

## Round 5

### 1. PHYSICS

Writer: Brooklyn Tech

Toss Up: Multiple Choice

Radio waves are propagated through the inter- action of

W) nuclear and electric fields

X) electric and magnetic fields

Y) gravitational and magnetic fields

Z) gravitational and electric fields

Toss Up Answer: X

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Bonus: Multiple Choice

A positively charged glass rod attracts object X. The net charge of object X

W) may be zero or negative

X) may be zero or positive

Y) must be negative

Z) must be positive

Bonus Answer: W

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### 2. PHYSICS

Writer: Lakeside

Toss Up: Short Answer

Name this subset of fermions that do not interact via the strong interaction, have antiparticles that are only opposite in charge and number, and contain the set of neutral particles known as neutrinos.

Bonus Answer: Leptons

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Bonus: Short Answer

In the Davisson-Germer experiment, electrons were fired at nickel crystals and a diffraction pattern was observed, proving what principle or equation?

Bonus Answer: De Broglie Equation

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### 3. PHYSICS

Writer: Lakeside

Toss Up: Short Answer

What is the term referring to an electronic circuit with two stable states, often also called a bistable multivibrator, which can serve as one bit of memory?

Bonus Answer: FLIP-FLOP

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Bonus: Short Answer

Name the following property: It is believed to be caused by fields of electron spins in combination with exchange coupling and substances exhibit this property below the Curie temperature.

Bonus Answer: FERROMAGNETISM

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### 4. MATHEMATICS

Writer: Lakeside

Toss Up: Short Answer

What theorem states that there are no integer solutions for the equation  $x^n + y^n = z^n$  for  $n > 2$ ?

when  $n$  is greater than 2, famously proposed in the margins of a book by its namesake?

**Bonus Answer: FERMAT'S LAST THEOREM**

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**Bonus: Short Answer**

What is the name given an  $n$ th root of a number which often yields an irrational number?

**Bonus Answer: SURD**

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## 5. MATHEMATICS

**Writer: Lakeside**

**Toss Up: Short Answer**

What is the probability of getting at least one tails when flipping 5 fair coins?

**Bonus Answer: 31/32 (Accept: .96875)**

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**Bonus: Multiple Choice**

Multiple Choice At  $x = -1/2$ , the graph of  $y = x^3$  is:

- W) increasing and concave up
- X) increasing and concave down
- Y) decreasing and concave up
- Z) decreasing and concave down

**Bonus Answer: X**

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## 6. MATHEMATICS

**Writer: Oxford**

**Toss Up: Short Answer**

In a 2 by 2 matrix with first row  $a, b$  and second row  $c, d$ , what is the name commonly associated with the value  $ad - bc$ ?

**Bonus Answer: Determinant**

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**Bonus: Multiple Choice**

What is the closest distance from the point  $(6, 8)$  to the line,  $3x + 2y - 1 = 0$ ?

- W) 2.3
- X) 3.3
- Y) 4.3
- Z) 5.3

**Bonus Answer: X**

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## 7. MATHEMATICS

**Writer: Oxford**

**Toss Up: Multiple Choice**

A complex number multiplied by its complex conjugate is equivalent to which of the following?

- W) The argument
- X) The argument squared
- Y) The magnitude
- Z) The magnitude squared

**Toss Up Answer: Z**

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**Bonus: Short Answer**

The Hardy-Ramanujan is given as the smallest positive integer that can be expressed as the sum of two different pairs

of perfect positive cubes. What is the Hardy-Ramanujan number?

**Bonus Answer: 1729**

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## 8. MATHEMATICS

**Writer: Oxford**

**Toss Up: Multiple Choice**

Given the polynomial,  $24-50x+35x^2-10x^3+x^4$ , which of the following is not a possible root by the rational root theorem?

W) 2

X) 3

Y) 4

Z) 5

**Toss Up Answer: Z**

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**Bonus: Short Answer**

How many cubic polynomials,  $f(x)$  with positive integral coefficients have  $f(1)=6$ ?

**Bonus Answer: 84 (equivalent to 9C3 by stars and bars)**

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## 9. BIOLOGY

**Writer: Brooklyn Tech**

**Toss Up: Multiple Choice**

What enzyme is responsible for "unzipping" the DNA strand during replication?

W) DNA helicase

X) DNA ligase

Y) DNA polymerase

Z) RNA primase

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

Which macromolecule can be formed using the sugars produced by plants during photosynthesis?

W) cellulose

X) DNA

Y) lipid

Z) protein

**Bonus Answer: W**

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## 10. BIOLOGY

**Writer: Great Neck South**

**Toss Up: Multiple Choice**

Which of the following structures prevents the passive flow of water and solutes into the stele of a tracheophyte?

W) Endodermis

X) Pericycle

Y) Casparian Strip

Z) Pith

**Toss Up Answer: Y**

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**Bonus: Short Answer**

Which structure in the cell does protein modification last occur before exocytosis?

**Bonus Answer: Golgi apparatus**

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## **11. BIOLOGY**

**Writer: Lakeside**

**Toss Up: Short Answer**

Name the ground tissue in a leaf that is sandwiched between the epidermal layers and is split into sections named palisade and spongy.

**Bonus Answer: MESOPHYLL**

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**Bonus: Short Answer**

Plants such as grasses are able to continue growing vertically after have their tops cut off because of the presence of which plant organ?

**Bonus Answer: AXILLARY MERISTEMS**

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## **12. BIOLOGY**

**Writer: Lakeside**

**Toss Up: Short Answer**

Which well-known transcription factor, named for its size, is activated by DNA damage and serves to halt the cell cycle?

**Bonus Answer: p53**

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**Bonus: Short Answer**

The transition from mitosis to interphase is regulated by the compound cyclin D, which is degraded. What process regulates the degradation of cyclin D via proteasomes?

**Bonus Answer: UBIQUITINATION**

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## **13. BIOLOGY**

**Writer: Lakeside**

**Toss Up: Short Answer**

In 1990, Michael Menaker conducted an experiment using hamsters with mutations that changed their circadian rhythms to observe the effects on which part of the hypothalamus?

**Bonus Answer: SUPERCHIASMATIC NUCLEUS (Accept: SCN)**

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**Bonus: Short Answer**

Which disease is characterized by neurofibrillary tangles made up primarily of the tau protein?

**Bonus Answer: ALZHEIMER'S DISEASE**

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## **14. CHEMISTRY**

**Writer: Lakeside**

**Toss Up: Short Answer**

Order the following three gases from least to greatest in terms of value of b in the Van der Waals equation: Benzene, Neon, and Hydrogen.

**Bonus Answer: HYDROGEN, NEON, BENZENE**

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**Bonus: Multiple Choice**

Adding an inert gas into a gas-phase equilibrium at constant volume will result in an equilibrium shift in which direction?

W) the equilibrium will shift towards the side with fewer moles of gas

X) the equilibrium will shift towards the side with more moles of gas

Y) the equilibrium will not shift

Z) it depends on the gas

**Bonus Answer: Y**

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## 15. CHEMISTRY

**Writer: Lakeside**

**Toss Up: Short Answer**

What is the hybridization and the molecular geometry about the central atom in the molecule phosphorous pentachloride?

**Bonus Answer: DSP3 AND TRIGONAL BIPYRAMIDAL**

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**Bonus: Short Answer**

What is the bond order for diatomic oxygen?

**Bonus Answer: TWO**

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## 16. CHEMISTRY

**Writer: Lakeside**

**Toss Up: Multiple Choice**

Which of the following is true about Raoult's Law?

W) total vapor pressure of a solution is based on the vapor pressures and mole fractions of the constituents

X) there is no such thing as a nonideal solution when using Raoult's law

Y) low boiling azeotropes can be fractionally distilled via addition of another chemical

Z) ideal solutions contain constituents that have stronger intermolecular interactions with the each other than themselves

**Toss Up Answer: W**

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**Bonus: Short Answer**

Because Gibbs free energy is limited to isobaric reactions, which thermodynamic potential is used instead, which assumes constant temperature and volume?

**Bonus Answer: HELMHOLTZ FREE ENERGY**

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## 17. CHEMISTRY

**Writer: Brooklyn Tech**

**Toss Up: Multiple Choice**

Which element has the highest electronegativity?

W) Bromine

X) Krypton

Y) Iodine

Z) Xenon

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

What is the anhydride of sulfuric acid?

W) Hydrogen Sulfide

X) Hydrogen Oxide

Y) Sulfur Dioxide

Z) Sulfur Trioxide

**Bonus Answer: Z**

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## 18. CHEMISTRY

Writer: Brooklyn Tech

Toss Up: Multiple Choice

Which of the following hydrocarbons is the most reactive?

W) C<sub>2</sub>H<sub>6</sub>

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

Y) C<sub>2</sub>H<sub>2</sub>

Z) CH<sub>4</sub>

Toss Up Answer: Y

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Bonus: Short Answer

What is the name of the acid mixture that can dissolve Gold?

Bonus Answer: Aqua Regia

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## 19. EARTH and SPACE

Writer: Brooklyn Tech

Toss Up: Multiple Choice

What do we call a protostar that evolves to a point where it begins steady state hydrogen fusion in its core and first achieves hydrostatic equilibrium?

W) First Born Main Sequence Star

X) Zero Age Main Sequence Star

Y) T-Tauri Star

Z) Proplyd

Toss Up Answer: X

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Bonus: Multiple Choice

The term "reddening" explains what phenomenon?

W) redshifting of distant galaxies from the expansion of the universe

X) the absorption of higher wavelength light by gas and dust that block distant galaxies from Earth's view

Y) the decreasing amount of red wavelengths observed emitting from distant Type Ia supernovae

Z) the process by which dust grains absorb and scatter shorter wavelength light more efficiently

Bonus Answer: X

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## 20. EARTH and SPACE

Writer: Brooklyn Tech

Toss Up: Short Answer

What atmospheric gas does O.C.O monitor?

Bonus Answer: Carbon dioxide.

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Bonus: Short Answer

What geometric distortion does across-track scanners generally experience from the rotation of the Earth?

Bonus Answer: Skew distortion.

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## 21. EARTH and SPACE

Writer: Brooklyn Tech

Toss Up: Multiple Choice

What direction does a comet's tail face?

- W) away from the sun
- X) towards the sun
- Y) away from the moon
- Z) towards the moon

**Toss Up Answer: W**

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**Bonus: Short Answer**

What was the first man made satellite in space called?

**Bonus Answer: Sputnik 1**

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## 22. EARTH and SPACE

**Writer: Brooklyn Tech**

**Toss Up: Short Answer**

What are the three types of rock?

**Bonus Answer: Igneous, Sedentary, and Metamorphic rocks.**

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**Bonus: Multiple Choice**

Which of the following is not a igneous rock.

- W) Diorite
- X) Gabbro
- Y) Limestone
- Z) Granite

**Bonus Answer: Y**

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## 23. ENERGY

**Writer: Lakeside**

**Toss Up: Multiple Choice**

Which US state consumes the most coal annually?

- W) California
- X) Wyoming
- Y) Texas
- Z) New York

**Toss Up Answer: Y**

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**Bonus: Short Answer**

What byproduct of coal combustion is used as filler for tennis rackets, golf balls, and linoleum?

**Bonus Answer: COAL ASH**

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## 24. ENERGY

**Writer: Lakeside**

**Toss Up: Multiple Choice**

About how much solar power does the Earth receive in its upper atmosphere?

- W) 569 Gigawatts
- X) 174 Petawatts
- Y) 298 Exawatts
- Z) 40 Zetawatts

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

In which US state is the world's largest solar power plant found?

- W) California
- X) Arizona
- Y) Texas
- Z) North Carolina

**Bonus Answer: W**

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**25. ENERGY**

**Writer: Oxford**

**Toss Up: Multiple Choice**

To the nearest thousand megawatts, how much geothermal energy does the US have installed?

- W) 1000
- X) 2000
- Y) 3000
- Z) 4000

**Toss Up Answer: Y**

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**Bonus: Multiple Choice**

Which country produces the second most geothermal electricity?

- W) The US
- X) The Phillipeans
- Y) China
- Z) Russia

**Bonus Answer: X**

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