

TOSS-UP

1) Physics – *Multiple Choice* An electron beam is directed in the positive y direction. If a magnetic field is applied in the negative x direction, in what direction will the beam be deflected?

- W) Positive x
- X) Negative y
- Y) Positive z
- Z) Negative z

ANSWER: Z) NEGATIVE Z [LY, WESTVIEW]

BONUS

1) Physics – *Short Answer* To an observer at rest, a particle is moving at 0.28c. What is the ratio of the particle's energy to its rest mass in terms of c?

ANSWER: 25/24 c^2 (ACCEPT: 25/24) [LY, SBST]

TOSS-UP

2) Biology – *Multiple Choice* In an interrupted mating experiment between an Hfr cell and an F [READ: F MINUS] cell, which of the following describes the most probable resulting statuses of the two cells?

- W) F⁺ and F⁻
- X) Hfr and F⁺
- Y) Hfr and Hfr
- Z) Hfr and F⁻

ANSWER: Z) HFR AND F⁻ [JH, BACTERIA]

BONUS

2) Biology – *Short Answer*. What is the effective population size of a population containing 420 peacocks and 210 peahens where all individuals are breeding?

ANSWER: 560 [JH, PEACOCKS]

TOSS-UP

3) Math – *Multiple Choice* Suppose a function satisfies the equation $f(x + y) = f(x) + f(y)$ for all real numbers x and y. Which of the following statements must be true about the function f?

- W) $f(x)$ is linear
- X) $f(x)$ is continuous
- Y) $f(x)$ is monotonous
- Z) $f(x)$ has a root at $x = 0$

ANSWER: Z) $f(x)$ HAS A ROOT AT $x = 0$ [GW, Functions]

BONUS

- 3) Math – *Short Answer* Find the limit as n goes to infinity of the fraction with numerator the n-th root of n! (*n factorial*) and denominator n.

ANSWER: 1/e [GW, Logs/Exponents]

TOSS-UP

- 4) Earth and Space – *Multiple Choice* Which of the following statements is NOT true regarding roche moutonnees?

- W) Plucking occurs on the lee side
- X) Abrasion occurs on the stoss side
- Y) The less steep side of roche moutonnees dips towards the direction of glacial movement
- Z) Roche moutonnees are strictly erosional structures

ANSWER: Y) THE LESS STEEP SIDE OF ROCHE MOUTONNEES DIPS TOWARDS THE DIRECTION OF GLACIAL MOVEMENT [LY, SBST]

BONUS

- 4) Earth and Space – *Multiple Choice* Which of the following phyllosilicates is commonly known as magnesium mica?

- W) Annite
- X) Phlogopite
- Y) Siderophyllite
- Z) Muscovite

ANSWER: X) PHLOGOPITE [LY, LEX]

TOSS-UP

- 5) Chemistry – *Multiple Choice* Which of the following amino acids is best able to function as a hydrogen bond acceptor under normal bodily conditions?

- W) Tyrosine

- X) Valine
- Y) Methionine
- Z) Isoleucine

ANSWER: W) TYROSINE [LY, idk]

BONUS

5) Chemistry – *Short Answer* Consider a beaker containing a saturated solution of silver sulfide, with some solid remaining at the bottom. Identify all of the following 3 changes to the system that would allow more silver sulfide to be dissolved: 1) Addition of ammonia; 2) Addition of sodium hydroxide; 3) Addition of more solid silver sulfide.

ANSWER: 1 ONLY [LY, NEWTOWN]

TOSS-UP

6) Energy – *Short Answer* Researchers probably sometimes use programming languages? Identify all of the following four languages that are statically typed: 1) C++; 2) Java; 3) Javascript; 4) Python.

ANSWER: 1 AND 2 [GW, Types/CS]

BONUS

6) Energy – *Short Answer* Scientists at Ames National Lab are using X-ray crystallography to study the structure of the small peptide pro-opiomelanocortin, or POMC. Identify all of the following 3 hormones that are derived from POMC: 1) ACTH; 2) Thyroxine; 3) MSH.

ANSWER: 1 AND 3 [LY, R10]

TOSS-UP

7) Physics – *Short Answer* A compound machine is made from the combination of a lever with efficiency 0.8 and a screw with efficiency 0.6. If 100 Joules of work is inputted into the system, how much work will be lost to external forces?

ANSWER: 52 [LY, R10]

BONUS

7) Physics – *Short Answer* A bouncy ball is dropped from a height of 3 meters. Each time it bounces, it loses a third of its kinetic energy. What is the total vertical distance it will travel before it comes to rest?

ANSWER: 15 [LY, SBST]

TOSS-UP

8) Biology – *Multiple Choice* Which of the following describes the difference in the number of action potentials and the location of peak basilar membrane vibration of a 60 decibel, 400 Hz tone compared to a 100 decibel, 200 Hz tone?

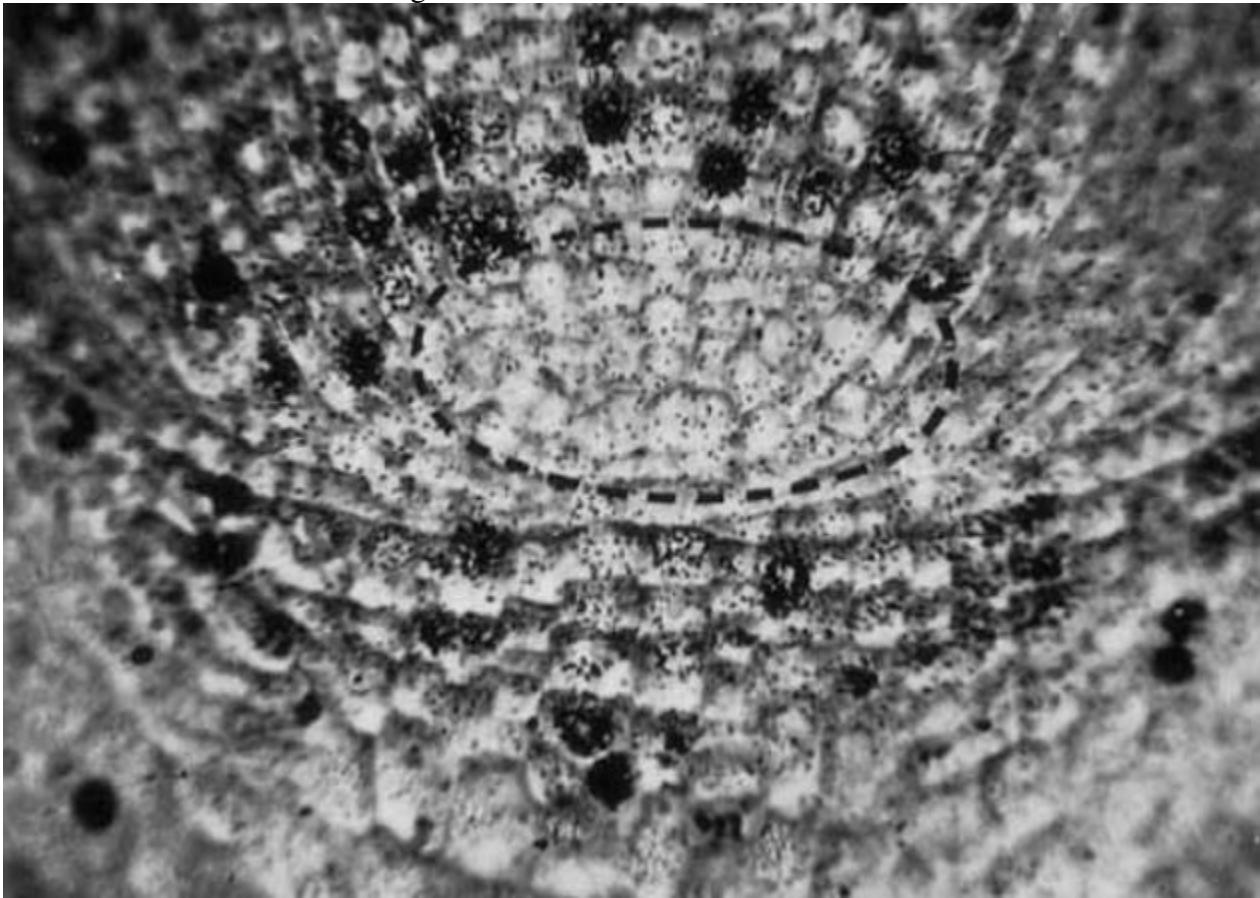
- W) Fewer action potentials, closer to the oval window
- X) Fewer action potentials, further from the oval window
- Y) More action potentials, closer to the oval window
- Z) More action potentials, further from the oval window

ANSWER: W) FEWER ACTION POTENTIALS, CLOSER FROM THE OVAL WINDOW
[JH, EARS]

VISHWAL BONUS

8) Biology – *Short Answer* In an experiment, a root was grown in a medium containing radioactively labeled thymidine for one day. Answer the following two questions regarding the image from the experiment: 1) Which canonical root zone is shown in the image: the zone of maturation, elongation, or cell division? 2) What is the term given to the oval-shaped region

outlined in the center of the image?



ANSWER: 1) ZONE OF CELL DIVISION; 2) QUIESCENT CENTER [JH, CENTERS]

TOSS-UP

9) Math – *Short Answer* Joe has 8 flexible bars of unit length. What is the area of the largest possible region he can enclose with these bars?

ANSWER: 16 OVER PI [LY, cringe]

BONUS

9) Math – *Short Answer* The Pell numbers are defined by P_0 equals 0, P_1 equals 1, and P_n equals 2 times P_{n-1} plus P_{n-2} . As n approaches infinity, what is the limit of the ratio of P_{n+1} to P_n ?

ANSWER: ROOT 2 PLUS 1 [LY, SEQS]

TOSS-UP

10) Earth and Space – *Short Answer* Order the following 3 clastic rock types in terms of increasing quartz to clay ratio: 1) Quartz arenite; 2) Greywacke; 3) Siltstone.

ANSWER: 3, 2, 1 [LY, SBST]

BONUS

10) Earth and Space – *Short Answer* To one significant figure and in scientific notation, what is the radius of the innermost stable circular orbit of a massive particle around a nonrotating black hole with mass 9 times 10 to the 24th kilograms?

ANSWER: 4 TIMES 10 TO THE NEGATIVE 2 [LY, so cringe man]

TOSS-UP

11) Chemistry – *Multiple Choice* Which of the following statements is correct regarding the selectivity of the Diels-Alder reaction?

- W) The endo product is both thermodynamically and kinetically favored
- X) The exo product is both thermodynamically and kinetically favored
- Y) The endo product is thermodynamically favored while the exo product is kinetically favored
- Z) The exo product is thermodynamically favored while the endo product is kinetically favored

ANSWER: Z) THE EXO PRODUCT IS THERMODYNAMICALLY FAVORED WHILE THE ENDO PRODUCT IS KINETICALLY FAVORED [LY, R10]

BONUS

11) Chemistry – *Short Answer* When calculating lattice energy, what material-specific constant accounts for the arrangement of ions in the lattice?

ANSWER: MADELUNG CONSTANT [LY, NEWTOWN]