

## Round 1

### 1. CHEMISTRY

**Toss Up: Short Answer**

What metal is the least reactive?

**Bonus Answer:**

Platinum

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**Bonus: Multiple Choice**

Which of the following is closest to the percentage of the isotope Uranium-235 in nature?

W) 20%

X) 5%

Y) 1%

Z) 0.10%

**Bonus Answer: Y**

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### 2. EARTH and SPACE

**Toss Up: Multiple Choice**

Which of the following parts of the sun has the lowest temperature

W) Corona

X) Chromosphere

Y) Transition region

Z) Photosphere

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Throughout the second half of the 20th century, the number of neutrinos measured coming from the Sun was a third of the theoretically predicted number. What behavior of neutrinos revealed that the predicted number of neutrinos were, indeed, being released?

**Bonus Answer: Neutrino oscillation (accept: neutrinos change flavor)**

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### 3. 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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### 4. ENERGY

**Toss Up: Multiple Choice**

What type of battery is the typical modern car battery?

W) nickel cadmium

X) lead acid

- Y) lithium ion  
Z) unreachgale

**Toss Up Answer: X**

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**Bonus: Short Answer**

Name either of the two countries that are currently carbon neutral, having net zero carbon emissions.

**Bonus Answer: bhutan, vatican city**

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## 5. MATHEMATICS

**Toss Up: Multiple Choice**

If  $x + (1/x) = 2$ , find  $x^{128} + (1/x)^{128}$

- W) 256  
X) 128  
Y) 64  
Z) 2

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Given the quadratic  $x^2 - 20x + 9$  and its roots  $p$  and  $q$ , find  $(1/p)^2 + (1/q)^2$

**Bonus Answer: 382/81**

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## 6. 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  $1 \text{ m}^3$  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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## 7. MATHEMATICS

**Toss Up: Short Answer**

In Triangle ABC the angle bisector of A intersects BC at D. Given  $AB=9$ ,  $AC=21$ , and  $DB=15$ , compute DC.

**Bonus Answer: 35**

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**Bonus: Short Answer**

In triangle ABC,  $AB=14$ ,  $AC=13$ , and  $BC=15$ . Let the incenter be I. Compute CI in simplest radical form.

**Bonus Answer: square root of 65**

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## 8. 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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**9. MATHEMATICS**

**Toss Up: Short Answer**

What is the value of the quantity  $((\sin^4 x) + 2(\cos^2 x)(\sin^2 x) + (\cos^4 x)^2$ ?

**Bonus Answer: 1**

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**Bonus: Multiple Choice**

Which of the following assumptions are made in chaos theory?

- W) The initial parameters are unknown and the future is deterministic
- X) The initial parameters are known and the future is deterministic
- Y) The initial parameters are not all known and the future is randomly determined
- Z) The initial parameters are all known and the future is randomly determined

**Bonus Answer: X**

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**10. CHEMISTRY**

**Toss Up: Short Answer**

What material is used in a flame test to filter out light from yellow flames?

**Bonus Answer: Cobalt glass (accept smalt or cobalt blue glass)**

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**Bonus: Short Answer**

What is the name for the effect that describes why under certain conditions, hot water will freeze faster than cold water?

**Bonus Answer: The Mpemba effect**

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**11. EARTH and SPACE**

**Toss Up: Short Answer**

What month does earth's perihelion occur in?

**Bonus Answer: January**

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**Bonus: Multiple Choice**

What is the name of the supercontinent that formed about 600 million years ago, just before Pangaea?

- W) Pannotia
- X) Ur
- Y) Laurentia
- Z) Columbia

**Bonus Answer: W**

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**12. BIOLOGY**

**Toss Up: Multiple Choice**

Which of the following refers to the fact that when we have experienced a conditioned stimulus by itself many times, it can be difficult to later condition to another stimulus?

- W) Blocking
- X) Dormant Inhibition
- Y) Extinction
- Z) Latent Inhibition

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is the corepressor molecule in the trp operon?

**Bonus Answer: tryptophan**

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### 13. 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:  $x = a * t^2 = (10 \text{ m/s}^2)(45\text{s})^2 = 20250\text{m} \rightarrow \text{rounded to } 20000$ ]**

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### 14. EARTH and SPACE

**Toss Up: Multiple Choice**

In August 2012, it was announced that Voyager 1 had exited the Solar System. What boundary did the spacecraft cross to merit this announcement?

- W) Termination Shock
- X) Heliosheath
- Y) Heliopause
- Z) The Oort Cloud

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

What is Voyager 1's primary source of power?

- W) Solar cells
- X) Radioactive decay
- Y) Thermal cells
- Z) Voyager 1 is not generating power

**Bonus Answer: X**

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### 15. MATHEMATICS

**Toss Up: Short Answer**

Which of the following transformations is a wallpaper group

- 1 Rotation by 90 degrees

2 Glide Reflection

3 Dilation

4 Reflection

**Bonus Answer: 1,2, and 4**

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**Bonus: Short Answer**

In a circle O, diameter AB is drawn. Chord CD intersects AB at E.

If  $CE = 3$ ,  $DE = 6$ ,  $AE = x$ , and  $BE = x + 4$ , compute the radius of the circle.

**Bonus Answer:  $\sqrt{22}$**

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## 16. EARTH and SPACE

**Toss Up: Short Answer**

Order the following structures by descending concentration of stars:

1. Globular cluster
2. Arms of the Milky Way
3. Bulge of the Milky Way
4. Halo of the Milky Way

**Bonus Answer: 1, 3, 2, 4**

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**Bonus: Short Answer**

What stellar Population is most common in globular clusters?

**Bonus Answer: Population II (accept "2")**

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## 17. PHYSICS

**Toss Up: Multiple Choice**

Sound waves can propagate through a plasma because of:

- W) high coulomb interactions between particles
- X) high density of particles
- Y) high energy of particles
- Z) high kinetic pressure force

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which description(s) of plasma is most often used to understand the macroscopic features of plasma: Single particle theory, kinetic theory, fluid description

**Bonus Answer: Fluid description**

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## 18. BIOLOGY

**Toss Up: Multiple Choice**

In which fluid-filled cavity do organs develop in organisms such as earthworms?

- W) Ring
- X) Column
- Y) Coelom
- Z) Peritoneal cavity

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What is the specific name for the motion that pythons and boas undergo?

**Bonus Answer: Rectilinear Motion**

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**19. CHEMISTRY**

**Toss Up: Multiple Choice**

Which of the following is more soluble in ethanol than in water?

- W) I<sub>2</sub>
- X) HCl
- Y) AgNO<sub>3</sub>
- Z) NH<sub>3</sub>

**Toss Up Answer: W**

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**Bonus: Short Answer**

Reactions of which order are typically associated with catalysts?

**Bonus Answer: zeroth**

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**20. BIOLOGY**

**Toss Up: Multiple Choice**

Where might a proteasome be found?

- W) Nucleus
- X) Plasma membrane
- Y) Extracellular Matrix
- Z) Lysosome

**Toss Up Answer: W**

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**Bonus: Short Answer**

Which small protein tags other proteins for degradation?

**Bonus Answer: Ubiquitin**

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**21. CHEMISTRY**

**Toss Up: Multiple Choice**

Which compound, made from the indicated pairs of ions, will be insoluble?

- W) Iron (III) and phosphate ion
- X) Bromide ion and ammonium ion
- Y) Calcium ion and bromide ion
- Z) Bromide ion and iron (III)

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

When the combustion reaction for benzene is properly balanced with the smallest whole-number coefficients, the sum of the coefficients is

- W) 15
- X) 12
- Y) 35
- Z) 17.5

**Bonus Answer: Y**

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## 22. BIOLOGY

### Toss Up: Multiple Choice

Which of the following genetic diseases is not matched correctly with the type of inheritance it has?

- W) Hemophilia; X-linked recessive
- X) PKU; Autosomal dominant
- Y) Sickle cell anemia; Autosomal recessive
- Z) Rett Syndrome; X-linked dominant

**Toss Up Answer: X**

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### Bonus: Short Answer

What are the names for the two processes that, respectively, inhibit and promote gene expression by regulating access to a chromosome?

**Bonus Answer: Methylation; Acetylation (only accept this order)**

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## 23. CHEMISTRY

### Toss Up: Multiple Choice

Which of the following factors will contribute to a decrease in oxygen in a pond?

- W) decreasing salinity
- X) increasing acidity
- Y) increasing temperature
- Z) increasing surface tension of the water

**Toss Up Answer: Y**

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### Bonus: Multiple Choice

When KCl dissolves in water, the solution cools noticeably to the touch. It may be concluded that

- W) the entropy increase overcomes the unfavorable heat of dissolution
- X) KCl is relatively insoluble in water
- Y) the entropy decreases when KCl dissolves
- Z) the boiling point of the solution will be less than 100 degrees Celsius

**Bonus Answer: W**

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## 24. CHEMISTRY

### Toss Up: Multiple Choice

Polystyrene is produced by which of the following reactions:

- W) free radical vinyl polymerization from the monomer styrene
- X) metallocene catalysis polymerization
- Y) graft copolymerization
- Z) butadiene polymerization

**Toss Up Answer: W**

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### Bonus: Short Answer

What general term describes a substance whose electrons are all spin-paired and that are weakly repelled by magnetic fields?

**Bonus Answer: Diamagnetic**

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## 25. CHEMISTRY

### Toss Up: Multiple Choice

Most non-metals are

W) paramagnetic

X) ferromagnetic

Y) diamagnetic

Z) antiferromagnetic

**Toss Up Answer: Y**

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**Bonus: Short Answer**

It is hard to find temperatures at which oils and fats boil because before they boil, they begin to break down. What is the name of this point?

**Bonus Answer: Smoke Point**

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