

## Round 5

### 1. PHYSICS

#### Toss Up: Short Answer

What is the torque in  $\text{N}\cdot\text{m}$  (read as newton meters) acting on a disk with radius of 3 meters, mass of 5kg, and rotating with an angular acceleration of  $10 \text{ rad/s}^2$ ?

**Bonus Answer: 225  $\text{N}\cdot\text{m}$**

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#### Bonus: Short Answer

If a sphere with radius of 4 meters and a mass of 5kg is rolling at a velocity of 12m/s, find the total energy of the sphere in joules.

**Bonus Answer: 648 J**

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### 2. PHYSICS

#### Toss Up: Multiple Choice

Which of the following is the most accurate? The center of mass of the system consisting of Earth, the Sun, and the planet Mars is:

- W) closer to the Sun than to either of the other bodies
- X) closer to Earth than to either of the other bodies
- Y) at the geometric center of the triangle formed by the three bodies
- Z) at the center of the line joining Earth and Mars

**Toss Up Answer: W**

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#### Bonus: Multiple Choice

At the same instant that a 0.50-kg ball is dropped from 25m above Earth, a second ball, with a mass of 0.25 kg, is thrown straight upward from Earth's surface with an initial speed of 15m/s. They move along nearby lines and pass each other without colliding. At the end of 2.0 s the height above Earth's surface of the center of mass of the two-ball system is:

- W) 3.0m
- X) 5.0m
- Y) 6.5m
- Z) 7.1m

**Bonus Answer: Z**

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### 3. PHYSICS

#### Toss Up: Short Answer

In a spherical shell with radius of 2 meters a magnetic field with strength of 2 teslas passes through. What is the net magnetic flux?

**Bonus Answer: 0**

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#### Bonus: Short Answer

What is the magnitude of the induced current produced as the magnetic field passing through a circle with radius of 2m and resistance of 5 ohms changes from 50 teslas to 25 teslas in 5 seconds to the nearest whole number?

**Bonus Answer: 13 amperes**

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### 4. PHYSICS

#### Toss Up: Short Answer

The quantity epsilon naught multiplied by the time derivative of electric flux represents what quantity in the Maxwell-Ampere equation?

Bonus Answer: Displacement current

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Bonus: Short Answer

In a solenoid of length 20m with a current of 10 amperes traveling through it and undergoes 20 turns what is the magnitude of the magnetic field within it in teslas? Assume the vacuum permittivity is  $9 \times 10^{-12}$  and  $\pi$  is approximately 3.

Bonus Answer:  $1.8 \times 10^{-9}$  teslas

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## 5. MATHEMATICS

Toss Up: Short Answer

How many vertices does a dodecahedron have?

Bonus Answer: 20

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Bonus: Short Answer

In  $a+bi$  form, what is the square root of  $i$ ?

Bonus Answer:  $(1/(\sqrt{2})) + (1/(\sqrt{2}))i$

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## 6. MATHEMATICS

Toss Up: Multiple Choice

Let  $f$  be an odd function over the real numbers. What is the value of  $f$  at 0?

W) -1

X) 0

Y) 1

Z) There is not enough information to determine an answer

Toss Up Answer: Z

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Bonus: Multiple Choice

Which of the following is true?

W) An irrational number raised to an irrational power must have an irrational value.

X) For all positive number  $x$  and  $y$ ,  $x^{\ln(y)}$  is equal to  $y^{\ln(x)}$

Y) For all real numbers  $a, b, c, d$  with  $b$  and  $d$  being non-zero, if  $a/b > c/d$ , then  $a \cdot d$  must be greater than  $b \cdot c$

Z) There are more complex numbers than there are real numbers.

Bonus Answer: X

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## 7. 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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## 8. MATHEMATICS

**Toss Up: Multiple Choice**

To test products, there is a test that identifies 95% of defective products as defective, but also labels 10% of all working products as defective. If 85% of the products made are not defective, what probability of products the test determines to be defective are actually defective?

- W) 39%
- X) 84%
- Y) 67%
- Z) 42%

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Compute the surface area of a cylinder with radius 8 and height 2

**Bonus Answer: 160pi**

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**9. BIOLOGY**

**Toss Up: Multiple Choice**

The phenomenon by which diploid cells cease to divide is known as

- W) parthenogenesis
- X) alternation of generations
- Y) cellular senescence
- Z) lysis

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What country has the highest human life expectancy?

**Bonus Answer: Japan**

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**10. BIOLOGY**

**Toss Up: Short Answer**

How many ATP molecules are produced by the Calvin cycle?

**Bonus Answer: 0**

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**Bonus: Short Answer**

How many ATP molecules are used in the Calvin cycle to make one glucose molecule?

**Bonus Answer: 18**

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**11. BIOLOGY**

**Toss Up: Multiple Choice**

If the recessive allele of gene A is epistatic to gene B, what is the phenotypic ratio of the two genes?

- W) 9:3:3:1
- X) 12:4:3
- Y) 9:4:3
- Z) 9:7

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What genetic structure is responsible for the metabolism of lactose in E. Coli?

**Bonus Answer: the lac operon**

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## 12. BIOLOGY

### Toss Up: Short Answer

What phenomenon explains why bacteria rapidly adapt to new treatments?

**Bonus Answer: Punctuated equilibrium**

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### Bonus: Multiple Choice

What genetic relationship is present if there are 36 blue flowers, 9 white flowers, and 3 blue flowers are present in a group?

- W) Recessive epistasis
- X) Dominant epistasis
- Y) Complementation
- Z) No linkage

**Bonus Answer: X**

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## 13. BIOLOGY

### Toss Up: Multiple Choice

What hormone is an antioxidant, forms cadmium with other metals, and is produced to help regulate the circadian cycle for animals?

- W) Epinephrine
- X) Thyroxine
- Y) Calcitonin
- Z) Melatonin

**Toss Up Answer: Z**

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### Bonus: Short Answer

Myasthenia gravis is a disease characterized by muscle weakness and fatigue, and is caused when antibodies inhibit a chemical in the human body. What is this chemical?

**Bonus Answer: Acetylcholine**

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## 14. CHEMISTRY

### Toss Up: Short Answer

What is the theoretical end of a titration?

**Bonus Answer: equiv point**

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### Bonus: Short Answer

In the electrolysis of a copper chloride solution, what forms at the cathode and anode, respectively?

**Bonus Answer: CATHODE = COPPER (ACCEPT: Cu); ANODE = CHLORINE (ACCEPT: CHLORINE GAS or Cl<sub>2</sub>)**

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## 15. CHEMISTRY

### Toss Up: Multiple Choice

Which of the following is a nonpolar molecule with polar bonds

- W) F<sub>2</sub>
- X) CHF<sub>3</sub>
- Y) HCl
- Z) CO<sub>2</sub>

**Toss Up Answer: Z**

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**Bonus: Short Answer**

When  $\text{M}_2\text{S}_3$  is heated in air, it is converted to  $\text{MO}_2$ . A 4.000g sample of  $\text{M}_2\text{S}_3$  shows a decrease in mass of .277 g when it is heated in air. To the nearest whole number, what is the average atomic mass of M?

**Bonus Answer: 184 g/mol**

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## 16. CHEMISTRY

**Toss Up: Short Answer**

Assuming no double or triple bonds in the molecule, what form of hybridization does a ketone carbon have?

**Bonus Answer:  $\text{sp}^2$**

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**Bonus: Multiple Choice**

Which of the following is amphoteric?

W) Zinc Oxide

X) Aluminum Chloride

Y) Acetic Acid

Z) Magnesium Oxide

**Bonus Answer: W**

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## 17. 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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## 18. CHEMISTRY

**Toss Up: Short Answer**

To the nearest tenth of a liter, at standard conditions, how many liters does two moles of methane gas take up?

**Bonus Answer: 44.8**

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**Bonus: Multiple Choice**

What is the main method of helium production?

W) Retrieval from the upper atmosphere

X) Distillation from natural gas

Y) Extraction from rock compounds

Z) Distillation from the lower atmosphere

**Bonus Answer: X**

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## 19. CHEMISTRY

**Toss Up: Short Answer**

If the molar mass of neon is 20 grams and the molar mass of argon is 40 grams, to the nearest tenth, what is the ratio

of the rates of effusion of neon to argon?

**Bonus Answer: 1.4**

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**Bonus: Multiple Choice**

Which element has the highest second ionization energy?

- W) Lithium
- X) Hydrogen
- Y) Helium
- Z) Beryllium

**Bonus Answer: W**

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**20. EARTH and SPACE**

**Toss Up: Multiple Choice**

A red dwarf is

- W) A large variation of brown dwarf
- X) The remnant of a main sequence star
- Y) A small and cool star in the main sequence
- Z) Unable to complete nuclear fusion

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What type of star will the Sun become once it leaves the main sequence?

**Bonus Answer: Red giant**

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**21. 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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**22. EARTH and SPACE**

**Toss Up: Short Answer**

What is the name of the plane on which the planets and Sun of the solar system move?

**Bonus Answer: The ecliptic**

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**Bonus: Short Answer**

"Planet" means "wanderer", as the ancients saw that planets, unlike stars, sometimes move forward with the stars through the sky and sometimes change direction and move in the opposite direction. What are the names of these two types of motion through the sky?

**Bonus Answer: Retrograde and prograde**

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**23. EARTH and SPACE**

**Toss Up: Multiple Choice**

What type of star has characteristics similar to Jupiter and does not necessarily perform nuclear fusion?

- W) Red dwarf
- X) White dwarf
- Y) Brown dwarf
- Z) Hot Jupiter

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What mechanism occurs in Jupiter and in brown dwarfs, and is responsible for Jupiter radiating more energy than it receives from the Sun?

**Bonus Answer: Kelvin–Helmholtz mechanism (accept: the outer layers cool and the object compresses, which then heats up the core)**

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**24. EARTH and SPACE**

**Toss Up: Short Answer**

What behavior of Mercury could not be explained by Newtonian mechanics, and perplexed the astronomical community until it was explained by General Relativity?

**Bonus Answer: Precession of its orbit (accept: advance of its perihelion; advance of its periapsis)**

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**Bonus: Short Answer**

The space race between the United States and the Soviet Union was a big deal for the two nations in the 1960's and early 1970's. In 1971, NASA deployed the first spacecraft ever to orbit a another planet, and beat the USSR's deployment by a month. What planet did the NASA mission orbit?

**Bonus Answer: Mars**

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**25. ENERGY**

**Toss Up: Short Answer**

What is energy of motion?

**Bonus Answer: KE**

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**Bonus: Short Answer**

What is energy of location?

**Bonus Answer: PE**

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