

## Round 11

### 1. PHYSICS

#### Toss Up: Multiple Choice

In a simple series circuit, which of these is equal among all resistors?

- W) Potential difference
- X) Resistance
- Y) Current
- Z) Capacitance

**Toss Up Answer: Y**

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#### Bonus: Multiple Choice

A circuit is made with a battery and four resistors connected in series. Two resistors changed to be in parallel in the circuit. What is the change in the power dissipated by the original two resistors?

- W) The power increases
- X) The power decreases
- Y) The power stays the same
- Z) No power is being generated by any resistor

**Bonus Answer: W**

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### 2. CHEMISTRY

#### Toss Up: Multiple Choice

Which element is expected to have the greatest polarizability?

- W) Fe
- X) Ca
- Y) Ne
- Z) S

**Toss Up Answer: W**

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#### Bonus: Multiple Choice

A student observed that a small amount of acetone sprayed on the back of the hand felt very cool compared to a similar amount of water. Your explanation of this phenomena should be that

- W) all organic compounds do this
- X) acetone has a lower viscosity and transfers heat quanta better
- Y) water has a higher heat capacity than acetone, therefore retaining more heat
- Z) the higher vapor pressure of acetone results in more rapid evaporation and heat loss

**Bonus Answer: Z**

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### 3. MATHEMATICS

#### Toss Up: Short Answer

If Bruce can do a job in 3 hours, and Clark can do the same job in 4 hours, how long, in hours, will it take them to do the job if they work together? You may leave your answer as a fraction.

**Bonus Answer: 12/7**

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#### Bonus: Short Answer

What is the eccentricity of an ellipse with  $a = 5$  and  $b = 4$ ?

**Bonus Answer: 3/5**

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## 4. MATHEMATICS

### Toss Up: Multiple Choice

Fermat's Last Theorem conjectures that no three positive integers  $a, b$ , and  $c$  can satisfy the equation  $a^n + b^n = c^n$  for any integer value of  $n$  greater than 2. It went unproved for more than 300 years until it was finally proved in 1994 by a mathematician who received a substantial monetary prize only this year. What is the name of this mathematician?

- W) Grigori Perelman
- X) John Nash
- Y) Andrew Wiles
- Z) Terence Tao

**Toss Up Answer: Y**

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### Bonus: Short Answer

Prime numbers of the form  $2^n + 1$ , where  $n$  is a non-negative integer, are known as this.

**Bonus Answer: Fermat Primes**

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## 5. BIOLOGY

### Toss Up: Short Answer

Which model is currently accepted as representative of the dynamic nature of the Golgi apparatus?

**Bonus Answer: Cisternal Maturation model**

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### Bonus: Short Answer

Which cytoskeletal element functions in cleavage furrow formation?

**Bonus Answer: Microfilament**

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## 6. PHYSICS

### Toss Up: Short Answer

Which principle of quantum mechanics allows for the quantum state of any particle to be expressed as a linear combination of distinct quantum states?

**Bonus Answer: Superposition principle**

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### Bonus: Short Answer

A free electron has a momentum of  $5.0 \times 10^{-24}$  kg · m/s (read as 5.0 times 10 to the negative 24 kilogram times meter per second). The wavelength of its wave function in meters is:

**Bonus Answer:  $\sim 1.3 \times 10^{-10}$  meters (explanation: deBroglie wavelength)**

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## 7. BIOLOGY

### Toss Up: Multiple Choice

Which of these would not be found in a plant vacuole?

- W) pigments
- X) poisons
- Y) inorganic ions
- Z) smaller organelles

**Toss Up Answer: Z**

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### Bonus: Short Answer

Which cytoskeletal element has a diameter of 7nm?

**Bonus Answer: Microfilament**

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## 8. 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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## 9. 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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## 10. 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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## 11. EARTH and SPACE

### Toss Up: Multiple Choice

What star class is used to characterize the hottest stars?

- W) A
- X) B
- Y) M
- Z) O

Toss Up Answer: Z

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### Bonus: Short Answer

Which two moons are larger than the smallest planet in our solar system?

Bonus Answer: Ganymede and Titan

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## 12. MATHEMATICS

### Toss Up: Multiple Choice

Which of the following cannot be the root of a polynomial with rational coefficients?

- W)  $5i + 6$
- X)  $\phi - 1/2$ , where  $\phi$  is the golden ratio
- Y)  $\sqrt{3+i}$
- Z)  $6 - \pi i$

Toss Up Answer: Z

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### Bonus: Short Answer

What is the name given to a number that is not a root of any non-zero polynomial equation with rational coefficients?

Bonus Answer: Transcendental number (Accept transcendental)

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## 13. MATHEMATICS

### Toss Up: Multiple Choice

Given the equation of a conic section,  $y^2/16 - x^2/25 = 1$ , what is the length of the conjugate axis?

- W) 16
- X) 8
- Y) 10
- Z) 25

Toss Up Answer: Y

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### Bonus: Multiple Choice

Compute  $\log_2$  of  $2048^2$

- W) 20
- X) 22
- Y) 24
- Z) 26

Bonus Answer: X

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## 14. CHEMISTRY

### Toss Up: Multiple Choice

Compared to ideal gases, real gases tend to have

- W) larger volumes
- X) lower average kinetic energies
- Y) lower pressures

Z) Both (W) and (Y)

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

A gas has a density, at STP, of  $3.48 \text{ g L}^{-1}$ . The most reasonable formula for this compound is

W)  $\text{C}_2\text{H}_6$

X)  $\text{C}_6\text{H}_6$

Y)  $\text{CCl}_4$

Z)  $\text{CaF}_2$

**Bonus Answer: X**

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## 15. BIOLOGY

**Toss Up: Multiple Choice**

After three rounds of cell fractionation, the pellet would be rich in:

W) nuclei

X) microsomes

Y) mitochondria

Z) ribosomes

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

P53 is a

W) tumor-inducing protein

X) tumor-suppressing protein

Y) tumor-inducing hormone

Z) tumor-suppressing hormone

**Bonus Answer: X**

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## 16. BIOLOGY

**Toss Up: Multiple Choice**

Which experimental treatment would increase the rate of sucrose transport into a plant cell?

W) decreasing extracellular sucrose concentration

X) decreasing extracellular pH

Y) decreasing cytoplasmic pH

Z) adding a substance that makes the membrane more permeable to  $\text{H}^+$  ions

**Toss Up Answer: X**

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**Bonus: Short Answer**

If the entire cell cycle in a certain cell takes 24 hours, how long does mitosis take?

**Bonus Answer: 2 hours**

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## 17. PHYSICS

**Toss Up: Multiple Choice**

A magnetic field CANNOT:

W) Exert a force on a charged particle

X) Change the trajectory of a charged particle

Y) Change the kinetic energy of a charged particle

Z) Do no work on a charged particle

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

A magnet and a conducting loop are placed next to each other at rest on a horizontal surface. If the magnet with the north pole facing left is put through the loop and is moved left in which direction will the induced current within the loop move with reference to the magnet?

W) Into the magnet

X) Counter-clockwise

Y) Clockwise

Z) There is no current.

**Bonus Answer: X**

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## 18. CHEMISTRY

**Toss Up: Multiple Choice**

Sulfur forms the following compounds:  $\text{SO}_2$ ,  $\text{SCI}_2$ , and  $\text{SO}_3^{2-}$ . Which form of hybridization is NOT represented by these molecules?

W) sp

X)  $\text{sp}^2$

Y)  $\text{sp}^3$

Z) None of these

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which of the following is least related to the strength of a covalent bond?

W) vibrational frequency

X) bond order

Y) bond length

Z) bond direction

**Bonus Answer: Z**

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## 19. PHYSICS

**Toss Up: Short Answer**

When charging or discharging a capacitor, what the quantity  $RC$  (read as resistance times capacitance) known as?

**Bonus Answer: Time constant**

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**Bonus: Multiple Choice**

At point 'A' on a circuit the wire is grounded. At point 'B' on the same circuit there is a emf of 30 volts. If there are two identical resistors with resistance of 10 ohms in parallel, between point 'A' and point 'B', what is the current in ampere flowing through either resistor?

W) 15

X) 3

Y) 9

Z) 6

Bonus Answer: X

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## 20. PHYSICS

Toss Up: Multiple Choice

Which of the following is NOT true about magnetism?

- W) Electric field lines go from the North pole to the South pole
- X) There are instances where electric field lines cross each other
- Y) Cutting a magnet in half will not create two magnetic monopoles
- Z) They are all true

Toss Up Answer: X

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Bonus: Short Answer

By name or number, list all of the following elements that are ferromagnetic: Cobalt, Manganese, Cobalt, Cadmium, Silver

Bonus Answer: Cobalt. Accept: Co, 1

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## 21. ENERGY

Toss Up: Multiple Choice

Which country generates the highest percentage of its energy from nuclear power?

- W) France
- X) China
- Y) Britain
- Z) Denmark

Toss Up Answer: W

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Bonus: Short Answer

List the operating temperatures from lowest to highest of these types of fuel cells

PEMFC  
PAFC  
MCFC  
SOFC

Bonus Answer: 1,2,3,4

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## 22. CHEMISTRY

Toss Up: Multiple Choice

Which of these molecules has the most pi bonds?

- W) HCN
- X) PF<sub>5</sub>
- Y) NH<sub>3</sub>
- Z) SO<sub>3</sub>

Toss Up Answer: W

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Bonus: Short Answer

What name should be given to a molecule with the formula N<sub>2</sub>O<sub>5</sub>?

Bonus Answer: dinitrogen pentoxide

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## 23. CHEMISTRY

Toss Up: Multiple Choice

Which of the following is a correct formula?

- W)  $\text{KH}_2\text{PO}_4$
- X)  $\text{CaC}_2\text{H}_3\text{O}_2$
- Y)  $\text{Na}_2\text{ClO}_4$
- Z)  $\text{Ba}(\text{CO}_3)_2$

**Toss Up Answer: W**

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**Bonus: Short Answer**

What is the formula for the iodate ion?

**Bonus Answer:  $\text{IO}_3^-$**

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## 24. CHEMISTRY

**Toss Up: Multiple Choice**

An electron is also called this in nuclear reactions.

- W) Alpha particle
- X) Positron
- Y) Gamma Ray
- Z) Beta Particle

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

In which of the following are nuclear particles listed in order of increasing penetrating power?

- W) Alpha particles < beta particles < neutrons
- X) Beta particles < alpha particles < neutrons
- Y) Neutrons < alpha particles < beta particles
- Z) Beta particles < neutrons < alpha particles

**Bonus Answer: W**

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## 25. CHEMISTRY

**Toss Up: Multiple Choice**

Most elements in the periodic table are

- W) metals
- X) nonmetals
- Y) liquids
- Z) gases

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

In which of the following pairs of elements is the element with the lower boiling point listed first?

- W) Na, Cs
- X) Te, Se
- Y) P, N
- Z) Ba, Sr

**Bonus Answer: Z**

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