

## Round 7

### 1. PHYSICS

Writer: Shamaul Dilmohamed

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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### 2. PHYSICS

Writer: Shantanu Jha

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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### 3. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

For what major contribution was Albert Einstein awarded the nobel prize in 1921?

W) Einstein Field Equations

X) General Theory of Relativity

Y) Special Theory of Relativity

Z) Photoelectric Effect

Toss Up Answer: Z

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Bonus: Multiple Choice

Which year in Albert Einstein's life is now known as his "annus mirabilis"?

W) 1905

X) 1921

Y) 1915

Z) 1928

**Bonus Answer: W**

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## 4. PHYSICS

**Writer: Seiji Yawata**

**Toss Up: Multiple Choice**

Why do the bubbles from a freshly opened bottle of champagne grow as they rise to the surface?

W) Fluid pressure falls as the bubble rises in the glass.

X) The bubble continues to accumulate dissolved gas molecules as it moves through the champagne.

Y) The bubble does expansive work on the champagne as it loses potential energy.

Z) Friction with the champagne heats the gas inside the bubble.

**Toss Up Answer: X**

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**Bonus: Multiple Choice**

The bubbles in a glass of champagne form a steady stream and leave the surface of the glass in regular time intervals. Why is this?

W) It takes a constant amount of time for gas from the air to make it to the growing bubble.

X) The bubbles occur due to vibrations in the room that have a constant frequency.

Y) The bubbles rise when the buoyant force exceeds the adhesive force.

Z) The bubbles form due to pressure waves in the champagne that have a constant wavelength.

**Bonus Answer: Y**

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## 5. PHYSICS

**Writer: Shantanu Jha**

**Toss Up: Short Answer**

Which law says that the total electric flux of a closed surface is equal to the charge enclosed divided by the permittivity?

**Bonus Answer: Gauss's Law**

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**Bonus: Multiple Choice**

What is the electric permittivity of free space?

W)  $2.27 \times 10^{(-12)}$  Farads / meters

X)  $8.85 \times 10^{(-12)}$  Farads / meters

Y)  $8.99 \times 10^{(9)}$  Farads / meters

Z)  $6.67 \times 10^{(-11)}$  Farads / meters

**Bonus Answer: X**

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## 6. MATHEMATICS

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the relationship between the surface area and the volume of a solid?

**Bonus Answer: The surface area is the derivative of the volume/ the volume is the integral of the surface area when the constant is 0**

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**Bonus: Multiple Choice**

When the inner diagonal of a cube is 7 times root 3 inches, what is the surface area of the cube?

- W) 216 square inches
- X) 294 square inches
- Y) 343 square inches
- Z) 512 square inches

**Bonus Answer: X**

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## 7. MATHEMATICS

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the integral of  $\sec x \, dx$ ?

**Bonus Answer:  $\ln(\sec x + \tan x) + C$**

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**Bonus: Multiple Choice**

Which of these functions cannot be integrated and represented with elementary functions?

- W)  $(\sin^5 x) \times (\cos^6 x) \, dx$
- X)  $e^x \times x^3 \, dx$
- Y)  $e^{(x^2)} \, dx$
- Z)  $\tan x \sin x \, dx$

**Bonus Answer: Y**

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## 8. MATHEMATICS

**Writer: Shamaul Dilmohamed**

**Toss Up: Short Answer**

What is the sum of the infinite geometric series whose first term is 1 and fourth term is  $1/64$ ?

**Bonus Answer:  $4/3$**

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**Bonus: Multiple Choice**

What is the value of  $e$  to the  $(\pi \times i/2)$ ?

- W)  $e^{-1}$
- X) 1
- Y) -1
- Z)  $i$

**Bonus Answer: Z**

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## 9. MATHEMATICS

**Writer: Andrew Chen**

**Toss Up: Short Answer**

What is 11 base 5 in base 2?

**Bonus Answer: 110**

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**Bonus: Short Answer**

If  $\log_{10} x$  is 100, what is  $\log_{100} x$ ?

**Bonus Answer: 50**

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## 10. BIOLOGY

**Writer: William Chan**

**Toss Up: Multiple Choice**

A product of noncyclic photophosphorylation is

- W) NADPH
- X) water
- Y) carbon dioxide
- Z) ADP

**Toss Up Answer: W**

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**Bonus: Multiple Choice**

All of the following occur in cyclic photophosphorylation EXCEPT:

- W) Electrons move along an electron transport chain.
- X) Electrons in chlorophyll become excited.
- Y) ATP is produced.
- Z) NADPH is produced.

**Bonus Answer: Z**

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**11. BIOLOGY**

**Writer: Calvin Aw**

**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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**12. BIOLOGY**

**Writer: William Chan**

**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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**13. BIOLOGY**

**Writer: William Chan**

**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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**14. CHEMISTRY**

**Writer: Andrew Chen**

**Toss Up: Short Answer**

To the nearest tenth of a liter, at standard conditions, how many liters does two moles of methane gas take up?

**Bonus Answer: 44.8**

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**Bonus: Multiple Choice**

What is the main method of helium production?

- W) Retrieval from the upper atmosphere
- X) Distillation from natural gas
- Y) Extraction from rock compounds
- Z) Distillation from the lower atmosphere

**Bonus Answer: X**

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**15. CHEMISTRY**

**Writer: Andrew Chen**

**Toss Up: Short Answer**

If the molar mass of neon is 20 grams and the molar mass of argon is 40 grams, to the nearest tenth, what is the ratio of the rates of effusion of neon to argon?

**Bonus Answer: 1.4**

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**Bonus: Multiple Choice**

Which element has the highest second ionization energy?

- W) Lithium
- X) Hydrogen
- Y) Helium
- Z) Beryllium

**Bonus Answer: W**

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**16. CHEMISTRY**

**Writer: Andrew Chen**

**Toss Up: Short Answer**

How many nodes does a 3p orbital have?

**Bonus Answer: 2**

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**Bonus: Short Answer**

Name any amino acid that contains a phenyl group.

**Bonus Answer: Phenylalanine, Tyrosine, Tryptophan**

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## 17. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Multiple Choice**

Which element with no stable isotopes has the lowest atomic mass?

W) Bismuth

X) Technetium

Y) Uranium

Z) Radium

**Toss Up Answer: X**

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**Bonus: Short Answer**

What color is the H-alpha spectral line?

**Bonus Answer: Red**

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## 18. CHEMISTRY

**Writer: Andrew Chen**

**Toss Up: Short Answer**

Which form of coal has the highest percentage of carbon?

**Bonus Answer: anthracite**

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**Bonus: Multiple Choice**

Which of the following is a salt?

W) Water

X) Soap

Y) Plastic

Z) Rust

**Bonus Answer: X**

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## 19. CHEMISTRY

**Writer: Nicholas Parker Ng**

**Toss Up: Multiple Choice**

Which type of nuclear reactor does not require a moderator?

W) Light Water Reactor

X) Heavy Water Reactor

Y) Graphite Moderated Reactor

Z) Fast Breeder Reactor

**Toss Up Answer: Z**

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**Bonus: Short Answer**

Which types of fuel cells mainly use platinum catalysts?

PEMFC  
PAFC  
DMFC  
MCFC

**Bonus Answer: 1 and 3**

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## 20. EARTH and SPACE

**Writer: Wilson Berkow**

**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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## 21. EARTH and SPACE

**Writer: Wilson Berkow**

**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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## 22. EARTH and SPACE

**Writer: Wilson Berkow**

**Toss Up: Short Answer**

What body is the most volcanic in the solar system?

**Bonus Answer: Io**

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**Bonus: Short Answer**

What effect gives Io the energy for this volcanic activity?

**Bonus Answer: Tidal heating (accept: tidal friction, tidal forces, tidal forces by Jupiter, tidal forces by Jupiter and its moons)**

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## 23. EARTH and SPACE

**Writer: Wilson Berkow**

**Toss Up: Short Answer**

From what body do astronomers believe most comets originate?

**Bonus Answer: The Oort Cloud**

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**Bonus: Short Answer**

Which tail of a comet is always directed in the opposite direction of the Sun?

**Bonus Answer: The ion tail (accept: gas tail. Reject dust tail as incorrect.)**

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## 24. EARTH and SPACE

**Writer: Wilson Berkow**

**Toss Up: Short Answer**

Which planet in the solar system has the greatest albedo?

**Bonus Answer: Venus**

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**Bonus: Multiple Choice**

What gas is most abundant in the troposphere of Venus?

W) Carbon dioxide

X) Nitrogen

Y) Sulfur dioxide

Z) Methane

**Bonus Answer: W**

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## 25. ENERGY

**Writer: Andrew Chen**

**Toss Up: Multiple Choice**

What is one advantage to geothermal energy?

W) Low cost

X) Can be built anywhere

Y) Doesn't produce any hazardous chemicals

Z) Will never run out of steam

**Toss Up Answer: W**

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**Bonus: Short Answer**

In an internal combustion engine, what is the name of the device that ignites the fuel?

**Bonus Answer: Spark plug**

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