

## Round 8

### 1. PHYSICS

#### Toss Up: Short Answer

What is a famous impossible result of the classical modeling of blackbody intensity as a function of frequency?

**Bonus Answer: "Ultraviolet Catastrophe"**

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#### Bonus: Multiple Choice

What is the classical law that attempts to map blackbody intensity as a function of frequency and leads to "ultraviolet catastrophe"?

- W) Henderson-Hasselbalch's Law
- X) Rayleigh-Jeans Law
- Y) Plank's Law
- Z) Kirchhoff Law

**Bonus Answer: X**

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### 2. PHYSICS

#### Toss Up: Short Answer

What is the magnitude of the magnetic force caused by an electric current of 10 Amperes flowing perpendicular to a magnetic field of 10 Teslas through a length of 10 meters?

**Bonus Answer: 1000 Newtons**

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#### Bonus: Multiple Choice

Two point charges are placed on the x-axis. The first has a charge of -3 Coulombs and is placed at  $x=0$ . The second is placed 3 meters to the right of the first and has a charge of 3 Coulombs. What is the dipole moment of these charges?

- W) 9 Coulomb-Meters in the direction of the positive x-axis
- X) 1 Coulomb-Meters in the direction of the positive x-axis
- Y) 9 Coulomb-Meters in the direction of the negative x-axis
- Z) 1 Coulomb-Meters in the direction of the negative x-axis

**Bonus Answer: W**

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### 3. PHYSICS

#### Toss Up: Short Answer

What is the total voltage of a circuit with a total current of 10 Amperes running through four resistors placed in parallel, each with a resistance of 4 Ohms?

**Bonus Answer: 10 Volts**

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#### Bonus: Short Answer

What does the abbreviation MOSFET stand for?

**Bonus Answer: Metal-Oxide-Semiconductor Field-Effect Transistor**

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### 4. PHYSICS

#### Toss Up: Short Answer

What is the unit of a Poynting vector?

**Bonus Answer: Watt/meter<sup>2</sup> (accept equivalent variations)**

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#### Bonus: Short Answer

What's the order of magnitude of a Poynting vector of an EM wave, where the amplitude of the electric field is 300 N/C

(newton per coulomb) and the amplitude of the magnetic field is 400 tesla?

**Bonus Answer: 11**

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## 5. PHYSICS

**Toss Up: Short Answer**

What is the equivalent capacitance of three Capacitors, each of 9 micro Farad Capacitance, placed in parallel?

**Bonus Answer: 27 micro Farads**

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**Bonus: Short Answer**

Determine the amount of charge stored on either plate of a capacitor of 4 micro Farads when connected across a 12 Volt batter.

**Bonus Answer: 48 micro Coulombs,  $4.8 \times 10^{-5}$  Coulombs**

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## 6. 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  $i$  (give the answer with positive imaginary part)?

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

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## 7. 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  $a*d$  must be greater than  $b*c$
- Z) There are more complex numbers than there are real numbers.

**Bonus Answer: X**

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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. 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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## 10. BIOLOGY

**Toss Up: Short Answer**

Which structural component of the cell cytoskeleton has alpha and beta subunits and is involved with intracellular transport?

**Bonus Answer: Microtubules**

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**Bonus: Short Answer**

What are the units of inheritance?

**Bonus Answer: Genes (accept DNA)**

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## 11. BIOLOGY

**Toss Up: Multiple Choice**

Researchers in 2015 reported that resistance to a certain antibiotic was found in a growing number of bacteria from meat samples in China. What is the name of this antibiotic that treats Gram-negative bacteria?

W) Colistin

X) Carbapenems

Y) Linezolid

Z) Vancomycin

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the name of polymer in bacterial walls not found in Gram-negative bacteria?

**Bonus Answer:**

## Peptidoglycan

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### 12. BIOLOGY

#### Toss Up: Multiple Choice

What is MYC?

W) Holoenzyme

X) Oncogene

Y) DNA

Z) Scientist name

**Toss Up Answer: X**

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#### Bonus: Short Answer

What is the pacemaker of the heart?

**Bonus Answer: SA (sinoatrial) node**

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### 13. BIOLOGY

#### Toss Up: Multiple Choice

What is another name for the cell body of neurons?

W) Stroma

X) Soma

Y) Cellulite

Z) Thylakoid

**Toss Up Answer: X**

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#### Bonus: Short Answer

What molecule do Ras protein's hydrolyze?

**Bonus Answer: GTP**

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### 14. CHEMISTRY

#### Toss Up: Short Answer

What is the general name for a hypothetical gas that does not obey Boyles's law at all temperatures and pressures?

**Bonus Answer: non ideal**

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#### Bonus: Short Answer

Gypsum is calcium sulfate hydrated with two water molecules. Gypsum is what percent water by weight? (atomic mass of calcium = 40; sulfur = 32 and oxygen = 16.)

**Bonus Answer: 21**

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### 15. CHEMISTRY

#### Toss Up: Short Answer

If the electronegativity difference in the bonding atoms is between 0.4 and 1.7, what type of bond is formed?

**Bonus Answer: polar covalent**

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#### Bonus: Short Answer

what is the formula for potassium perchlorate?

**Bonus Answer: kclo4**

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### 16. CHEMISTRY

#### Toss Up: Short Answer

How many calories of heat are required to vaporize one gram of water?

**Bonus Answer: 540**

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**Bonus: Short Answer**

What is the name for the straight-chain alkane containing 5 carbons?

**Bonus Answer: pentane**

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## 17. CHEMISTRY

**Toss Up: Short Answer**

1)An aqueous solution with amount of of OH<sup>-</sup> ions is greater than that of H<sup>+</sup> ions is what

**Bonus Answer: basic**

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**Bonus: Short Answer**

3)Charles law talks about what?

**Bonus Answer: Hot air rising after being heated**

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## 18. CHEMISTRY

**Toss Up: Short Answer**

In the standard notation for a voltaic cell, the double vertical line "||" represents

**Bonus Answer: A standard Hydrogen Electrode (Accept: Hydrogen Electrode)**

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**Bonus: Short Answer**

Approximately how long must a current of 5.0 amperes be maintained to electroplate 60 g of calcium from molten Calcium Chloride (Molar Mass = 111 g/mol)? Answer in hours.

**Bonus Answer: 16 hours**

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## 19. CHEMISTRY

**Toss Up: Short Answer**

What is the most common isotope of Hydrogen?

**Bonus Answer: Protium**

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**Bonus: Short Answer**

What is the hybridization of carbon atoms in alkanes?

**Bonus Answer: sp<sup>3</sup>**

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## 20. CHEMISTRY

**Toss Up: Short Answer**

Which noble gas is heavier than air?

**Bonus Answer: Xenon (Accept: Xe)**

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**Bonus: Short Answer**

What is the mass of Sodium Chloride that is in the average human body? Answer in grams.

**Bonus Answer: 250 grams**

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## 21. 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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## 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 the most similar characteristics 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 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: Multiple Choice**

Using current technologies, which of the following sources of energy is nonrenewable?

- W) Geothermal
- X) Wind
- Y) Nuclear
- Z) Solar

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of the following is NOT a fossil fuel?

- W) Coal
- X) Petroleum
- Y) Natural gas
- Z) Uranium

**Bonus Answer: Z**

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