

TOSS-UP

1) Physics — *Multiple Choice* Which of the following electronic circuit components is passive?

- W) Capacitor
- X) Transistor
- Y) Relay
- Z) Integrated circuit

ANSWER: W) CAPACITOR

BONUS

1) Physics — *Short Answer* Andrew drops a ball off of a building and records the distance it has fallen at several different times. He then graphs time in seconds on the x -axis and the square root of the distance traveled in meters on the y -axis, and obtains a linear graph. To two significant figures, what is the slope of this graph?

ANSWER: 2.2

TOSS-UP

2) Biology — *Short Answer* In humans, what hormone is responsible for the contraction of the uterus in labor as well as the ejection of milk during lactation?

ANSWER: OXYTOCIN

BONUS

2) Biology — *Multiple Choice* Which of the following best describes the conversion of 2PG to PEP in glycolysis [*glye-KAWL-eh-sis*]?

- W) An isomerization [*eye-saw-mor-ih-AY-shun*] reaction
- X) An NADH-producing reaction
- Y) A carbon-carbon bond-cleaving reaction
- Z) A carbon-oxygen bond-cleaving reaction

ANSWER: Z) A CARBON-OXYGEN BOND-CLEAVING REACTION

TOSS-UP

3) Chemistry — *Short Answer* What is the degree of unsaturation of cyclobutane?

ANSWER: 1

BONUS

3) Chemistry — *Short Answer* Identify all of the following three classes of compounds that are hydrocarbons:

1) Amines [*ah-MEENZ*]; 2) Alkanes; 3) Alkynes [*AL-kines*].

ANSWER: 2, 3

TOSS-UP

4) Earth and Space — *Multiple Choice* The Leonid [*LEE-ah-nid*] meteor shower occurs in what month?

- W) January
- X) March
- Y) July
- Z) November

ANSWER: Z) NOVEMBER

BONUS

4) Earth and Space — *Short Answer* Place the following three phases in the stellar evolution of the Sun in chronological order:
1) T Tauri [*tee-TOOR-ee*]; 2) White dwarf; 3) Red giant.

ANSWER: 1, 3, 2

TOSS-UP

5) Energy — *Multiple Choice* Scientists at Brookhaven National Lab are studying a possible critical point in the phase diagram of nuclear matter. Which of the following best describes what occurs at a thermodynamical critical point?

- W) A phase transition occurs
- X) Three phases coexist
- Y) Matter becomes unstable
- Z) A phase equilibrium curve ends

ANSWER: Z) A PHASE EQUILIBRIUM CURVE ENDS

BONUS

5) Energy — *Short Answer* Scientists at Lawrence Berkeley National Lab are studying polycyclic aromatic hydrocarbons, or PAHs. Which PAH consists of 60 carbon atoms fused into a geodesic dome-like structure?

ANSWER: BUCKMINSTERFULLERENE (ACCEPT: C60 FULLERENE, BUCKYBALL)

TOSS-UP

6) Math — *Short Answer* Consider a pair of points in a coordinate plane whose coordinates consist of 4 different prime numbers. What is the minimum possible distance between these 2 points?

ANSWER: $\sqrt{5}$

BONUS

6) Math — *Short Answer* For the increasing arithmetic sequence with first two terms 10 and 13, what is the sum of the first 60 terms?

ANSWER: 5910

TOSS-UP

7) Physics — *Multiple Choice* Which of the following circuit laws is a direct consequence of the conservation of charge?

- W) Ohm's law
- X) Thevenin's [*THEV-eh-nins*] law
- Y) Kirchhoff's [*KEER-koffs*] junction law
- Z) Kirchhoff's loop law

ANSWER: Y) KIRCHHOFF'S JUNCTION LAW

BONUS

7) Physics — *Short Answer* A forklift lifts a 200-kilogram crate 2 meters into the air over the course of 16 seconds. In watts, what is its average power output during this maneuver?

ANSWER: 245

TOSS-UP

8) Biology — *Short Answer* What type of selection is occurring if the fitness curve for a trait resembles a bimodal distribution?

ANSWER: DISRUPTIVE (ACCEPT: DIVERSIFYING)

BONUS

8) Biology — *Multiple Choice* Which of the following is NOT an adaptation for flight in birds?

- W) Hollow bones
- X) Lack of urinary bladder
- Y) Keeled sternum
- Z) Solitary testis in males

ANSWER: Z) SOLITARY TESTIS IN MALES

TOSS-UP

9) Chemistry — *Multiple Choice* Which of the following salts will produce an acidic solution when dissolved in water?

- W) Aluminum nitrate
- X) Potassium nitrate
- Y) Cesium cyanide
- Z) Sodium fluoride

ANSWER: W) ALUMINUM NITRATE

BONUS

9) Chemistry — *Multiple Choice* When performing distillation, which of the following substances would be expected to be collected last based on boiling point?

- W) Pentane
- X) Pentanoic [*pen-ten-OH-ik*] acid
- Y) Dipropyl [*dye-pro-pil*] ether [*EE-thur*]
- Z) Pentanol [*PEN-ten-awl*]

ANSWER: X) PENTANOIC ACID

TOSS-UP

10) Earth and Space — *Multiple Choice* Tektites are typically formed by what type of metamorphism?

- W) Contact
- X) Shock
- Y) Burial
- Z) Low-grade

ANSWER: X) SHOCK

BONUS

10) Earth and Space — *Short Answer* Identify all of the following three sedimentary rocks that may be formed by dead organisms:
1) Chert; 2) Limestone; 3) Phosphorite.

ANSWER: ALL

TOSS-UP

11) Energy — *Short Answer* Scientists supported by the Department of Energy are studying the enzyme hexokinase [*hexo-KYE-nayse*]. This enzyme catalyzes the first step of what respiration pathway?

ANSWER: GLYCOLYSIS

BONUS

11) Energy — *Short Answer* Scientists supported by the Department of Energy are making radioisotopes for nuclear medicine. What molecule is modified with fluorine-18 in PET imaging?

ANSWER: GLUCOSE (ACCEPT: FLUORODEOXYGLUCOSE)



TOSS-UP

12) Math — *Short Answer* What is the integral from 36 to 64 of open parenthesis, the derivative with respect to x of the square root of x , close parenthesis, dx ?

ANSWER: 2

BONUS

12) Math — *Short Answer* An obtuse triangle has longest side of length 31 and another side of length 24. What is the largest possible integer length of the third side?

ANSWER: 19



TOSS-UP

13) Physics — *Short Answer* Identify all of the following three substances that will float in mercury: 1) Water; 2) Iron; 3) Gold.

ANSWER: 1, 2

BONUS

13) Physics — *Short Answer* Identify all of the following three entities that would experience a net magnetic force if placed into a uniform, non-varying magnetic field: 1) Stationary charge; 2) Moving charge; 3) Current-carrying wire.

ANSWER: 2, 3

TOSS-UP

14) Biology — *Short Answer* Slow-twitch muscle fibers are characterized by an abundance of what oxygen-binding protein?

ANSWER: MYOGLOBIN

BONUS

14) Biology — *Short Answer* Identify all of the following three plant responses that can be induced by indole-3-acetic acid: 1) Stem elongation; 2) Fruit growth; 3) Stomata [*stow-MAH-tah*] closure.

ANSWER: 1, 2

TOSS-UP

15) Chemistry — *Short Answer* Reducing sugars are so-called because they possess what functional group?

ANSWER: CARBONYL (ACCEPT: ALDEHYDE, KETONE, HEMIACETAL)

BONUS

15) Chemistry — *Short Answer* Identify all of the following three atoms that have partially-filled f orbitals in their elemental state:

- 1) Lanthanum [*LAN-tha-num*];
- 2) Neodymium [*neo-DIM-ee-um*];
- 3) Uranium.

ANSWER: 2, 3

TOSS-UP

16) Earth and Space — *Multiple Choice* Which of the following best explains why Cepheid [*SEF-ee-id*] variables can be used as standard candles?

- W) Their periods and luminosities [*loo-min-AW-sih-tees*] are highly correlated
- X) Their absolute luminosities can be calculated by simulating fusion
- Y) Their redshifts determine their distance from Earth
- Z) They are always found in star-forming nebulae [*NEB-yoo-lee*]

ANSWER: W) THEIR PERIODS AND LUMINOSITIES ARE HIGHLY CORRELATED

BONUS

16) Earth and Space — *Short Answer* The flux of energy from the Sun at Earth is about 1,000 watts per square meter. What is the solar flux, in watts per square meter, for Jupiter, which is a distance of 5 astronomical units from the Sun?

ANSWER: 40

TOSS-UP

17) Energy — *Multiple Choice* What intermediate age radiotracer used by the Pacific Northwest National Laboratories allows scientists to better date groundwater between 50 and 1000 years old?

- W) Argon-39
- X) Carbon-14
- Y) Hydrogen-3
- Z) Oxygen-18

ANSWER: W) ARGON-39

BONUS

17) Energy — *Short Answer* Scientists supported by the Department of Energy are studying excitons. As a multiple of the charge of an electron, what is the electric charge of an exciton?

ANSWER: ZERO

TOSS-UP

18) Math — *Short Answer* What is the $\frac{3}{5}$ power of -32 ?

ANSWER: -8

BONUS

18) Math — *Short Answer* What is the volume of the solid obtained by rotating about the y -axis the region bounded by the graphs of $y = x^2 - x^3$ and $y = 0$?

ANSWER: $\pi/10$ (ACCEPT: $(1/10)\pi$, 0.1π)

Before we leave, let's confirm the team's score. What score does the Official Scorekeeper have? And what is the final score in the Chat Box? Does anyone disagree?

I'd like to remind the Scorekeeper to submit the official scoresheet. Best of luck to the team and thanks for competing in today's event.