TOSS-UP

1) CHEMISTRY *Short Answer* How many radial nodes does a 6d orbital have?

ANSWER: 3

BONUS

1) CHEMISTRY *Short Answer* Identify all of the following three statements that are true about the azeotrope formed between water and ethanol:

1. It has a positive deviation from Raoult's law
2. The azeotrope has a greater boiling point than pure ethanol, but less than pure water
3. The azeotrope can not be separated by traditional fractional distillation

ANSWER: 1 and 3

TOSS-UP

2) EARTH AND SPACE *Short Answer* Give the elements for all of the following 4 ores: 1. Chalcopyrite 2. Pyrolusite 3. Pentlandite 4. Wolframite

ANSWER: Copper, Manganese, Nickel, Tungsten

BONUS

2) EARTH AND SPACE *Short Answer* One day, Amaan the geologist is walking in a lahar when he discovers an interesting igneous rock. Given that the rock is Aphanitic, has an andesitic composition, is made primarily of alkali feldspar and produces a metallic clicking sound when hit, what is the name of the rock that Amaan is looking at.

ANSWER: Phonolite

TOSS-UP

3) BIOLOGY *Multiple Choice* Which of the following fungi causes ergotism in some plants

W) Claviceps Purpurea
X) Cryphonectria Parasitica
Y) Fruisana Circinatum
Z) Rhizopus Stolonifer

ANSWER: W) Claviceps Purpurea

BONUS

3) BIOLOGY *Short Answer* What is the term for the relationship where a fungi lives within the leaf of a plant

ANSWER: Endophyte

TOSS-UP

4) MATH *Short Answer* In a regular 9 pointed star, what is the measure of each acute interior angle formed at the pointed portions? (*Gideon*)

ANSWER: 20 degrees

BONUS

4) MATH *Short Answer* What is the indefinite integral of $\frac{ln(x)}{x}$ dx? (*Gideon*)

ANSWER: $\frac{ln^2(x)}{2} + C$

TOSS-UP

5) PHYSICS *Multiple Choice* A certain array has two 2 ohm resistors in series. What is the equivalent resistance of 3 such arrays in parallel? (*Zhang*)

ANSWER: 4/3 ohms

BONUS

5) PHYSICS *Short Answer* For a spherical droplet of water falling through the air, if the radius and density are each doubled, by what factor will the terminal velocity increase? (*Gideon*)

ANSWER: $\sqrt{2}$

TOSS-UP

6) CHEMISTRY *Multiple Choice* In the Fischer esterification, which of the following will not affect the position of the equilibrium?

W) Adding more mineral acid in catalytic amounts

X) Adding more alcohol

Y) Adding more carboxylic acid

Z) Decreasing the temperature

ANSWER: W) Adding more mineral acid in catalytic amounts

BONUS

6) CHEMISTRY *Multiple Choice* Which of the following explains why lanthanide contraction occurs?

W) Valence s orbitals have high penetration into nuclear regions

X) Inner core f electrons provide especially poor shielding from the nuclear charge

Y) Valence s electrons have a higher probability closer to the nucleus

Z) Inner core f electrons have a higher probability closer to the nucleus

ANSWER: X) Core f electrons have especially poor shielding from the nuclear charge

---

TOSS-UP

7) EARTH AND SPACE *Short Answer* Order the following layers of an ophiolite from deepest to shallowest: 1. Sheeted Dikes 2. Gabbro 3. Pillow Lavas 4. Peridotite

ANSWER: 2, 4, 1 , 3

BONUS

7) EARTH AND SPACE *Multiple Choice* What is the name for the group of monoclinic ores of manganese with moh's hardness between 5 and 6 that includes Romanechite

W) Pyrolusite

X) Psilomelane

Y) Black Hematite

Z) Manganite

ANSWER: X) Psilomelane

TOSS-UP

8) MATH *Short Answer* What is the remainder when $4^{2020}+4^{2019}+4^{2018}+...+4^2+4^1$ is divided by 3? (*Gideon*)

ANSWER: 1

BONUS

8) MATH *Short Answer* If $cos(\alpha) + cos(\beta) = 2/3$, what is the value of $cos^3(\alpha) + cos^3(\beta)$? (*Gideon*)

ANSWER: 23/27

TOSS-UP

9) BIOLOGY *Short Answer* What protist is characteristic of the red tides that occur in the gulf of mexico

ANSWER: Red Tides

BONUS

9) BIOLOGY *Short Answer* Deniseis Gridieon is a new protist that you have discovered in the lab. You find that it contains a red pigmented chloroplast and features two flagella, one hairy and one smooth. Based on this information, which Protist super group would this species most likely belong to

ANSWER: Stramenopiles

TOSS-UP

10) PHYSICS *Short Answer* A ball is dropped from a very tall cliff. If it falls a distance of *d* meters in the first 5 seconds, what is the total distance in terms of *d* that it falls 15 seconds after it is first dropped? (*Gideon*)

ANSWER: 9*d*

BONUS

10) PHYSICS *Multiple Choice* Which of the following quasiparticles is associated with the vibrations of atoms in a crystal lattice? (*Gideon*)

W) Phonon

X) Exciton

Y) Electron hole

Z) Magnon

ANSWER: W) Phonon

TOSS-UP

11) CHEMISTRY *Short Answer* Identify all of the following three graphs that will yield a straight line with a positive slope:

1. ln(A) versus time for a first order reaction
2. 1/A versus time for a second order reaction
3. $1/A^2$ versus time for a third order reaction

ANSWER: 2 and 3

BONUS

11) CHEMISTRY *Multiple Choice* Which of the following when added to water will create a solution with the lowest freezing point?

W) Ag_2SO_4, molar mass of 312 grams per mole

X) Glucose, molar mass of 180 grams per mole

Y) KI, molar mass of 166 grams per mole

Z) Sucrose, molar mass of 342 grams per mole

ANSWER: Y) KI, molar mass of 166 grams per mole

TOSS-UP

12) EARTH AND SPACE *Short Answer* Give the name of the mineral for all of the following 4 chemical formulas: 1. KCl 2. Fe_2O_3 3. FeS_2 4. $BaSo_4$

ANSWER: 1. Sylvite, 2. Hematite 3. Pyrite 4, Barite.

BONUS

12) EARTH AND SPACE *Short Answer* Give, by name or number, all of the following 3 statements that are true of the jet stream:

1. The subpolar jet stream is lower than the subtropical jet stream
2. The subpolar jet stream moves west to east

3. Subpolar Rossby waves can cause polar vortexes

ANSWER: All

TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following situations would result in decreased production of tryptophan and increased breakdown of lactose

W) Tryptophan high lactose low
X) Tryptophan low lactose low
Y) Tryptophan high lactose high
Z) Tryptophan high lactose low

ANSWER: Y) Tryptophan High Lactose HIgh

BONUS

13) BIOLOGY *Short Answer* Gideon the captain had a son. His son appears to be severely mentally retarded and in addition has large eye folds around his eye. While studying a karyotype of Gideon's son, you notice that Chromosome 5 is abnormally short. Based on this information, what disease does Gideon's son most likely have.

ANSWER: Cri du Chat

TOSS-UP

14) MATH *Multiple Choice* For how many integer values of a does $x^2 - ax + 9$ have two distinct real roots? (*Kira*)

W) 10

X) 11

Y) 12

Z) 13

ANSWER: X) 11

BONUS

14) MATH *Short Answer* What is the volume of the region created by rotating the graph of $y=x^2$ between x=0 and x=5 about the x axis? (*Gideon*)

ANSWER: 625π

TOSS-UP

15) PHYSICS *Multiple Choice* Which one of Maxwell's laws forbids the presence of magnetic monopoles? (*Zhang*)

W) Ampere's law
X) Biot Savart Law
Y) Gauss's law of electricity
Z) Gauss's law of magnetism

ANSWER: Z

BONUS

15) PHYSICS *Short Answer* Order the following 3 configurations in order of increasing equivalent resistance if all the resistors are identical:

1. 3 resistors in series
2. 2 resistors in parallel connected to one resistor in series
3. 3 resistors in parallel

ANSWER: 3 2 1

TOSS-UP

16) CHEMISTRY *Short Answer* What is the hybridization of the central xenon atom in xenon difluoride?

ANSWER: dsp^3

BONUS

16) CHEMISTRY *Short Answer* Rank the following three molecules in increasing length of the nitrogen oxygen bond:

1. NO
2. NO_3^-
3. N_2O

ANSWER: 1 3 2

TOSS-UP

17) EARTH AND SPACE *Multiple Choice* Under which of the following circumstances would travertine form? (*Zhang)*

W) Kettle lakes
X) Turbidite currents
Y) White Smokers
Z) Hot Springs

ANSWER: Z) Hot Springs

BONUS

17) EARTH AND SPACE *Short Answer* Name all of the following 3 rocks which are usually considered to be hydrous:

1. Opal
2. Agate
3. Gypsum

ANSWER: 1 and 3

TOSS-UP

18) PHYSICS *Short Answer* What type of radioactive decay results in the emission of an electron neutrino, a positron, and a daughter nuclide with an atomic number 1 less than the parent nuclide? (*Gideon*)

ANSWER: Beta plus decay

BONUS

18) PHYSICS *Short Answer* What quantum mechanical operator is equal to the sum of the kinetic and potential energies of all the particles of a system? (*Gideon*)

ANSWER: Hamiltonian

TOSS-UP

19) MATH *Short Answer* Robin is thinking of a 3-digit positive integer. She writes it twice, forming a 6-digit number with digits in the pattern *abcabc*. What is the greatest factor that must divide Robin's new 6-digit number? (*Kira*)

ANSWER: 1001

BONUS

19) MATH *Short Answer* A point P is placed inside rectangle ABCD with lengths AB = 6 and BC = 8. If AP is twice the length of CP and BP is one third the length of DP, what is the ratio of the length of AP to the length of DP? (*Gideon*)

ANSWER: $\frac{2\sqrt{2}}{3}$

TOSS-UP

20) BIOLOGY *Short Answer* What is the name of the structure that is responsible for anchoring the protonema of a non vascular plant to the ground

ANSWER: Rhizoid

BONUS

20) BIOLOGY *Short Answer* Kira is studying a moss under the microscope. While pursuing the anatomical features of the moss, she notices a bulb shaped structure with an opening composed of multiple interlocking teeth anchored to the body of the moss by a long thin stalk. What structure is Kira most likely looking at?

ANSWER: Sporophyte

TOSS-UP

21) CHEMISTRY *Multiple Choice* Which of the following groups of ionic compounds is the most soluble in water?

W) Nitrates

X) Sulfates

Y) Carbonates

Z) Fluorides

ANSWER: W) Nitrates

BONUS

21) CHEMISTRY *Short Answer* Answer the following three questions about the Sandmeyer reactions:

1. Sandmeyer reactions use halides of what transition metal?
2. What is the oxidation state of the transition metal in the halide?
3. Sandmeyer reactions are used to create aryl halides from what group of compounds?

ANSWER: 1 Copper, 2. +1, 3. Aryl diazonium salts

TOSS-UP

22) EARTH AND SPACE *Multiple Choice* The graph of nuclear burning time as a function of atomic number is best described as which of the following?

W) Linear
X) Quadratic
Y) Logarithmic
Z) Exponential

ANSWER: Z) Exponential

BONUS

22) EARTH AND SPACE *Short Answer* Give, by name or number, all of the following 3 statements concerning stellar nucleosynthesis which are true:

1. Neon burning requires a minimum of 8 solar masses
2. A type II supernova occurs when a white dwarf exceeds the chandrasekhar limit
3. The product of the proton proton chain is an alpha particle

ANSWER: 1 and 3

TOSS-UP

23) BIOLOGY *Multiple Choice* One day, Bob the corkscrew snail and Abby the spiral snail decide to mate. However, when they attempt to do so, they realize that their shells spiral in the opposite directions, therefore preventing copulation. What type of prezygotic isolation is this

W. Mechanical

X. Temporal

Y. Hybrid Breakdown

Z. Behavioral

ANSWER: Y. Hybrid Breakdown

BONUS

23) BIOLOGY *Short Answer* Oh No! Daniel has fallen prey to a mysterious virus. Given that this virus has a viral envelope and it causes an inflammation of the brain accompanied by seizures and a high fever, what family would the virus most likely be classified in

ANSWER: Togavirus

TOSS-UP

24) MATH *Multiple Choice* What is the slope of the tangent line to the unit circle at $(\frac{\sqrt{3}}{2} , - \frac{1}{2})$? (*Gideon*)

W) $-\frac{\sqrt{3}}{3}$

X) $-\sqrt{3}$

Y) $\frac{\sqrt{3}}{3}$

Z) $\sqrt{3}$

ANSWER: Z) $\sqrt{3}$

BONUS

24) MATH *Short Answer* What is the cross product of the vectors i+2j+3k and 3i+2j+k? (*Gideon*)

ANSWER: -4i+8j-4k

TOSS-UP

25) PHYSICS *Short Answer* An observer is going at 0.6 c towards a 25 meter long asteroid. What length does the observer see the asteroid as? (*Zhang*)

ANSWER: 20 meters

BONUS

25) PHYSICS *Short Answer* An atwood machine is built from a massless pulley with a massless rope holding two masses of 5 and 10 kilograms at each end. What is the magnitude of the force of tension in the rope as a fraction in terms of g? (*Gideon*)

ANSWER $\frac{20g}{3}$ newtons