subunits

Y) Increased hydrophobic interactions between hemoglobin α subunits

Z) Increased hydrophobic interactions between hemoglobin β subunits

ANSWER: Z) INCREASED HYDROPHOBIC INTERACTIONS BETWEEN HEMOGLOBIN β SUBUNITS

BONUS

22. Biology *Multiple Choice* During which stage of cellular respiration does the NADH produced, on average, result in the fewest protons being pumped across the inner mitochondrial membrane?

W) Glycolysis

X) Pyruvate oxidation

Y) Krebs cycle

Z) All the processes would result in the same outcome

ANSWER: W) GLYCOLYSIS

TOSS-UP

23. Energy *Multiple Choice* Students at Montgomery Blair are playing around with batteries. Which of the following plots would be linear in an electrochemical cell, assuming all other parameters remain constant and n is the number of moles of electrons transferred and K is the equilibrium constant?

W) n vs K

X) Natural logarithm of n vs K

Y) n vs natural logarithm of K

Z) n vs the inverse of K

ANSWER: Y) N VS NATURAL LOGARITHM OF K

BONUS

23. Synergy *Short Answer* How many positive integers n exist such that if a regular n-gon has its internal angles measured in arcseconds, the angles are all integers?

ANSWER: 158
