

## Round 7

### 1. PHYSICS

#### Toss Up: Multiple Choice

A constant force acting on a body experiencing no change in its environment will give the body:

- W) constant acceleration
- X) constant speed
- Y) constant velocity
- Z) zero acceleration

**Toss Up Answer: W**

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#### Bonus: Multiple Choice

What is the MOST common term for the inwardly directed force exerted on an object to keep the object moving in a circle?

- W) Centripetal Acceleration
- X) Friction
- Y) Normal Force
- Z) Centripetal Force

**Bonus Answer: Z**

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### 2. PHYSICS

#### Toss Up: Multiple Choice

Which of the following explains what happens when a negatively charged rod is held to the metal conductor of a leaf electroscope?

- W) The leaves close because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- X) The leaves close because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.
- Y) The leaves open because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- Z) The leaves open because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.

**Toss Up Answer: Y**

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#### Bonus: Short Answer

A positive charge of +5.3 Coulombs is placed in an electric field of 420. Newtons per Coulomb. Find the magnitude of the force the charge experiences in this electric field, rounded to two significant figures.

**Bonus Answer: 2200 N (Explanation:  $F = E \cdot q$ )**

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### 3. PHYSICS

#### Toss Up: Short Answer

Which of the following units are a measure of magnetic field strength?

- 1 - Gauss
- 2 - Tesla
- 3 - Weber
- 4 - Henry

**Bonus Answer: 1,2 (Gauss, Tesla)**

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**Bonus: Multiple Choice**

If the axle of a wheel is moving at a velocity of  $v$ , what is the instantaneous velocity of the top of the wheel?

- W)  $-2v$
- X)  $0$
- Y)  $v$
- Z)  $2v$

**Bonus Answer: Z**

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**4. PHYSICS****Toss Up: Short Answer**

What color is a mirror?

**Bonus Answer: green**

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**Bonus: Short Answer**

Using  $g = 10 \text{ m/s}^2$ , given the weight of an object is 2700 Newtons, what is the mass of the object on the Moon, if its gravitational force is  $1/6$  as strong as that on Earth? Round your answer to the first decimal place.

**Bonus Answer: 270 kg**

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

Which of the following is not a group?

- W) the integers under multiplication
- X) the integers under addition
- Y) the symmetries of a regular  $n$ -gon
- Z) the permutations of integers between 1 and  $n$

**Toss Up Answer: W**

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**Bonus: Short Answer**

find the smallest positive solution to the following congruences.

$x \text{ congruent to } 3 \text{ mod } 13$

$x \text{ congruent to } 8 \text{ mod } 11$

**Bonus Answer:  $x=107$**

**Also accept: 107**

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

MULTIPLE CHOICE: tossup

For an infinite sequence of numbers  $a_0, a_1, \dots$ , which of the following best describes the polynomial  $P(x) = \sum_{i=0}^{\infty} a_i x^i$ .

- W) Reimann-Zeta function
- X) Generating function
- Y) Newtonian series
- Z) Tchebychev polynomial

**Toss Up Answer: X**

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**Bonus: Short Answer**

In the Pell equation  $x^2 - 3y^2 = 1$  the smallest solution is  $x=2$  and  $y=1$ . The next smallest solution is  $x=7$  and  $y=4$ . Compute the third smallest solution.

**Bonus Answer:**  $x=26, y=15$

**Also accept** (26,15)

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## 7. MATHEMATICS

**Toss Up: Short Answer**

which of the following are true about the number and nature of the roots of the polynomial

$$x^3 - 29x^2 + 229x$$

I. 0 is a root

II. There must be a real, positive root

III. There must be three real roots

**Bonus Answer:** I

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**Bonus: Short Answer**

Solve the following linear system of equations in 3 variables:

$$2x + y + 4z = 9$$

$$-x + 2y + 5z = -11$$

$$5x + 3y + 3z = -4$$

**Bonus Answer:**  $x=4, y=-11, z=3$

**Also accept** (4,-11,3)

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## 8. 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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## 9. BIOLOGY

**Toss Up: Multiple Choice**

All of the following are examples of substances found in bacteria or archaea EXCEPT:

W) peptidoglycan

X) flagellin

Y) chitin

Z) phycobilin

**Toss Up Answer:** Y

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**Bonus: Multiple Choice**

Which of the following groups of organisms lacks motility?

W) Cellular slime molds

X) Ciliates

Y) Dinoflagellates

Z) Apicomplexans

**Bonus Answer: Z**

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## **10. BIOLOGY**

### **Toss Up: Multiple Choice**

All of the following are examples of evolution EXCEPT:

- W) mutations in an individual
- X) changes in an allele frequency in a population
- Y) changes in an allele frequency in a species
- Z) adaptive radiation

**Toss Up Answer: W**

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### **Bonus: Multiple Choice**

Which of the following generates the formation of adaptations?

- W) Genetic drift
- X) Mutations
- Y) Gene Flow
- Z) Natural Selection

**Bonus Answer: Z**

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## **11. BIOLOGY**

### **Toss Up: Multiple Choice**

Genetic variation can be introduced into bacteria by all of the following methods EXCEPT:

- W) transfer of DNA between bacteria through pili
- X) mutation
- Y) transformation
- Z) DNA amplification

**Toss Up Answer: Z**

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### **Bonus: Multiple Choice**

An mRNA actively being translated in the cytoplasm would have all of the following EXCEPT:

- W) a poly-A tail
- X) a 5' (read as 5 prime) cap
- Y) exons
- Z) introns

**Bonus Answer: Z**

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## **12. BIOLOGY**

### **Toss Up: Multiple Choice**

The inheritance of skin color in humans is an example of which of the following?

- W) pleiotropy
- X) codominance
- Y) epistasis
- Z) polygenic inheritance

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

A human genetic defect that is caused by nondisjunction of the sex chromosomes is

- W) sickle-cell disease
- X) hemophilia
- Y) red-green color blindness
- Z) Turner syndrome

**Bonus Answer: Z**

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**13. BIOLOGY****Toss Up: Multiple Choice**

If a cell has 46 chromosomes at the beginning of mitosis, then at anaphase there would be a total of

- W) 23 chromatids
- X) 23 chromosomes
- Y) 46 chromosomes
- Z) 92 chromosomes

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

All of the following statements are true EXCEPT:

- W) spindle fibers are composed largely of microtubules.
- X) centrioles consist of nine triplets of microtubules arranged in a circle.
- Y) all eukaryotic cells have centrioles
- Z) many of the microtubules in a spindle apparatus attach to kinetochores of chromosomes

**Bonus Answer: Y**

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**14. 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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**15. 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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## 16. CHEMISTRY

**Toss Up: Short Answer**

What principle states that an electron will occupy the lowest energy orbital that can receive it?

**Bonus Answer: Aufbau Principle**

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**Bonus: Short Answer**

What is the name of the radioactive decay chain for uranium-235?

**Bonus Answer: Actinium series or Plutonium cascade.**

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## 17. 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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## 18. CHEMISTRY

**Toss Up: Multiple Choice**

Which one of these metals doesn't produce a red flame in a flame test?

W) Rubidium

X) Strontium

Y) Cesium

Z) Lithium

**Toss Up Answer: Y**

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**Bonus: Short Answer**

A solution contains some BaSO<sub>4</sub> at 25° C. It is found to contain 4x10<sup>-5</sup> mole/liter of Ba<sup>2+</sup> ions. What is the K<sub>sp</sub> of the BaSO<sub>4</sub> in scientific notation?

**Bonus Answer: 1.6\*10<sup>-9</sup>**

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## 19. CHEMISTRY

**Toss Up: Multiple Choice**

Which of the following molecules has a lewis structure that is a resonance hybrid?

W) C<sub>2</sub>H<sub>6</sub>

X) HBr

Y) SO<sub>2</sub>

Z) CH<sub>4</sub>

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What mass of HCL dissolved to make a 1 liter solution will give a PH of 1? Give your answer in grams rounded to the nearest hundredth.

**Bonus Answer: 0.37**

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## 20. EARTH and SPACE

**Toss Up: Short Answer**

Which planet in the solar system has the greatest albedo?

**Bonus Answer: Venus**

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**Bonus: Multiple Choice**

What gas is most abundant in the troposphere of Venus?

- W) Carbon dioxide
- X) Nitrogen
- Y) Sulfur dioxide
- Z) Methane

**Bonus Answer: W**

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## 21. 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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## 22. EARTH and SPACE

**Toss Up: Multiple Choice**

What is defined to be the distance from the Sun, to a body whose stellar parallax is one arcsecond?

- W) astronomical unit
- X) Schwarzschild radius
- Y) parsec
- Z) light-second

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

An amateur astronomer observes a star over the course of a year and finds that from January 1 to June 1, the star's position on the celestial sphere shifts by 3 arcseconds. How far is the star from the Earth, to the nearest tenth of a parsec?

- W) 3
- X) 0.3
- Y) 1.5
- Z) 0.7

**Bonus Answer: Z**

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## **23. EARTH and SPACE**

**Toss Up: Short Answer**

After reaching what mass can a white dwarf no longer remain stable?

**Bonus Answer: The Chandrasekhar Limit**

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**Bonus: Short Answer**

What is the pressure that prevents the gravitational collapse of a stable white dwarf?

**Bonus Answer: Electron degeneracy pressure**

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## **24. EARTH and SPACE**

**Toss Up: Multiple Choice**

What is the name for the apparent line dividing night and day

W) Separator

X) Day-Night Meridian

Y) Terminator

Z) Prime Meridian

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What Gas Giant emits the least amount of energy?

**Bonus Answer: Uranus**

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## **25. ENERGY**

**Toss Up: Multiple Choice**

What is one advantage to geothermal energy?

W) Low cost

X) Can be built anywhere

Y) Doesn't produce any hazardous chemicals

Z) Will never run out of steam

**Toss Up Answer: W**

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**Bonus: Short Answer**

In an internal combustion engine, what is the name of the device that ignites the fuel?

**Bonus Answer: Spark plug**

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