ROUND 10

TOSS-UP

1) Physics – *Short Answer* Identify all of the following 3 statements that are true: 1) A diverging lens always produces a smaller image than object, 2) A converging lens always produces a bigger image than object, 3) A convergent mirror always produces a virtual image?

ANSWER: 1

BONUS

1) Physics – *Multiple Choice* A lens has a focal length of f in water, and a focal length of r in a medium with index of refraction 1.66. The ratio of f/r is closest to which of the following?

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

ANSWER: Z) 2

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TOSS-UP

2) Energy – *Multiple Choice* Researchers are studying how poplar trees grow on the molecular level so that they can optimize their growth for energy production. Which of the following properties of poplar trees best explains why they are a promising source for bioenergy and biomass?

W) They have very thick trunks
X) They grow very quickly
Y) They produce fruits rapidly
Z) Their roots grow very quickly

ANSWER: X) THEY GROW VERY QUICKLY

BONUS

2) Energy – *Multiple Choice* The researchers were specifically looking at how the growth of lignocellulosic material is regulated. Which of the following best explains why regulating the growth of this type of biomass may be beneficial to energy production?
W) By decreasing the production of lignin, the bioenergy can be more easily extracted.
X) By increasing the production of lignin, the bioenergy can be more easily extracted.
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Y) By decreasing the production of lignin, the poplar trees will grow better.
Z) The regulation of lignin has no effect on the energy production.

ANSWER: W) BY DECREASING THE PRODUCTION OF LIGNIN, THE BIOENERGY CAN BE MORE EASILY EXTRACTED

ROUND 10

TOSS-UP

3) Chemistry – *Short Answer* What is the specific term for a redox reaction in which the same element is both oxidized and reduced?

ANSWER: DISPROPORTIONATION (ACCEPT: DISMUTATION)

BONUS

3) Chemistry – *Short Answer* What two functional groups are the products of alkyl radical disproportionation?

ANSWER: ALKANE AND ALKENE

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TOSS-UP

4) Biology - *Short Answer* A hospitalized patient is experiencing extreme pain in his heels and tailbone due to prolonged pressure on those areas from lack of movement. What is the name of this skin problem?

ANSWER: DECUBITUS/PRESSURE ULCER (ACCEPT BED SORE)

BONUS

4) Biology - *Short Answer* By name or number, which of the following are true about the epidermis: 1) There are five layers, 2) The stratum corneum layer undergoes mitosis, 3) It is vascular, 4) Merkel and langerhan cells are present in the stratum spinosum layer

ANSWER: 1 ONLY
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ROUND 10

TOSS-UP

5) Math – *Short Answer* A circle has a sector with central angle θ. Given that the radius of the circle and the area of the the sector are both equal to 5, what is the value of θ (in radians)?

ANSWER: 1

BONUS

5) Math – *Multiple Choice* What is the height of a cone made out of a circular sector with radius 2 and central angle π?

W) *1*
X) $\sqrt{2}$
Y) $\sqrt{3}$
Z) *2*

ANSWER: Y) $\sqrt{3}$

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TOSS-UP

6) Earth and Space - *Short Answer* What is the term for the type of mass wasting where unconsolidated material slides downwards along a curved surface?

ANSWER: SLUMP

BONUS

6) Earth and Space - *Multiple Choice* Which of the following is true about the weathering of silicates?

W) almost all silicates are incredibly resistant to weathering
X) silicates higher up on the Bowen's reaction series are generally more resistant to weathering
Y) silicates higher up on the Bowen's reaction series are generally less resistant to weathering
Z) silicates that have a higher ranking on the Mohs hardness scale are always more resistant to weathering

ANSWER: Y) SILICATES HIGHER UP ON THE BOWEN'S REACTION SERIES ARE GENERALLY LESS RESISTANT TO WEATHERING
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ROUND 10

TOSS-UP

7) Energy – *Short Answer* Researchers at Pacific Northwest National Laboratory are studying how the sun's rays interact with a 3-D surface, such as those on mountains. What is the term for the fraction of incoming solar radiation that is reflected by a surface?

ANSWER: ALBEDO

BONUS

7) Energy – *Multiple Choice* The researchers found that in general, a 3-D surface has higher temperatures than a 2-D surface would. At which of the following times of day would the 3-D effect of solar radiation on a mountain be at its lowest, leading to a relative cooling?

W) Dawn
X) Midday
Y) Evening
Z) Dusk

ANSWER: X) MIDDAY

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TOSS-UP

8) Biology - *Short Answer* What type of inhibitor is an inhibitor if the K_m of an enzyme decreases from 85 micromolar to 60 micromolar when the inhibitor is added to the enzyme solution?

ANSWER: COMPETITIVE

BONUS

8) Biology - *Short Answer* What name is given to the type of inhibition where the inhibitor binds to the enzyme at the same time as the substrate and whose presence is indicated by a decrease in both v_{max} and k_m?

ANSWER: UNCOMPETITIVE
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ROUND 10

TOSS-UP

9) Physics – *Short Answer* If sound intensity has units of W/m^2, what are it's SI base units?

ANSWER: kg/s^3

BONUS

9) Physics – *Multiple Choice* Snell's Law does not help explain or provide information about which of the following scenarios?

W) Reflection
X) Refraction
Y) Diffraction
Z) Materials with Negative Indices of Refraction

ANSWER: Y) DIFFRACTION

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TOSS-UP

10) Chemistry – *Short Answer* What is the chemical formula of the compound sodium arsenite?

ANSWER: Na_3AsO_3

BONUS

10) Chemistry – *Multiple Choice* Which of the following compounds is the least stable?

W) Vanadium (I) nitrate
X) Vanadium (II) sulfate
Y) Vanadium (III) nitride
Z) Vanadium (IV) oxide (READ Vanadium 4 oxide)

ANSWER: W) VANADIUM (I) NITRATE

TOSS-UP
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ROUND 10

11) Math – *Multiple Choice* If g(x) is the inverse of f(x) and f(x) = ln(x), Which of the following is the value of g'(1)?

W) $\frac{1}{e}$
X) e
Y) 1
Z) -1

ANSWER: X) e

BONUS

11) Math – *Short Answer* A twenty-sided die with faces labeled with positive integers from 1 to 20 is rolled 4 times. What is the expected value of the sum of the rolls?

ANSWER: 42

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TOSS-UP

12) Earth and Space - *Short Answer* By what factor would the transit depth increase in a system consisting of a planet orbiting around a star if the radius of the planet is multiplied by 6 and the radius of the star is multiplied by 2?

ANSWER: 3

BONUS

12) Earth and Space - *Short Answer* The Cascade Mountains are a mountain range found in the United States that formed because of a subduction zone. What are the names of the two continental plates colliding at this convergent plate boundary?

ANSWER: JUAN DE FUCA AND NORTH AMERICAN
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ROUND 10

TOSS-UP

13) Biology - *Multiple Choice* What type of fruit develops from many carpels of one flower?

W) Simple Fruit
X) Aggregate Fruit
Y) Multiple Fruit
Z) Accessory Fruit

ANSWER: X) AGGREGATE FRUIT

BONUS

13) Biology - *Multiple Choice* Which of the following is an example of when an incomplete flower results in the flower being sterile?

W) Grass flowers that lack petals
X) The parts of a sunflower that appear to be the petals
Y) Coconut flower that lacks stamen
Z) Watermelon flower that lacks carpel

ANSWER: X) THE PARTS OF A SUNFLOWER THAT APPEAR TO BE THE PETALS

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TOSS-UP

14) Energy – *Short Answer* Scientists at Oak Ridge National Laboratory are attempting to compute an atomic nucleus, specifically the deuteron. Deuteron is an isotope of which element?

ANSWER: HYDROGEN

BONUS

14) Energy – *Short Answer* Deuteron is also the nucleus of deuterium, which is widely used as a tracer for analyzing chemical reactions. What compound is formed when deuterium combines with oxygen?

ANSWER: HEAVY WATER (ACCEPT: DEUTERIUM OXIDE)
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ROUND 10

TOSS-UP

15) Physics – *Multiple Choice* In conducting the double slit experiment, Thomas Young wanted which of the following to produce a more visible diffraction pattern?

W) Greater distance between slits
X) Less distance between Slits
Y) More transparent material on either side of slit
Z) Object with high index of refraction between slits

ANSWER: X) LESS DISTANCE BETWEEN SLITS

BONUS

15) Physics – *Short Answer* What is the term for the property of materials that refract light differently depending on the direction of the light?

ANSWER: BIREFRINGENCE

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TOSS-UP

16) Earth and Space - *Multiple Choice* Which of the following radioisotopes would be least useful when dating a 10,000 year old rock?

W) Carbon - 14
X) Uranium - 238
Y) Thorium - 230
Z) Potassium - 40

ANSWER: X) URANIUM - 238

BONUS

16) Earth and Space - *Short Answer* Assume that there is a cross section of stratas labeled from top to bottom as A, B, and C with a dike going through stratas B and C. What period did strata B likely form in if strata C is found to be 400 million years old and the dike is found to be 360 million years old?

ANSWER: DEVONIAN PERIOD
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ROUND 10

TOSS-UP

17) Chemistry – *Short Answer* Which industrial process uses molten cryolite and produces aluminum?

ANSWER: HALL-HEROULT PROCESS

BONUS

17) Chemistry – *Short Answer* What is the chemical process used to make nitric acid called?

ANSWER: OSTWALD PROCESS

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TOSS-UP

18) Math – *Short Answer* What are the dimensions of a matrix that is the product of a 2x5 matrix and a 5x3 matrix?

ANSWER: 2x3

BONUS

18) Math – *Short Answer* The diagonals of a parallelogram have lengths 5 and 6. The larger angle between the diagonals is $150°$.What is the area of the parallelogram?

ANSWER: $\frac{15}{2}$
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ROUND 10

TOSS-UP

19) Chemistry – *Multiple Choice* Which of the following compounds is the least soluble in water at 25°C?

W) Aluminum sulfate
X) Silver iodide
Y) Lead nitrate
Z) Calcium acetate

ANSWER: X) SILVER IODIDE

BONUS

19) Chemistry – *Multiple Choice* When calcium fluoride is dissolved in water, the temperature of the water decreases. Which of the following would increase the molar solubility of calcium fluoride?

W) Decrease the temperature
X) Add sodium fluoride to the solution
Y) Add hydrochloric acid
Z) Add ammonia

ANSWER: Y) ADD HYDROCHLORIC ACID

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TOSS-UP

20) Physics – *Short Answer* What is the work done on a 5 C charge by an external magnetic field of 2 T as the charge moves at 5 m/s into the field and moves in a semicircle with radius 2/pi?

ANSWER: 0

BONUS

20) Physics – *Short Answer* If there are two equal but opposite charges in a plane, what is the shape of the locus of coplanar points that have an electric potential of zero?

ANSWER: LINE
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ROUND 10

TOSS-UP

21) Earth and Space - *Short Answer* By name or number, identify all of the following 5 choices that are characteristic of a quasar: 1) Consists of a massive black hole, 2) Consists of a neutron star, 3) Pulsates every few milliseconds, 4) Emits radiation mostly in the microwave range, 5) Contains an accretionary disk.

ANSWER: 1, 5 (ACCEPT: CONSISTS OF A MASSIVE BLACK HOLE, CONTAINS AN ACCRETIONARY DISK)

BONUS

21) Earth and Space - *Multiple Choice* Which of the following best explains what WHIM is?

W) it makes up the majority of dark matter
X) it makes up over 50% of the baryonic matter in the universe
Y) it consists of a cool gas and particles of dust found in-between galaxies
Z) it is emitted by stars and can oscillate flavors as it travels through space

ANSWER: X) IT MAKES UP OVER 50% OF THE BARYONIC MATTER IN THE UNIVERSE

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TOSS-UP

22) Biology - *Short Answer* What is the name of the family of proteins responsible for forming tight junctions between cells?

ANSWER: CLAUDIN

BONUS

22) Biology - *Multiple Choice* Which of the following BEST describes the composition of proteoglycan, which forms a complex that holds together the Extracellular Matrix?

W) 5% carbohydrates, 95% proteins
X) 5% proteins, 95% carbohydrates
Y) 15% lipids, 85% proteins
Z) 15% carbohydrates, 85% lipids

ANSWER: X) 5% PROTEINS, 95% CARBOHYDRATES
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ROUND 10

TOSS-UP

23) Math – *Multiple Choice* What is the sum of $\cos \pi/7 + \cos 9\pi/14 + \cos 8\pi/7 + \cos 23\pi/14$?

W) -1
X) 0
Y) 1
Z) 2

ANSWER: X) 0

BONUS

23) Math – *Short Answer* Identify all of the following 4 shapes that could be the graph of a degenerate conic in the xy plane: 1) Nothing, 2) A point, 3) A line, 4) Two parallel lines

ANSWER: ALL