

## Round 10

### 1. PHYSICS

#### Toss Up: Multiple Choice

Monochromatic light is normally incident on a diffraction grating that is 1cm wide and has 10,000 slits. The first order line is deviated at a  $30^\circ$  angle. What is the wavelength, in nm, of the incident light?

- W) 300
- X) 500
- Y) 877
- Z) 1000

Toss Up Answer: X

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#### Bonus: Multiple Choice

A spectral line of a certain star is observed to be "red shifted" from a wavelength of 500nm to a wavelength of 1500nm. Interpreting this as a Doppler effect, the speed of recession of this star is:

- W) .33c
- X) .5c
- Y) .71c
- Z) .8c

Bonus Answer: Z

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### 2. PHYSICS

#### Toss Up: Multiple Choice

The equation of continuity for fluid flow can be derived from the conservation of:

- W) Energy
- X) Mass
- Y) Angular momentum
- Z) Volume

Toss Up Answer: X

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#### Bonus: Multiple Choice

A coil has a resistance of  $60\Omega$  and an impedance of  $100\Omega$ . Its reactance, in ohms, is:

- W) 40
- X) 60
- Y) 80
- Z) 117

Bonus Answer: Y

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### 3. PHYSICS

#### Toss Up: Short Answer

The Curie temperature is the temperature at which ferromagnets become paramagnets. What is the name for the point at which antiferromagnets become paramagnets?

Bonus Answer: The Neel temperature

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#### Bonus: Multiple Choice

A hall probe measures which of the following:

- W) Capacitance

- X) Viscosity
- Y) Magnetic Field
- Z) Electric Field

**Bonus Answer: Y**

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## 4. PHYSICS

**Toss Up: Short Answer**

What is the name for the effect that explains the small attractive force that acts between two close parallel uncharged conducting plates in a vacuum?

**Bonus Answer: The Casimir Effect**

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**Bonus: Multiple Choice**

According to Beer's law:

- W) the energy of a photon of light is inversely proportional to its wavelength
- X) the concentration of a species that absorbs light can be measured by the amount of light absorbed
- Y) the energy of characteristic X-rays increases with increasing atomic number of the emitting element
- Z) excitation of the electrons in a molecule takes place on a shorter time scale than motion of the nuclei

**Bonus Answer: X**

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## 5. PHYSICS

**Toss Up: Short Answer**

How many bosons are in a regular hydrogen atom?

**Bonus Answer: 1 (it's the electron)**

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**Bonus: Short Answer**

Two forces have magnitudes of 15 newtons and 5 newtons. Using interval notation, what is the range of the possible magnitudes of their sum?

**Bonus Answer: [10, 20], accept: between 10 and 20 Newtons inclusive**

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## 6. MATHEMATICS

**Toss Up: Short Answer**

Compute the dot product of the following vectors:

$\langle 2, 1, 3 \rangle$  and  $\langle 10, -1, -5 \rangle$

**Bonus Answer: 4**

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**Bonus: Multiple Choice**

$(64 + 196 + 81)(49 + 256 + 49) > (56 + 224 + 63)^2$  [Read "the quantity  $64+196+81$  times the quantity  $49+256+49$  strictly greater than the quantity  $56+224+63$  squared] is most directly an example of what inequality?

- W) Triangle inequality
- X) Power Mean Inequality
- Y) Cauchy-Schwarz inequality [COW-SHEE sch-WARTS]
- Z) Jensen's inequality [YEN-SIN]

**Bonus Answer: Y**

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## 7. MATHEMATICS

**Toss Up: Short Answer**

If the log of  $n$  is 10, what is the log of  $100n$ ?

**Bonus Answer: 12**

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**Bonus: Short Answer**

How many ways are there to seat 5 people around a circular table, if rotations are ignored?

**Bonus Answer: 24**

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## **8. MATHEMATICS**

**Toss Up: Short Answer**

If the first term in an arithmetic sequence is 2 and the third term is 6, find the 10th term.

**Bonus Answer: 20**

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**Bonus: Short Answer**

Compute the sum of the first 100 positive integers.

**Bonus Answer: 5050**

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## **9. MATHEMATICS**

**Toss Up: Short Answer**

Find the perimeter of a right triangle with legs 11 and 60.

**Bonus Answer: 132**

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**Bonus: Short Answer**

In a 15-75-90 degrees right triangle with hypotenuse 4, what are the lengths of the shorter and longer leg, respectively? Exact answers please.

**Bonus Answer: radical 6 - radical 2, radical 6 + radical 2**

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## **10. BIOLOGY**

**Toss Up: Multiple Choice**

Which mollusk does not possess a radula?

W) Squid

X) Scallop

Y) Snail

Z) Chiton

**Toss Up Answer: X**

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**Bonus: Short Answer**

What is the scientific name for the job or role an organism plays in its habitat?

**Bonus Answer: Niche**

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## **11. BIOLOGY**

**Toss Up: Multiple Choice**

What branching nerve fibers receive messages?

W) Axons

X) Axes

Y) Dendrons

Z) Dendrites

**Toss Up Answer: Z**

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**Bonus: Multiple Choice**

What protein was first isolated in red blood cells?

- W) Myoglobin
- X) Hemocyanin
- Y) Spectrin
- Z) Collagen

**Bonus Answer: Y**

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## 12. BIOLOGY

**Toss Up: Short Answer**

Give the genus and species name of the organism that Beadle and Tatum worked with.

**Bonus Answer: Neurospora crassa**

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**Bonus: Short Answer**

Archibald Garrod is credited with the discovery of which disease, characterized by blackened urine?

**Bonus Answer: Alkaptonuria**

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## 13. BIOLOGY

**Toss Up: Short Answer**

Name the two types of cell death.

**Bonus Answer: Apoptosis, Necrosis**

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**Bonus: Short Answer**

In C4 and CAM photosynthesis, which specific enzyme is used to fix CO<sub>2</sub> in lieu of RuBisCO?

**Bonus Answer: PEP Carboxylase**

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## 14. CHEMISTRY

**Toss Up: Multiple Choice**

Which of the follow is true regarding complex ions?

- W) Their formation constants are usually very small and they often form colored coordination compounds.
- X) Their formation constants are usually very small and they often form colorless coordination compounds.
- Y) Their formation constants are usually very large and they often form colored coordination compounds.
- Z) Their formation constants are usually very large and they often form colorless coordination compounds.

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which of the following is a monodentate ligand?

- W) Oxalate
- X) Chloride Ion
- Y) Aluminum (III) Ion
- Z) Ammonium Ion

**Bonus Answer: X**

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## 15. CHEMISTRY

**Toss Up: Short Answer**

In complex of manganese (II) ion exhibiting a low spin state, how many d electrons are paired?

**Bonus Answer: Four**

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**Bonus: Short Answer**

What is the conjugate base of  $\text{HPO}_4^{2-}$  (Read as: Hydrogen Phosphate)?

**Bonus Answer:**  $\text{PO}_4^{3-}$  (Accept: Phosphate, PO four 3 minus)

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## 16. CHEMISTRY

**Toss Up: Multiple Choice**

For compounds with the same number of carbon atoms, the compound with the lowest boiling point is expected to be

- W) a ketone
- X) an amine
- Y) an ether
- Z) an alcohol

**Toss Up Answer:** Y

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**Bonus: Multiple Choice**

To have cis and trans isomers, a compound must have

- W) sp bonded carbon atoms
- X) sp<sup>3</sup> bonded carbon atoms
- Y) sp<sup>2</sup> bonded carbon atoms
- Z) (W) and (X)

**Bonus Answer:** Y

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## 17. CHEMISTRY

**Toss Up: Multiple Choice**

Which of the following pairs of constants are NOT mathematically related to each other?

- W) Equilibrium constant and Gibbs free energy
- X) Rate constant and activation energy
- Y) Standard cell voltage and equilibrium constant
- Z) Standard cell voltage and rate constant

**Toss Up Answer:** Z

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**Bonus: Multiple Choice**

Which of the following is FALSE?

- W) Reduction involves a gain of electrons
- X) Batteries are galvanic cells
- Y) A thermodynamically favored reaction always has a positive E
- Z) Electrolysis reactions always produce a gas at at least one electrode.

**Bonus Answer:** Z

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## 18. CHEMISTRY

**Toss Up: Multiple Choice**

The evaporation of any liquid is expected to have

- W) a positive delta H and a negative delta S
- X) a negative delta H and a negative delta S
- Y) a positive delta H and a positive delta S
- Z) a positive delta H and a negative delta S

**Toss Up Answer:** Y

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**Bonus: Multiple Choice**

Which of the following is most likely to be true?

- W) Combustion of organic compounds has a negative delta H
- X) A positive delta G indicates a thermodynamically favorable reaction.
- Y) A positive delta S always means that the reaction is thermodynamically favored.
- Z) A thermodynamically favored reaction always goes to completion.

**Bonus Answer: W**

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**19. CHEMISTRY****Toss Up: Multiple Choice**

Modern automobiles use a catalytic converter to

- W) increase horsepower by burning more gasoline
- X) absorb pollutants from the exhaust
- Y) complete the combustion of unburned gases
- Z) cool the exhaust gases

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

A catalyst will NOT

- W) increase the forward reaction rate
- X) shift the equilibrium to favor the products
- Y) alter the reaction pathway
- Z) increase the speed at which equilibrium will be achieved

**Bonus Answer: X**

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**20. CHEMISTRY****Toss Up: Multiple Choice**

Diamond is classified as

- W) a covalent crystal
- X) an ionic crystal
- Y) a molecular crystal
- Z) a metallic crystal

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

A liquid substance that exhibits low intermolecular attractions is expected to have

- W) low viscosity, low boiling point, and low heat of vaporization
- X) high viscosity, low boiling point, and low heat of vaporization
- Y) low viscosity, high boiling point, and low heat of vaporization
- Z) low viscosity, low boiling point, and high heat of vaporization

**Bonus Answer: W**

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**21. 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 percentage-wise, based on the total amount of energy it receives from the sun?

**Bonus Answer: Uranus**

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## 22. EARTH and SPACE

**Toss Up: Short Answer**

What star has the greatest apparent magnitude

**Bonus Answer: Sun**

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**Bonus: Multiple Choice**

Which planet or planets rotate in retrograde?

W) Venus

X) Uranus

Y) Venus and Uranus

Z) Uranus and Jupiter

**Bonus Answer: Y**

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## 23. EARTH and SPACE

**Toss Up: Short Answer**

Which planet has the least eccentric orbit?

**Bonus Answer: Venus**

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**Bonus: Short Answer**

What are the two densest planets in our solar system?

**Bonus Answer: Earth and Mercury (accept in any order)**

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## 24. 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: red**

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## 25. ENERGY

**Toss Up: Multiple Choice**

16) Which uranium oxide is most commonly used in light water reactors?

W) uranium(IV) oxide

X) uranium(V) oxide

Y) uranium(VI) oxide

Z) Yellowcake

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

If a 1 kg mouse runs at 5 m/s, what is its approximate energy in electronvolts?

W)  $4.8 \times 10^{-3}$

X)  $2.9 \times 10^{15}$

Y)  $7.8 \times 10^{19}$

Z)  $4.4 \times 10^{22}$

**Bonus Answer: Y**

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