

ROUND 1

TOSS-UP

1) Physics – *Short Answer* Planck was able to describe the color change of black bodies at different temperatures by introducing what concept?

ANSWER: QUANTUM (ACCEPT: QUANTA, QUANTIZATION; DO NOT ACCEPT: PHOTON)

BONUS

1) Physics – *Short Answer* A horizontal force of 90 newtons is applied to a 20-kilogram block that is initially at rest on a horizontal surface. The coefficient of static friction between the block and the surface is 0.5 and the coefficient of kinetic friction of 0.2. In meters per second squared, what is the acceleration of the block?

ANSWER: 0

TOSS-UP

2) Energy – *Multiple Choice* Which of the following energy sources is most directly derived from the sun?

- W) Wind
- X) Tidal energy
- Y) Geothermal
- Z) Nuclear

ANSWER: W) WIND

BONUS

2) Energy – *Short Answer* Transesterification is a reaction used to generate biodiesel from what class of biomolecule?

ANSWER: TRIGLYCERIDES (ACCEPT: LIPIDS)

TOSS-UP

3) Chemistry – *Short Answer* Given the percentages by mass of different elements in a compound, identify all of the following three characteristics of the compound that can be uniquely determined: 1) The empirical formula; 2) The molecular formula; 3) The structure

ANSWER: 1

BONUS

3) Chemistry – *Short Answer* What property of an element is defined as the amount of energy released when one mole of electrons is added to one mole of the neutral atomic element in the gaseous state?

ANSWER: ELECTRON AFFINITY



TOSS-UP

4) Biology – *Short Answer* The webbed hand of a human embryo develops into five separate fingers by a process of programmed cell death. What is the term for this process?

ANSWER: APOPTOSIS

BONUS

4) Biology – *Multiple Choice* What is the probability of obtaining an F1 purple pea flower if purple is dominant, white is recessive, and a parental cross is made between a heterozygous purple and homozygous white flower?

- W) 1/8
- X) 1/4
- Y) 1/2
- Z) 1

Answer: Y) 1/2

TOSS-UP

5) Math – *Multiple Choice* Matrices with which of the following pairs of dimensions cannot be multiplied together?

- W) 3 rows, 2 columns times 2 rows, 3 columns
- X) 6 rows, 5 columns times 6 rows, 5 columns
- Y) 1 row, 2 columns times 2 rows, 2 columns
- Z) 1,000 rows, 2,000 columns times 2,000 rows, 4,000 columns

ANSWER: X) 6 ROWS, 5 COLUMNS TIMES 6 ROWS, 5 COLUMNS

BONUS

5) Math – *Short Answer* Evaluate the following expression: open parenthesis negative cosine 360 degrees + sine 270 degrees close parenthesis times open parenthesis cosine 0 degrees + sine 0 degrees close parenthesis squared.

ANSWER: -2



TOSS-UP

6) Earth and Space – *Multiple Choice* What layer of the Earth’s atmosphere contains approximately 75% of its air mass?

- W) Troposphere
- X) Mesosphere
- Y) Stratosphere
- Z) Thermosphere

ANSWER: W) TROPOSPHERE

BONUS

6) Earth and Space – *Short Answer* Identify all of the following three statements that are true of seismic waves: 1) P waves are compressional; 2) S waves travel through fluids; 3) P waves travel faster than S waves.

ANSWER: 1 AND 3

TOSS-UP

7) Energy – *Short Answer* Uranium pellets that are sealed into fuel rods are composed of what specific uranium compound?

ANSWER: URANIUM DIOXIDE (ACCEPT: URANIUM(IV) OXIDE, URANOUS OXIDE, URANIA; DO NOT ACCEPT: URANIUM OXIDE)

BONUS

7) Energy – *Multiple Choice* What technology provides the vast majority of the worldwide grid energy storage capacity?

- W) Liquid or compressed air
- X) Lead-acid, nickel-cadmium and sodium-sulfur batteries
- Y) Hydroelectric pump storage
- Z) Superconducting magnetic energy storage

ANSWER: Y) HYDROELECTRIC PUMP STORAGE



TOSS-UP

8) Biology – *Multiple Choice* Which of the following best describes how oxygen is stored in the muscles?

- W) Spread throughout
- X) Bound to hemoglobin
- Y) Bound to calmodulin
- Z) Bound to myoglobin

ANSWER: Z) BOUND TO MYOGLOBIN

BONUS

8) Biology – *Multiple Choice* Which of the following examples is NOT evidence for evolution from a common ancestor?

- W) All living things have basic cell processes that are similar and use similar molecules
- X) Hox genes, or homeotic genes, control vertebrate body plans and are homologous in all vertebrates
- Y) Even though snakes don't have legs, some snake embryos have limb buds during development similar to other reptile embryos
- Z) Bats and birds both have wings that are adaptations for flying

ANSWER: Z) BATS AND BIRDS BOTH HAVE WINGS THAT ARE ADAPTATIONS FOR FLYING

TOSS-UP

9) Physics – *Multiple Choice* Which of the following is NOT true of laser light?

- W) It is highly coherent
- X) It is highly dispersive
- Y) It is highly monochromatic
- Z) It is highly directional

ANSWER: X) IT IS HIGHLY DISPERSIVE

BONUS

9) Physics – *Multiple Choice* What type of image is produced by a concave spherical mirror when an object is placed outside its focal point?

- W) Real and upright
- X) Real and inverted
- Y) Virtual and upright
- Z) Virtual and inverted

ANSWER: X) REAL AND INVERTED

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### TOSS-UP

10) Chemistry – *Multiple Choice* A molecule with the molecular formula  $C_5H_{12}$  cannot form which of the following structural orientations?

- W) Straight-chain alkane
- X) Branched alkane
- Y) Cycloalkane
- Z) Normal alkane

Answer: Y) CYCLOALKANE

### BONUS

10) Chemistry – *Short Answer* In the balanced equation for the combustion of octane, what are the coefficients for carbon dioxide and water respectively?

ANSWER: 16; 18

**TOSS-UP**

11) Math – *Short Answer* There are 8 siblings in a family, and when ranked from youngest to oldest, all differ from the next oldest in age by the same number of years. If the youngest is 8 and the oldest is 29, what is the common difference in their ages?

ANSWER: 3

**BONUS**

11) Math – *Multiple Choice* Following are four pairs of intersecting lines that are related to circles. For three of them, the measures of the angles formed can always be found by taking half of the difference of the angle measures of the intercepted arcs. For which does this calculation generally fail?

- W) Two tangents
- X) Two secants that intersect outside the circle
- Y) A tangent and a secant that intersect outside the circle
- Z) The lines containing two intersecting chords

ANSWER: Z) THE LINES CONTAINING TWO INTERSECTING CHORDS



**TOSS-UP**

12) Earth and Space – *Multiple Choice* What is the boundary that traps moisture and the associated weather in the troposphere?

- W) Mesosphere
- X) Mesoboundary
- Y) Tropopause
- Z) Stratopause

ANSWER: Y) TROPOPAUSE

**BONUS**

12) Earth and Space – *Short Answer* What state of matter is the most common in the universe?

ANSWER: PLASMA

**TOSS-UP**

13) Biology – *Multiple Choice* As the average temperature dropped during the last glacial period, a species of cave bears evolved a layer of thicker fur. What kind of selection is this an example of?

- W) Speciation
- X) Disruptive selection
- Y) Stabilizing selection
- Z) Directional selection

ANSWER: Z) DIRECTIONAL SELECTION

**BONUS**

13) Biology – *Multiple Choice* What substance composes the frustule [*FRUH-stool*] of a diatom?

- W) Silica
- X) Cellulose
- Y) Keratin
- Z) Calcium carbonate

ANSWER: W) SILICA



**TOSS-UP**

14) Energy – *Multiple Choice* Which of the following is the most common usage of syngas?

- W) Electricity production
- X) Transportation
- Y) Water heating
- Z) Production of ethanol

ANSWER: W) ELECTRICITY PRODUCTION

**BONUS**

14) Energy – *Short Answer* What is the most commonly used process for desulfurizing gas?

ANSWER: CLAUS PROCESS

**TOSS-UP**

15) Physics – *Short Answer* A helicopter uses a main rotor as propulsion and control, but requires a tail rotor to counteract torque. The balance of forces resulting from this configuration is represented best by which of Newton's laws?

ANSWER: THIRD (ACCEPT: FOR EVERY ACTION, THERE IS AN EQUAL AND OPPOSITE REACTION)

**BONUS**

15) Physics – *Short Answer* Measured in radians per second, what is the resonant angular frequency of a circuit consisting of a 2 millifarad capacitor and an 8 millihenry inductor?

ANSWER: 250



**TOSS-UP**

16) Earth and Space – *Multiple Choice* The Jurassic period occurred during which era?

- W) Cenozoic
- X) Mesozoic
- Y) Paleozoic
- Z) Neoproterozoic

ANSWER: X) MESOZOIC

**BONUS**

16) Earth and Space – *Short Answer* Christmas Pie is a small hamlet in Surrey, England, at 51.25 degrees north latitude. In degrees to the nearest integer, what is the noon sun angle over Christmas Pie on the winter solstice?

ANSWER: 15

### TOSS-UP

17) Chemistry – *Short Answer* What principle of chemical equilibrium states that if a chemical system at equilibrium experiences a change in concentration, temperature, or pressure, the equilibrium will shift in order to counteract that change?

ANSWER: LE CHATELIER'S PRINCIPLE

### BONUS

17) Chemistry – *Multiple Choice* Consider both the hydrogenation [*high-draw-jen-AY-shun*] and the bromination [*broh-min-AY-shun*] of alkenes using elemental bromine. Which of the following statements concerning these reactions is TRUE?

- W) Both reactions are *syn*-additions
- X) Hydrogenation is a *syn*-addition, but bromination is an *anti*-addition
- Y) Hydrogenation is an *anti*-addition, but bromination is a *syn*-addition
- Z) Both reactions are *anti*-additions

ANSWER: X) HYDROGENATION IS A SYN-ADDITION, BUT BROMINATION IS AN ANTI ADDITION

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TOSS-UP

18) Math – *Short Answer* What are the critical numbers for the function $y = 3t^3 - t$?

ANSWER: $1/3, -1/3$ (ACCEPT: $\pm 1/3$)

BONUS

18) Math – *Multiple Choice* Each day, Adam eats 20% of the cookies left in a jar. At the end of the 2nd day, there are 32 cookies left in the jar. How many cookies were in the jar originally?

- W) 40
- X) 48
- Y) 50
- Z) 60

ANSWER: Y) 50

TOSS-UP

19) Chemistry – *Short Answer* One confirmed transformation of ununoctium [*un-un-AWK-tee-um*] is the decay of ununoctium-294 into livermorium [*liver-MOOR-ee-um*]-290. What type of decay process is this?

ANSWER: ALPHA DECAY

BONUS

19) Chemistry – *Multiple Choice* Which of the following IR spectrum wavenumber ranges are characteristic of alcohols, terminal alkynes, and amines?

- W) 3700 – 3200
- X) 3200 – 2700
- Y) 2300 – 2100
- Z) 1750 – 1650

ANSWER: W) 3700 – 3200

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### TOSS-UP

20) Physics – *Multiple Choice* Which of the following isotopes is fissile?

- W) Thorium-232
- X) Uranium-233
- Y) Uranium-238
- Z) Plutonium-238

ANSWER: X) URANIUM-233

### BONUS

20) Physics – *Short Answer* Two resistors in parallel have an equivalent resistance of 6 ohms. One of the resistors has a resistance of 8 ohms. What is the resistance, in ohms, of the second resistor?

ANSWER: 24

**TOSS-UP**

21) Earth and Space – *Multiple Choice* Hydraulic fracturing is used to obtain which of the following resources?

- W) Coal
- X) Natural gas
- Y) Uranium ore
- Z) Water

ANSWER: X) NATURAL GAS

**BONUS**

21) Earth and Space – *Short Answer* Every silicate mineral contains what two elements?

ANSWER: SILICON AND OXYGEN



**TOSS-UP**

22) Biology – *Multiple Choice* Which of the following is NOT true about plant physiology?

- W) Meristematic [*meh-rih-stuh-MAT-ic*] tissue located at the tips of stems and roots forms the apical [*A-pik-ul*] meristems [*MEH-rih-stems*]
- X) Some plants, like shrubs, have lateral meristems
- Y) Vascular and cork cambium [*KAM-bee-um*] are produced by apical meristems
- Z) Intercalary [*In-TER-cah-lair-ee*] meristems allow grass to grow even after it has been mowed

ANSWER: Y) VASCULAR AND CORK CAMBIUM ARE PRODUCED BY APICAL MERISTEMS

**BONUS**

22) Biology – *Short Answer* The high sugar content of honey gives it the ability to suppress growth of nearly all microbes via what kind of pressure on potentially colonizing cells?

ANSWER: OSMOTIC PRESSURE

**TOSS-UP**

23) Math – *Short Answer* How many lines of symmetry does a square have?

ANSWER: 4

**BONUS**

23) Math – *Short Answer* What are the coordinates of the vertex of the graph of  $y = -2x^2 - 8x + 7$ ?

ANSWER: (-2,15)