

TOSS-UP

1) Biology – *Short Answer* During intense periods of exercise, the blood may not be able to provide sufficient oxygen to the muscles to support aerobic respiration. Under these conditions, pyruvate is converted by fermentation into what molecule?

ANSWER: LACTIC ACID (ACCEPT: LACTATE)

BONUS

1) Biology – *Multiple Choice* What is the term for the structure that implants into the endometrium during mammalian development?

W) Blastocyst
X) Gastrula
Y) Chorionic villus
Z) Fetus

ANSWER: W) BLASTOCYST

TOSS-UP

2) Chemistry – *Multiple Choice* Which of the following is the best strategy to compensate for random errors during an experiment in an unbiased manner?

- W) Making repeated independent measurements
- X) Switching measurement devices
- Y) Using machine learning to model error
- Z) Apply a filter to reduce noise

ANSWER: W) MAKING REPEATED INDEPENDENT MEASUREMENTS

BONUS

2) Chemistry – *Multiple Choice* Biopolymers are, in general, what type of polymer?

- W) Polyamide
- X) Condensation
- Y) Polyether
- Z) Thermal

ANSWER: X) CONDENSATION

TOSS-UP

3) Earth and Space – *Multiple Choice* Which of the following statements about rivers is true?

- W) Point bars occur where river velocity reaches a maximum
- X) Water flow velocity is typically fastest near the headwaters
- Y) Oxbow lakes are the remnants of former river channels
- Z) Channel slopes tend to increase towards the river mouth

ANSWER: Y) OXBOW LAKES ARE THE REMNANTS OF FORMER RIVER CHANNELS

BONUS

3) Earth and Space – *Short Answer* Identify all of the following three plant nutrients that can originate from the atmosphere:

- 1) Carbon; 2) Phosphorus; 3) Nitrogen.

ANSWER: 1, 3

TOSS-UP

4) Energy – *Multiple Choice* Argonne National Lab scientists are utilizing lasers and levitation to improve the creation of refractory oxides such as hafnium (IV) oxide. These refractory materials are useful because of which of their properties?

W) Heat resistance
X) Extensive malleability
Y) High electrical conductivity
Z) High neutron cross section

ANSWER: W) HEAT RESISTANCE

BONUS

4) Energy – *Short Answer* Scientists supported by the Department of Energy are studying the most common catecholamine neurotransmitter in the brain. What is the name of this compound?

ANSWER: DOPAMINE

TOSS-UP

5) Math – *Short Answer* If the odds against an event are 8 to 3, what is the probability of the event occurring?

ANSWER: 3/11

BONUS

5) Math – *Short Answer* Solve the following equation for x :
 $x - 5$ equals the square root of open parenthesis, $4x + 1$, close parenthesis.

ANSWER: 12 (do not accept: 2)

TOSS-UP

6) Physics – *Multiple Choice* Which of the following best describes the difference between resistance and resistivity?

- W) They are synonymous
- X) Resistivity is intrinsic, while resistance is extrinsic
- Y) Resistivity is used for fluids, and resistance is used for solids
- Z) Superconductors have zero resistance but nonzero resistivity

ANSWER: X) RESISTIVITY IS INTRINSIC, WHILE RESISTANCE IS EXTRINSIC

BONUS

6) Physics – *Short Answer* Liam is test driving a new car. Starting from rest, he presses the gas pedal for 5 seconds, causing the car to move with a constant acceleration of 8 meters per second squared. In meters, how far does Liam travel over these 5 seconds?

ANSWER: 100

TOSS-UP

7) Biology – *Short Answer* What gaseous plant hormone is commonly used to accelerate ripening after shipping and transport of fruit?

ANSWER: ETHYLENE (ACCEPT: ETHENE)

BONUS

7) Biology – *Short Answer* Individuals with a thymine at position 478 in the *MC1R* gene will have red hair and freckles, whereas other individuals may have a cytosine at this nucleotide position. What is the term for such genetic variants that are determined by one base change?

ANSWER: SINGLE NUCLEOTIDE POLYMORPHISM (ACCEPT: SNP, “SNIP”)

TOSS-UP

8) Chemistry – *Multiple Choice* What type of bond is formed in the reaction of a Lewis acid with a Lewis base?

- W) Ionic
- X) Hydrogen
- Y) Dative
- Z) Nonpolar covalent

ANSWER: Y) DATIVE

BONUS

8) Chemistry – *Multiple Choice* The mass spectrum for a compound has a parent peak at 80 M over Z and another peak at 65 M over Z. This indicates that what species is present in the compound?

- W) Hydroxyl
- X) Carboxyl
- Y) Acetyl
- Z) Methyl

ANSWER: Z) METHYL

TOSS-UP

9) Earth and Space – *Multiple Choice* Earth reflects approximately 30% of the light it receives from the Sun back into space. Which of the following components of Earth is responsible for the predominant portion of this reflectivity?

- W) Clouds
- X) Atmospheric gasses
- Y) Land surface
- Z) Ocean surface

ANSWER: W) CLOUDS

BONUS

9) Earth and Space – *Multiple Choice* Which of the following is a key characteristic of a protostar?

- W) It is performing hydrogen fusion
- X) It is performing helium fusion
- Y) It is surrounded by an opaque envelope
- Z) It is at least one solar mass

ANSWER: Y) IT IS SURROUNDED BY AN OPAQUE ENVELOPE

TOSS-UP

10) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory are searching for bound states of gluons. Which of the following particles are bound together by gluons?

- W) Proton
- X) Electron
- Y) Muon
- Z) Higgs boson

ANSWER: W) PROTON

BONUS

10) Energy – *Short Answer* Scientists supported by the Department of Energy are making batteries based on the metal produced by the Hall-Heroult process. What is this metal?

ANSWER: ALUMINUM (ACCEPT: Al)

TOSS-UP

11) Math – *Short Answer* How many multiples of 12 are there between 22 and 100?

ANSWER: 7

BONUS

11) Math – *Short Answer* In a parallelogram, two non-congruent angles have degree measures, in terms of a number x , of $4x + 9$ and $7x - 5$, respectively. What is the value of x ?

ANSWER: 16

TOSS-UP

12) Physics – *Short Answer* A 80-kilogram man is standing on the left end of a 200-kilogram rowboat, which is floating in calm water. He then walks 1 meter to the other side of the rowboat. To the nearest centimeter, by what distance does the center of mass of the man and rowboat move while the man walks?

ANSWER: 0

BONUS

12) Physics – *Short Answer* In meters to two significant figures, what is the wavelength of a sound wave produced by a 225-hertz tuning fork?

ANSWER: 1.5

TOSS-UP

13) Biology – *Multiple Choice* Which of the following complexes breaks the central dogma of molecular biology?

- W) DNA polymerase
- X) RNA polymerase
- Y) Reverse transcriptase
- Z) Ribosome

ANSWER: Y) REVERSE TRANSCRIPTASE

BONUS

13) Biology – *Multiple Choice* In which of the following situations would it be most helpful for a patient to take an antihistamine?

- W) After getting a papercut
- X) During an allergic reaction
- Y) After getting scratched by a rusty nail
- Z) During a surgical procedure

ANSWER: X) DURING AN ALLERGIC REACTION

TOSS-UP

14) Chemistry – *Short Answer* What is the term for the state at which the rate of the forward reaction is equal to the rate of the reverse reaction?

ANSWER: EQUILIBRIUM (ACCEPT: DYNAMIC EQUILIBRIUM)

BONUS

14) Chemistry – *Multiple Choice* In which of the following compounds does hydrogen have an oxidation state that is NOT +1?
W) NH₃
X) CH₃COOH
Y) HF
Z) NaH

ANSWER: Z) NaH

TOSS-UP

15) Earth and Space – *Multiple Choice* What type of unconformity occurs when rocks are tilted and eroded before younger rocks are deposited?

W) Angular unconformity
X) Disconformity
Y) Nonconformity
Z) Oblique unconformity

ANSWER: W) ANGULAR UNCONFORMITY

BONUS

15) Earth and Space – *Multiple Choice* Which of the following statements is FALSE regarding sea and land breezes?

W) They result from the differential heating of sea and land
X) Sea breezes typically occur at night
Y) Land breezes blow from land to sea
Z) They are paired with a compensatory high-altitude wind blowing in the opposite direction

ANSWER: X) SEA BREEZES TYPICALLY OCCUR AT NIGHT

TOSS-UP

16) Energy – *Short Answer* Scientists supported by the Department of Energy are studying hexokinase, an enzyme that adds a phosphate group to glucose by taking it from what compound?

ANSWER: ATP (ACCEPT: ADENOSINE TRIPHOSPHATE)

BONUS

16) Energy – *Short Answer* Scientists at Princeton Plasma Physics Lab are studying magnetic reconnection events. Identify all of the following three processes that are caused by magnetic reconnection:
1) Solar flare; 2) Coronal mass ejection; 3) Aurora borealis.

ANSWER: 1, 2

TOSS-UP

17) Math – *Short Answer* The number of the year 2019 had 4 different digits. What is the next year with 4 different digits?

ANSWER: 2031

BONUS

17) Math – *Short Answer* What are the radius and the coordinates of the center of the circle with equation $x^2 + y^2 + 10x - 4y - 11 = 0$?

ANSWER: RADIUS $2\sqrt{10}$, CENTER $(-5, 2)$ (ACCEPT: $x = -5$ AND $y = 2$ FOR CENTER)

TOSS-UP

18) Physics – *Short Answer* Van travels a distance of 360 kilometers in 240 minutes. In kilometers per hour, what was his average speed?

ANSWER: 90

BONUS

18) Physics – *Multiple Choice* Which of the following quantities has the same units as angular momentum per time?

- W) Force
- X) Angular velocity
- Y) Moment of inertia
- Z) Torque

ANSWER: Z) TORQUE