

## Round 8

### 1. PHYSICS

#### Toss Up: Multiple Choice

What is true about the capacitance of two parallel plates?

- W) it is proportional to the square of the Area of the plates
- X) it is proportional to the inverse of the Area of the plates
- Y) it is proportional to the inverse of the plate separation
- Z) it is proportional to the plate separation

**Toss Up Answer: Y**

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#### Bonus: Multiple Choice

A 200 farad capacitor is used in a circuit. The voltage difference between the plates of the capacitor is 10 volts. What is the magnitude of the charge on each of the capacitor's plates?

- W) 100 Coulombs
- X) 2000 Coulombs
- Y) 10 Coulombs
- Z) 200 Coulombs

**Bonus Answer: X**

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### 2. PHYSICS

#### Toss Up: Short Answer

Given two frequencies of 410 Hertz and 412 Hertz, what is the period of the beats produced?

**Bonus Answer: .5 seconds**

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#### Bonus: Short Answer

A car is driving away at 50 meters/seconds from an observer at rest. The car is emitting a frequency at 80 Hz. What is the apparent frequency for the observer, given that the speed of sound is 350 meters/seconds? Give your answer to the nearest integer.

**Bonus Answer: 70 Hertz**

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### 3. PHYSICS

#### Toss Up: Short Answer

What is the first derivative of velocity?

**Bonus Answer: Acceleration**

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#### Bonus: Short Answer

If you are on an asteroid 100 km in diameter and it is rotating at 200 meters per second, what is your angular acceleration?

**Bonus Answer: 0.4 meters per second**

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### 4. PHYSICS

#### Toss Up: Multiple Choice

Which law of thermodynamics states that if two thermodynamic systems are each in thermal equilibrium with a third, then they are in thermal equilibrium with each other?

- W) Fourth
- X) Third
- Y) Second

Z) Zeroth

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

What factor is the energy density in radiation of a region of space changed by if the absolute temperature is increased by a factor of 2?

- W) Times 4
- X) Times 1/4
- Y) Times 2
- Z) Times 16

**Bonus Answer: Z**

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## 5. MATHEMATICS

**Toss Up: Short Answer**

Which of the following statements concerning prime numbers are true?

1. If  $a$  and  $n$  are relatively prime then there are infinitely many primes that leave a remainder of  $a$  when divided by  $n$ .
2. All integers less than  $p$  are quadratic residues modulo  $p$
3. There are infinitely many prime numbers

**Bonus Answer: 1 and 3**

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**Bonus: Short Answer**

If  $a_1 + a_2 + a_3 + a_4 + a_5 = 17$  for positive integers  $a_1, a_2, a_3, a_4, a_5$ , then maximize the product  $a_1 a_2 a_3 a_4 a_5$ ?

**Bonus Answer: 432**

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## 6. MATHEMATICS

**Toss Up: Multiple Choice**

Which of the following expressions in  $x$  grows fastest?

- W)  $3^x$  [3 to the  $x$ ]
- X)  $10(3/2)^x$  [10 times three halves to the  $x$ ]
- Y)  $x^2$  [ $x$  squared]
- Z)  $2^{(2x)}$  [2 to the  $2x$ ]

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Given  $504 = 2^3 \times 3^2 \times 7$  [504 equals 2 cubed times 3 squared times 7], compute the sum of the positive divisors of 504

**Bonus Answer: 1560**

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## 7. MATHEMATICS

**Toss Up: Multiple Choice**

1. What statistical average is most appropriate to use when the quantities being averaged when one or more of the quantities are not necessarily bounded?

- W) Geometric mean
- X) median
- Y) Harmonic mean
- Z) Arithmetic mean

**Toss Up Answer: Y**

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**Bonus: Short Answer**

You pick two cards at random without replacement from a standard, 52 card deck. Compute the probability

exactly one is a heart.

**Bonus Answer: 13/34**

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**8. MATHEMATICS**

**Toss Up: Short Answer**

What is the limit as  $x$  approaches 0 of  $x^x$ ?

**Bonus Answer: Does not exist. (NOT 1)**

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**Bonus: Short Answer**

Let  $f(x)$  be a function with no real roots. If  $f(3) = 4$ , then in what quadrants can  $f(x)$  be in?

**Bonus Answer: All four quadrants (b.c. there's no specification  $f$  has to be continuous)**

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**9. BIOLOGY**

**Toss Up: Short Answer**

How many turns of the Calvin Cycle are needed to make 1 glucose molecule?

**Bonus Answer: 6**

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**Bonus: Short Answer**

How many molecules of ATP are required to make a glucose molecule in the Calvin Cycle?

**Bonus Answer: 18 molecules of ATP (also accept "18", or "18 molecules")**

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**10. BIOLOGY**

**Toss Up: Multiple Choice**

All of the following processes release carbon dioxide EXCEPT:

- W) the Krebs's cycle
- X) alcohol fermentation
- Y) oxidative phosphorylation
- Z) the conversion of pyruvate to acetyl CoA

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

All of the following processes produce ATP EXCEPT:

- W) glycolysis
- X) the Krebs's cycle
- Y) lactic acid fermentation
- Z) oxidative phosphorylation of NADH

**Bonus Answer: Y**

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**11. BIOLOGY**

**Toss Up: Multiple Choice**

Each of the following molecules is a polymer EXCEPT:

- W) protein
- X) glucose
- Y) cellulose
- Z) starch

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

Hydrophilic properties are characteristic of all of the following EXCEPT:

- W) polar molecules
- X) molecules soluble in water
- Y) molecules that readily ionize in water
- Z) the long hydrocarbon chain components of some molecules

**Bonus Answer: Z**

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**12. 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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**13. BIOLOGY**

**Toss Up: Multiple Choice**

You find a new creature measuring over 4 millimeters in size in your bedroom. You notice that it has 6 legs so you know it is some type of:

- W) Arachnid
- X) Larva
- Y) Insect
- Z) Echinoderm

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which class does a spider belong to?

**Bonus Answer: Arachnid**

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**14. CHEMISTRY**

**Toss Up: Multiple Choice**

A tetrahedral molecule,  $XY_4$  would be formed if X were using the orbital hybridization:

- W)  $p^2$
- X)  $s^2$
- Y)  $sp^2$
- Z)  $sp^3$

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

How does a Bronsted-Lowry differ from its conjugate base?

- W) The acid has one more proton.
- X) The acid has one less proton.

Y) The acid has one more electron.

Z) The acid has one less electron.

**Bonus Answer: W**

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## 15. CHEMISTRY

**Toss Up: Short Answer**

What is the halide with no known stable isotopes?

**Bonus Answer: Astatine**

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**Bonus: Multiple Choice**

Which of the following molecules is a saturated hydrocarbon?

W) C<sub>2</sub>H<sub>4</sub>

X) C<sub>3</sub>H<sub>8</sub>

Y) CH<sub>3</sub>OH

Z) C<sub>4</sub>H<sub>6</sub>

**Bonus Answer: X**

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## 16. CHEMISTRY

**Toss Up: Short Answer**

fuel additive in what is commonly known as "dry-gas" by solubilizing water to reduce contamination in gasoline:

**Bonus Answer: Isopropyl Alcohol**

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**Bonus: Multiple Choice**

The latent heat of vaporization for water at its boiling point and in kJ per mole is:

W) 6.01

X) 42.7

Y) 40.7

Z) 40,000,000

**Bonus Answer: Y**

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## 17. CHEMISTRY

**Toss Up: Short Answer**

gypsum is what percent water by weight? (atomic masses of calcium = 40; sulfur = 32 and oxygen = 16.)

**Bonus Answer: 21!!!!!!**

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**Bonus: Short Answer**

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

**Bonus Answer: not ideal**

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## 18. CHEMISTRY

**Toss Up: Short Answer**

If the electronegativity difference in the bonding atoms is intermediate, 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:  $\text{KClO}_4$

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## 19. CHEMISTRY

Toss Up: Short Answer

If pure water boils at  $100^\circ\text{C}$ , how many additional calories of heat are needed to convert 1 gram of water from the liquid to the vapor?!

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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## 20. EARTH and SPACE

Toss Up: Short Answer

What type of rock comes in layers?

Bonus Answer: Sedimentary

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Bonus: Short Answer

What color is a flame of lithium?

Bonus Answer: Green

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## 21. EARTH and SPACE

Toss Up: Short Answer

What are the three types of asteroids, classified based on composition?

Bonus Answer: C-type (accept carbonaceous), M-type (accept metal-rich), S-type (accept silicate)

(Accept in any order)

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Bonus: Short Answer

Order these three types of asteroid from most common to least common in the asteroid belt.

Bonus Answer: C-type (accept carbonaceous), S-type (accept silicate), M-type (accept metal-rich)

About 75% of visible asteroids in the asteroid belt are carbonaceous, about 17% are silicate asteroids, and about 10% are metal-rich asteroids

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## 22. EARTH and SPACE

Toss Up: Multiple Choice

Stars in which portion of an Hertzsprung-Russell diagram are most likely to have supernova deaths?

W) Bottom right

X) Bottom left

Y) Top right

Z) Center

Toss Up Answer: Y

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Bonus: Multiple Choice

What characteristics do stars in this region of the diagram have compared to those in the other regions?

W) Hot surface temperature and bright

X) Cool surface temperature and bright

- Y) Hot surface temperature and dim
- Z) Cool surface temperature and dim

**Bonus Answer: X**

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## 23. EARTH and SPACE

**Toss Up: Multiple Choice**

What is closest to the ratio of the total mass of the asteroids of the asteroid belt to the mass of the moon?

- W) 100
- X) 10
- Y) 1
- Z) 0.1

**Toss Up Answer: Z**

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**Bonus: Short Answer**

What is currently believed to be the reason that the asteroid belt, rather than another planet, formed in that region of the solar system?

**Bonus Answer: Gravitational disturbance by Jupiter prevented sufficient accretion of matter.**

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## 24. EARTH and SPACE

**Toss Up: Short Answer**

What is the name for a section of the Earth's crust that has been displaced, but that still maintains its internal structure?

**Bonus Answer: massif**

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**Bonus: Multiple Choice**

Which of the following is a metamorphic form of shale?

- W) quartzite
- X) slate
- Y) marble
- Z) schist

**Bonus Answer: X**

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## 25. ENERGY

**Toss Up: Multiple Choice**

A metal coin and a plastic coin are heated to the same temperature. The two coins have the same size and shape, are dropped into the same tub of cold water at the same time, and are left for 30 seconds. Which coin will have the lower temperature?

- W) Metal coin
- X) Plastic Coin
- Y) Both coins will have the same temperature
- Z) Cannot be determined

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the general name for material that is used to block the flow of heat?

**Bonus Answer: Insulator**

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