

TOSS-UP

1) Math – *Short Answer* What is the determinant of the 2-by-2 matrix with first row 3, 10 and second row 2, 5?

ANSWER: -5

BONUS

1) Math – *Short Answer* A four-person bowling team’s average score for one game is 178. If the scores for three of the players are 126, 167, and 195, what was the score of the fourth player?

ANSWER: 224

TOSS-UP

2) Physics – *Multiple Choice* Given that middle C is 261.63 hertz, then, in hertz, what is the frequency of the next overtone of C?

- W) 130.31
- X) 523.26
- Y) 1046.5
- Z) 2093.0

ANSWER: X) 523.26

BONUS

2) Physics – *Short Answer* A wave has a wavelength of 2 meters and a frequency of 6 hertz. In meters per second, what is its speed?

ANSWER: 12

TOSS-UP

3) Biology – *Short Answer* One reason that the gene for sickle-cell disease has become fixed in the population is that it offers protection against what parasitic disease?

ANSWER: MALARIA

BONUS

3) Biology – *Short Answer* What bacterial enzymes recognize specific DNA sequences and introduce a double-stranded break?

ANSWER: RESTRICTION ENZYMES (ACCEPT: RESTRICTION ENDONUCLEASES)

TOSS-UP

4) Chemistry – *Short Answer* What is the adjective for a reaction that results in an energy transfer from the surroundings to the system?

ANSWER: ENDOTHERMIC

BONUS

4) Chemistry – *Multiple Choice* Consider a chemical reaction with a standard enthalpy change of 10 kilojoules per mole and a standard entropy change of 10 joules per mole kelvin. When is this reaction spontaneous?
W) At all temperatures
X) Above 1000 kelvins
Y) Below 1000 kelvins
Z) Never

ANSWER: X) ABOVE 1000 KELVINS

TOSS-UP

5) Earth and Space – *Short Answer* The fan-shaped feature that is formed where a river meets the sea is known as what?

ANSWER: DELTA

BONUS

5) Earth and Space – *Multiple Choice* Which of the following best describes the thermocline present in most of the world's oceans?

- W) Temperature increases with salinity
- X) Temperature decreases with salinity
- Y) Temperature increases with depth
- Z) Temperature decreases with depth

ANSWER: Z) TEMPERATURE DECREASES WITH DEPTH

TOSS-UP

6) Energy – *Short Answer* Scientists supported by the Department of Energy are studying the structures that connect muscle to bone. What is the name of these structures?

ANSWER: TENDONS

BONUS

6) Energy – *Short Answer* Scientists at Oak Ridge National Lab are developing new methods to train statistical learning systems that are based on a collection of connected units that transmit signals to one another. What is the general term for this system?

ANSWER: NEURAL NETWORK (ACCEPT: ARTIFICIAL NEURAL NETWORKS)

TOSS-UP

7) Math – *Short Answer* Increasing a number by 120% is equivalent to multiplying the number by what decimal?

ANSWER: 2.2

BONUS

7) Math – *Multiple Choice* Two cards are drawn from a standard 52-card deck. Which of the following is closest to the probability that both cards are aces?

- W) 0.1%
- X) 0.5%
- Y) 1%
- Z) 5%

ANSWER: X) 0.5%

TOSS-UP

8) Physics – *Short Answer* What is the term for the tendency of objects to resist changes in motion?

ANSWER: INERTIA

BONUS

8) Physics – *Short Answer* What phase change is characterized by evaporation below the surface of a liquid?

ANSWER: BOILING

TOSS-UP

9) Biology – *Short Answer* Decompression sickness, also called "the bends", is primarily the result of what dissolved blood gas coming out of solution?

ANSWER: NITROGEN (ACCEPT: DINITROGEN, NITROGEN GAS, N₂)

BONUS

9) Biology – *Multiple Choice* What is the term for the process of programmed cell death that helps structures develop shape during development?

- W) Necrosis
- X) Apoptosis
- Y) Cytokinesis
- Z) Telophase

ANSWER: X) APOPTOSIS

TOSS-UP

10) Chemistry – *Short Answer* In a galvanic cell, what is the term for the electrode at which reduction occurs?

ANSWER: CATHODE

BONUS

10) Chemistry – *Short Answer* Identify all of the following three factors that can introduce random errors to an experiment:

- 1) Uncontrolled variables;
- 2) Noisy measurement tools;
- 3) Truncating the measurements to two significant figures.

ANSWER: 1, 2

TOSS-UP

11) Earth and Space – *Multiple Choice* Lunar terrae are another name for what surface feature?

- W) Maria
- X) Impact craters
- Y) Highlands
- Z) Mountainous terrain

ANSWER: Y) HIGHLANDS

BONUS

11) Earth and Space – *Multiple Choice* What is the densest layer of the Sun's atmosphere?

- W) Corona
- X) Solar wind
- Y) Photosphere
- Z) Transition zone

ANSWER: Y) PHOTOSPHERE

TOSS-UP

12) Energy – *Short Answer* Scientists supported by the Department of Energy are studying the two bands closest to the Fermi level. One of these bands is called the valence band, while the other band is called what?

ANSWER: CONDUCTION BAND

BONUS

12) Energy – *Multiple Choice* Scientists at Brookhaven National Laboratory are studying particle-collision processes that create pairs of Higgs bosons. Which of the following pairs of particles could form from a single photon?

- W) Proton and neutron
- X) Up quark and down quark
- Y) W boson and Z boson
- Z) Electron and positron

ANSWER: Z) ELECTRON AND POSITRON

TOSS-UP

13) Math – *Short Answer* A plane has a groundspeed of 453 miles per hour. To the nearest second, how long does it take for the plane to travel one mile?

ANSWER: 8

BONUS

13) Math – *Short Answer* Rounding your answer to the nearest tenth, what is the length of a diagonal in a square with sides of length 26?

ANSWER: 36.8

TOSS-UP

14) Physics – *Short Answer* What principle states that the buoyant force on an object is equal to the weight of the liquid it displaces?

ANSWER: ARCHIMEDES' PRINCIPLE

BONUS

14) Physics – *Short Answer* Vince is standing halfway between the center and the outer edge of a merry-go-round, while Jan is standing at the outer edge. By what factor must Vince's tangential speed be multiplied to get Jan's tangential speed?

ANSWER: 2

TOSS-UP

15) Biology – *Short Answer* The role of cristae is to increase the surface area of the inner membrane of what eukaryotic organelle?

ANSWER: MITOCHONDRIA (ACCEPT: MITOCHONDRION)

BONUS

15) Biology – *Short Answer* Lettuce wilts when it loses water, which reduces pressure exerted against the cell wall. What is the term for this pressure, caused by the osmotic flow of water that pushes the cell membrane against the cell wall?

ANSWER: TURGOR

TOSS-UP

16) Chemistry – *Short Answer* Identify all of the following three mixtures that are considered heterogeneous mixtures: 1) Foam; 2) Alloy; 3) Air.

ANSWER: 1

BONUS

16) Chemistry – *Short Answer* Rank the following three elements in order of increasing first ionization energy: 1) Carbon; 2) Neon; 3) Sodium.

ANSWER: 3, 1, 2

TOSS-UP

17) Earth and Space – *Multiple Choice* The triple alpha process is primarily responsible for directly producing which of the following?

- W) Carbon-12
- X) Beryllium-9
- Y) Lithium-6
- Z) Helium-3

ANSWER: W) CARBON-12

BONUS

17) Earth and Space – *Short Answer* Venus has the highest albedo of any planet largely due to the presence of what atmospheric component?

ANSWER: SULFURIC ACID (ACCEPT: H_2SO_4)

TOSS-UP

18) Energy – *Multiple Choice* Scientists at Brookhaven National Lab are studying particles called neutral pions. Which of the following best explains why they are called neutral?

- W) They do not interact with other particles
- X) They have zero mass
- Y) They form from the decay of neutrons
- Z) They have no net electric charge

ANSWER: Z) THEY HAVE NO NET ELECTRIC CHARGE

BONUS

18) Energy – *Short Answer* Scientists at Brookhaven National Lab are researching metallic catalysts that accelerate the water-gas shift reaction. What nickel-group metal, which has the lowest reactivity on the reactivity series, is the catalyst they are studying?

ANSWER: PLATINUM