

TOSS-UP

1) Energy – *Short Answer* Scientists at Oak Ridge National Lab are researching methods to program bacteria to convert citric acid into itaconic acid, which involves the loss of a carboxyl group. What gas is produced as a byproduct of this reaction?

ANSWER: CARBON DIOXIDE (ACCEPT: CO₂)

BONUS

1) Energy – *Short Answer* Scientists at Argonne National Lab are using density functional theory to model the properties of hafnia, also known as hafnium dioxide. Identify all of the following three properties that this compound is expected to have: 1) Low melting point; 2) High electrical conductivity; 3) Chemically inert.

ANSWER: 3

TOSS-UP

2) Math – *Short Answer* Identify a linear factor of $x^2 + 4x - 96$.

ANSWER: $x + 12$ (ACCEPT: $x - 8$)

BONUS

2) Math – *Short Answer* What are the coordinates of the vertex of the parabola with equation $y = x^2 + 18x + 31$?

ANSWER: $(-9, -50)$ (ACCEPT: $x = -9, y = -50$)

TOSS-UP

3) Physics – *Multiple Choice* A particle is moving along a circular path with a constant speed. What is the term for the force that pulls the particle inwards towards the center of the circle?

- W) Centripetal force
- X) Centrifugal force
- Y) Tensional force
- Z) Torque

ANSWER: W) CENTRIPETAL FORCE

BONUS

3) Physics – *Short Answer* Rank the following three regions of the electromagnetic spectrum in order of increasing energy: 1) Infrared; 2) Gamma; 3) Ultraviolet.

ANSWER: 1, 3, 2

TOSS-UP

4) Biology – *Short Answer* In a clinical trial, a pharmacologically-inactive substance is often given as a substitute for an active substance to match as closely as possible the experience of a comparison group with that of a treatment group. This inactive substance is more commonly known as what?

ANSWER: PLACEBO

BONUS

4) Biology – *Multiple Choice* Which of the classes of biomacromolecules has the highest energy density per unit mass?
W) Fats
X) Carbohydrates
Y) Proteins
Z) Nucleic acids

ANSWER: W) FATS

TOSS-UP

5) Chemistry – *Multiple Choice* What is the term for the heat content of a system?

- W) Entropy
- X) Enthalpy
- Y) Lattice energy
- Z) Bond dissociation energy

ANSWER: X) ENTHALPY

BONUS

5) Chemistry – *Short Answer* Rank the following three substances in order of increasing absolute entropy at STP: 1) Ethane; 2) Water; 3) Graphite.

ANSWER: 3, 2, 1

TOSS-UP

6) Earth and Space – *Multiple Choice* Which of the following bodies does NOT have an atmosphere composed predominantly of nitrogen?

- W) Venus
- X) Titan
- Y) Earth
- Z) Pluto

ANSWER: W) VENUS

BONUS

6) Earth and Space – *Short Answer* Identify all of the following three moons that are tidally locked to their planets: 1) Earth's moon; 2) Phobos; 3) Deimos.

ANSWER: ALL

TOSS-UP

7) Energy – *Short Answer* Scientists at Brookhaven National Lab are developing technologies to detect dopamine in the brain. What disease is caused by the death of dopaminergic neurons in the substantia nigra?

ANSWER: PARKINSON'S DISEASE

BONUS

7) Energy – *Short Answer* Scientists supported by the Department of Energy are studying biopolymers. Identify all of the following three molecules that are examples of biopolymers: 1) Silk; 2) DNA; 3) Polyethylene.

ANSWER: 1, 2

TOSS-UP

8) Math – *Short Answer* If the length of each side of a regular pentagon is decreased by 70%, by what percentage is the area decreased?

ANSWER: 91

BONUS

8) Math – *Multiple Choice* A square is drawn with one vertex at the origin and another vertex at (6, 8). Which of the following could be the area of the square?

- W) 25
- X) 28
- Y) 50
- Z) 200

ANSWER: Y) 50

TOSS-UP

9) Physics – *Short Answer* What is the term for the positively charged nucleon?

ANSWER: PROTON

BONUS

9) Physics – *Short Answer* A 1000-kilogram plane is cruising at constant velocity. Its engines are exerting a constant thrust of 90,000 newtons. In meters per second squared, what is the acceleration of the plane?

ANSWER: 0

TOSS-UP

10) Biology – *Short Answer* What phylum are humans part of?

ANSWER: CHORDATA (ACCEPT: CHORDATES)

BONUS

10) Biology – *Short Answer* What polysaccharide is the major component of the fungal cell wall?

ANSWER: CHITIN

TOSS-UP

11) Chemistry – *Short Answer* What is the term for a chemical half-reaction that results in a gain of electrons?

ANSWER: REDUCTION

BONUS

11) Chemistry – *Multiple Choice* Methoxyethane is an example of what class of organic molecule?

- W) Alkane
- X) Alkyne
- Y) Ketone
- Z) Ether

ANSWER: Z) ETHER

TOSS-UP

12) Earth and Space – *Multiple Choice* In years, which of the following is closest to the age of Earth?

- W) 1.2 billion
- X) 3.3 billion
- Y) 4.5 billion
- Z) 6.2 billion

ANSWER: Y) 4.5 BILLION

BONUS

12) Earth and Space – *Short Answer* You find an igneous rock that has large, coarse crystals in its structure. Identify all of the following three statements that are reasonable conclusions about this rock:

- 1) It is felsic; 2) It is mafic; 3) It cooled in Earth's interior.

ANSWER: 3

TOSS-UP

13) Energy – *Short Answer* Scientists are using the Atmospheric Radiation Measurement facility to study a cloud type that covers vast areas of the ocean. What is this cloud type?

ANSWER: STRATOCUMULUS (ACCEPT: CUMULOSTRATUS, TWAIN)

BONUS

13) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory are colliding fully-ionized gold atoms. Which of the following is true regarding ionization energies on the periodic table?
W) They decrease from left to right
X) They increase from top to bottom
Y) They are greatest for alkali metals
Z) They are greatest for noble gases

ANSWER: Z) THEY ARE GREATEST FOR NOBLE GASES

TOSS-UP

14) Math – *Short Answer* For the function f of $x = 3x + 1$, what is f inverse of -11 ?

ANSWER: -4

BONUS

14) Math – *Short Answer* What is the 25^{th} term in the arithmetic sequence with third term 7 and sixth term 25 ?

ANSWER: 139

TOSS-UP

15) Physics – *Multiple Choice* Which of the following is an example of a longitudinal wave?

- W) Pressure wave
- X) Radio wave
- Y) Light
- Z) Shear wave

ANSWER: W) PRESSURE WAVE

BONUS

15) Physics – *Short Answer* What principle states that if two waves overlap, their displacements are added?

ANSWER: SUPERPOSITION

TOSS-UP

16) Biology – *Short Answer* What biochemical process converts glucose to two molecules of pyruvate?

ANSWER: GLYCOLYSIS

BONUS

16) Biology – *Short Answer* What is the term for the rhythmic muscle contractions that move food through the human digestive system?

ANSWER: PERISTALSIS

TOSS-UP

17) Chemistry – *Short Answer* What is the empirical formula of ammonium sulfate?

ANSWER: $(\text{NH}_4)\text{SO}_4$

BONUS

17) Chemistry – *Short Answer* What is the complete electron configuration for neutral boron?

ANSWER: $1\text{S}^2 2\text{S}^2 2\text{P}^1$

TOSS-UP

18) Earth and Space – *Short Answer* What is the process in Earth's mantle in which hot rock rises and cool rock sinks, driving circulation of fluid material similar to the flow of water in a heated pot?

ANSWER: CONVECTION

BONUS

18) Earth and Space – *Multiple Choice* In which of the following types of rocks would you be most likely to find a fossil?

- W) Shale
- X) Basalt
- Y) Andesite
- Z) Gneiss

ANSWER: W) SHALE