

## Round 1

### 1. PHYSICS

#### Toss Up: Multiple Choice

A body at rest in a system is capable of doing work if:

- W) the potential energy of the system is positive
- X) it is free to move in such a way as to decrease the potential energy of the system
- Y) it is free to move in such a way as to increase the potential energy of the system
- Z) it is free to move in such a way as to decrease its kinetic energy

**Toss Up Answer: X**

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#### Bonus: Short Answer

If the force of a non-linear spring is defined as  $F(x) = 3x^2 + 2x + 5$ , what is the work done on the spring if it's stretched to 3 meters from equilibrium?

**Bonus Answer: 51 J**

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### 2. PHYSICS

#### Toss Up: Short Answer

It is known that 28 g of a certain ideal gas occupy 22.4 liters at standard conditions. The volume occupied by 42 g of this gas at standard conditions is:

**Bonus Answer: 33.6 liters**

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#### Bonus: Multiple Choice

Use  $R = 8.2 \times 10^{-5} \text{ m}^3 \cdot \text{atm/mol} \cdot \text{K}$  and  $N_A = 6.02 \times 10^{23} \text{ mol}^{-1}$ . The approximate number of air molecules in a 1 m<sup>3</sup> volume at 300K and atmospheric pressure is:

- W) 41
- X) 450
- Y)  $2.5 \times 10^{25}$
- Z)  $5.4 \times 10^{26}$

**Bonus Answer: Y**

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### 3. PHYSICS

#### Toss Up: Short Answer

A parallel circuit has two resistors, one with a resistance of 4 ohms, and the other of 8 ohms. What is the equivalent resistance of the circuit? State the answer as a fraction.

**Bonus Answer: 8/3 ohms**

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#### Bonus: Short Answer

What is the equivalent capacitance of a parallel circuit with capacitors of 8 micro-Farads, 12 micro-Farads, and 15 micro-Farads?

**Bonus Answer: 35 micro-Farads**

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### 4. PHYSICS

#### Toss Up: Short Answer

In a well-known physical experiment, two small masses were suspended by a thread, each positioned near two much larger stationary masses. A mirror was used to measure the angle through which the thread twists due to the rotation of the small masses' movement. Which physicist conducted this experiment, and what constant did he/she derive from it?

**Bonus Answer: Henry Cavendish (accept "Cavendish") and Universal gravitational constant (accept "big G", don't accept "gravity" or just "g")**

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**Bonus: Short Answer**

A skydiver leaps from a plane at a high altitude. Given acceleration due to gravity is equal to 10 meters per second squared and it takes 45 seconds for the skydiver to fall, calculate the height at which the skydiver fell from, rounded to the nearest thousand meters.

**Bonus Answer:** 20000 [Calculation:  $x = a \cdot t^2 = (10 \text{ m/s}^2)(45\text{s})^2 = 20250\text{m} \rightarrow \text{rounded to } 20000$ ]

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**5. MATHEMATICS****Toss Up: Short Answer**

What is the length of the longest diagonal of a unit cube?

**Bonus Answer:** root3

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**Bonus: Short Answer**

What is the largest integer that cant be written as the sum of 3's and 4's?

**Bonus Answer:** 5

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**6. MATHEMATICS****Toss Up: Short Answer**

You are trying to give 5 apples to 3 friends. You can give any number of apples to each friend, including 0. How many ways are there to share the apples?

**Bonus Answer:** 56 (its  $8C3$ )

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**Bonus: Multiple Choice**

If a cubic function equals 0 at exactly two points, which of the following must be true?

- W) the function passes through the origin
- X) there is a double root
- Y) the function is even
- Z) one of the roots is imaginary

**Bonus Answer:** X

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**7. MATHEMATICS****Toss Up: Multiple Choice**

Which of the following salts is responsible for the browning of pretzels?

- W) Sodium Chloride
- X) Sodium Hydroxide
- Y) Potassium Chloride
- Z) Potassium Carbonate

**Toss Up Answer:** X

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**Bonus: Short Answer**

Consider the reaction  $A + 2B \rightarrow 4C$ . Assume all species in the reaction are gaseous. If the reaction is at equilibrium, and the concentration of every species is 2 molar, calculate the equilibrium constant of the reaction.

**Bonus Answer:** 2

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**8. MATHEMATICS****Toss Up: Multiple Choice**

Give the range for the following six values 2, 7, 11, 19, 25, 33:

- W) 2
- X) 31

Y) 33

Z) 15

**Toss Up Answer: X**

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**Bonus: Short Answer**

What percent of a circle is  $6/5\pi$  radians?

**Bonus Answer: 216**

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## 9. BIOLOGY

**Toss Up: Multiple Choice**

Which of the following proteins is involved in forming the cleavage furrow of a cell during cytokinesis?

W) G-coupled proteins

X) Keratin

Y) Myosin

Z) Tubulin

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Name the method in which a new species develops due to a population separated from one another by geographical isolation.

**Bonus Answer: Allopatric speciation (OR geographic speciation)**

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## 10. BIOLOGY

**Toss Up: Multiple Choice**

Which of the following is a neurotransmitter important for the functioning of myofilaments?

W) Dopamine

X) Acetylcholine

Y) Serotonin

Z) Acetaminophen

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Which of the following is not a layer of the epidermis in thin skin?

W) Stratum corneum

X) Stratum lucidum

Y) Stratum spinosum

Z) Stratum basale

**Bonus Answer: X**

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## 11. BIOLOGY

**Toss Up: Multiple Choice**

Which of the following is a ground tissue with thick secondary cell walls reinforced with lignin?

W) Collenchyma

X) Parenchyma

Y) Cleochoyma

Z) Sclerenchyma

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What anatomical structure is a projection of the cell membrane used for phagocytosis?

**Bonus Answer: Pseudopods/pseudopodia**

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**12. BIOLOGY**

**Toss Up: Multiple Choice**

What structure is present in cilia and flagella?

W) 9+0

X) 9+1

Y) 9+2

Z) 9+3

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Dicots feature vascular bundles arranged in what formation within the stem?

**Bonus Answer: Arranged in a ring.**

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**13. BIOLOGY**

**Toss Up: Short Answer**

What sequence on the mRNA of specific proteins determines whether or not the ribosome translating the mRNA will be bound to the rough endoplasmic reticulum?

**Bonus Answer: Signal sequence (OR targeting signal, localization signal, localization sequence, transit peptide, or leader sequence)**

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**Bonus: Short Answer**

What are the three types of articulating vertebrae in the human vertebral column?

**Bonus Answer: Cervical, thoracic, and lumbar vertebrae**

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**14. CHEMISTRY**

**Toss Up: Short Answer**

What is the oxidation state of chlorine in perchloric acid?

**Bonus Answer: +7**

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**Bonus: Short Answer**

The formula for the combustion of methane is  $\text{CH}_4 + 2\text{O}_2 \text{ yields } \text{CO}_2 + 2\text{H}_2\text{O}$ . Given that the heat of formation of methane gas is -75 kilojoules per mole, the heat of formation of carbon dioxide is -400 kilojoules per mole, and the heat of formation of water is -300 kilojoules per mole, find the heat of combustion for methane.

**Bonus Answer: 925kJ/mol**

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**15. CHEMISTRY**

**Toss Up: Multiple Choice**

Which noble gas is the most reactive?

W) Xenon

X) Radon

Y) Helium

Z) Argon

**Toss Up Answer: W**

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**Bonus: Short Answer**

How many carbon atoms are in a single molecule of trinitrotolulene, or TNT?

Bonus Answer: 7

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## 16. CHEMISTRY

Toss Up: Short Answer

Which nitrogen hydride is the most stable?

Bonus Answer: ammonia

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Bonus: Multiple Choice

Why isn't silicon a suitable candidate for life like carbon is?

- W) Silicon is too heavy
- X) Silicon atoms are too big to form pi bonds
- Y) Silicon is more reactive
- Z) Silicon is rarer in the earth's crust

Bonus Answer: X

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## 17. CHEMISTRY

Toss Up: Multiple Choice

Which of the following, when added to hydrofluoric acid, would decrease its acidity?

- W) sodium fluoride
- X) ammonium nitrate
- Y) acetic acid
- Z) sodium nitrate

Toss Up Answer: W

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Bonus: Short Answer

What is the name of the type of relatively unstable bonding found in many electron deficient compounds, such as  $\text{BeH}_2$ ?

Bonus Answer: three center bond

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## 18. CHEMISTRY

Toss Up: Multiple Choice

Which element has 10 stable isotopes, the highest of any element?

- W) Lead
- X) Xenon
- Y) Tin
- Z) Copper

Toss Up Answer: Y

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Bonus: Short Answer

Name the compound that has a formula of  $\text{C}_{60}$ .

Bonus Answer: buckminsterfullerene (or buckyballs)

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## 19. CHEMISTRY

Toss Up: Short Answer

In 1774, Joseph Priestly isolated what element by heating a powdered mercury compound?

Bonus Answer: Oxygen

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Bonus: Multiple Choice

Which of these is the strongest electrolyte

- W) HNO<sub>2</sub>
- X) (NH<sub>2</sub>)<sub>2</sub>CO
- Y) C<sub>2</sub>H<sub>5</sub>OH
- Z) NH<sub>4</sub>

**Bonus Answer: W**

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## 20. EARTH and SPACE

### Toss Up: Multiple Choice

Which radioactive isotope is most useful for determining the age of mastodont bones found in late Pleistocene sediments?

- W) U-238
- X) C-14
- Y) K-40
- Z) Rb-87

**Toss Up Answer: X**

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### Bonus: Multiple Choice

The absolute age of a rock is the approximate number of years ago that the rock formed. The absolute age of an igneous rock can best be determined by

- W) comparing the amounts of decayed and undecayed radioactive isotopes in the rock
- X) comparing the sizes of the crystals found in the upper and lower parts of the rock
- Y) examining the rock's relative position in a rock outcrop
- Z) examining the environment in which the rock is found

**Bonus Answer: W**

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## 21. EARTH and SPACE

### Toss Up: Multiple Choice

Which of the following models of the Moon's origin is currently considered most likely?

- W) The Moon was spun off by a rapidly spinning, molten Earth.
- X) The Moon was a passing body that was captured by Earth's gravity.
- Y) The Moon formed in place at the same time that Earth formed.
- Z) The Moon was ejected from a molten Earth by a giant impact.

**Toss Up Answer: Z**

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### Bonus: Multiple Choice

In which parts of Earth's interior would melted or partially melted material be found?

- W) stiffer mantle and inner core
- X) stiffer mantle and outer core
- Y) crust and inner core
- Z) asthenosphere and outer core

**Bonus Answer: Z**

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## 22. EARTH and SPACE

### Toss Up: Multiple Choice

Within the early Earth's vast molten region, substances underwent a process known as differentiation, during which

- W) substances of low density rise to Earth's surface, while those of high density sink toward its center
- X) substances of high density float to Earth's surface, while those of low density sink toward its center.
- Y) substances of high and low density chemically combine to form uniformly dense substances.
- Z) substances of high density form gases, while those of low density form solids.

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Earth's magnetic field is likely a result of

- W) convection currents in Earth's mantle
- X) convection currents in Earth's core
- Y) a high concentration of iron in Earth's crust
- Z) high-energy particles in the solar wind

**Bonus Answer: X**

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## **23. EARTH and SPACE**

**Toss Up: Multiple Choice**

Which statement best describes how galaxies generally move?

- W) Galaxies move toward one another.
- X) Galaxies move away from one another.
- Y) Galaxies move randomly.
- Z) Galaxies do not move.

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

The observable universe is estimated to be roughly 16-20 billion years old. Which statement best describes why a galaxy located 25 billion light-years from Earth may not be visible to an observer on Earth?

- W) Galaxies 25 billion light-years away would emit no visible light.
- X) Light from beyond 20 billion light years has not yet reached Earth.
- Y) Light from beyond 20 billion light years passed out galaxy before Earth existed.
- Z) No galaxies are located farther than 5 billion light-years from Earth.

**Bonus Answer: X**

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## **24. EARTH and SPACE**

**Toss Up: Multiple Choice**

Rock samples brought back from the Moon show absolutely no evidence of chemical weathering. This is most likely due to

- W) the lack of an atmosphere on the Moon
- X) extremely low surface temperatures on the Moon
- Y) lack of biological activity on the Moon
- Z) large quantities of water in the lunar "seas"

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

A major belt of asteroids is located between Mars and Jupiter. What is the approximate average distance between the

Sun and this major asteroid belt?

W) 110 million kilometers

X) 220 million kilometers

Y) 390 million kilometers

Z) 850 million kilometers

**Bonus Answer: Y**

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## **25. ENERGY**

**Toss Up: Short Answer**

What is the term for oil derived from oil shales or tar sands?

**Bonus Answer: Syncrude**

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**Bonus: Multiple Choice**

Burning of which of the following fuels produces the least amount of carbon dioxide per unit of energy?

W) coal

X) oil

Y) natural gas

Z) all of these produce the same amount of CO<sub>2</sub>

**Bonus Answer: Y**

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