

Round 8

1. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What is a famous impossible result of the classical modeling of blackbody intensity as a function of frequency?

Bonus Answer: "Ultraviolet Catastrophe"

Bonus: Multiple Choice

What is the classical law that attempts to map blackbody intensity as a function of frequency and leads to "ultraviolet catastrophe"?

W) Henderson-Hasselbalch's Law

X) Rayleigh-Jeans Law

Y) Plank's Law

Z) Kirchhoff Law

Bonus Answer: X

2. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What is the magnitude of the magnetic force caused by an electric current of 10 Amperes flowing perpendicular to a magnetic field of 10 Teslas through a length of 10 meters?

Bonus Answer: 1000 Newtons

Bonus: Multiple Choice

Two point charges are placed on the x-axis. The first has a charge of -3 Coulombs and is placed at $x=0$. The second is placed 3 meters to the right of the first and has a charge of 3 Coulombs. What is the dipole moment of these charges?

W) 9 Coulomb-Meters in the direction of the positive x-axis

X) 1 Coulomb-Meters in the direction of the positive x-axis

Y) 9 Coulomb-Meters in the direction of the negative x-axis

Z) 1 Coulomb-Meters in the direction of the negative x-axis

Bonus Answer: W

3. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What is the total voltage of a circuit with a total current of 10 Amperes running through four resistors placed in parallel, each with a resistance of 4 Ohms?

Bonus Answer: 10 Volts

Bonus: Short Answer

What does the abbreviation MOSFET stand for?

Bonus Answer: Metal-Oxide-Semiconductor Field-Effect Transistor

4. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

What is the unit of a Poynting vector?

Bonus Answer: Watt/meter² (accept equivalent variations)

Bonus: Short Answer

What's the order of magnitude of a Poynting vector of an EM wave, where the amplitude of the electric field is 300 N/C (newton per coulomb) and the amplitude of the magnetic field is 400 tesla?

Bonus Answer: 11

5. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

What is the equivalent capacitance of three Capacitors, each of 9 micro Farad Capacitance, placed in parallel?

Bonus Answer: 27 micro Farads

Bonus: Short Answer

Determine the amount of charge stored on either plate of a capacitor of 4 micro Farads when connected across a 12 Volt batter.

Bonus Answer: 48 micro Coulombs, 4.8×10^{-5} Coulombs

6. MATHEMATICS

Writer: Andrew Chen

Toss Up: Short Answer

How many vertices does a dodecahedron have?

Bonus Answer: 20

Bonus: Short Answer

In $a+bi$ form, what is the square root of i (give the answer with positive imaginary part)?

Bonus Answer: $(1/(\sqrt{2})) + (1/(\sqrt{2}))i$

7. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

Let f be an odd function over the real numbers. What is the value of f at 0?

W) -1

X) 0

Y) 1

Z) There is not enough information to determine an answer

Toss Up Answer: Z

Bonus: Multiple Choice

Which of the following is true?

W) An irrational number raised to an irrational power must have an irrational value.

X) For all positive number x and y , $x^{\ln(y)}$ is equal to $y^{\ln(x)}$

Y) For all real numbers a, b, c, d with b and d being non-zero, if $a/b > c/d$, then $a*d$ must be greater than $b*c$

Z) There are more complex numbers than there are real numbers.

Bonus Answer: X

8. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

To test products, there is a test that identifies 95% of defective products as defective, but also labels 10% of all working products as defective. If 85% of the products made are not defective, what probability of products the test determines to be defective are actually defective?

W) 39%

X) 84%

Y) 67%

Z) 42%

Toss Up Answer: Y

Bonus: Short Answer

Compute the surface area of a cylinder with radius 8 and height 2

Bonus Answer: 160pi

9. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

which of the following are true about the number and nature of the roots of the polynomial

$$x^3 - 29x^2 + 229x$$

I. 0 is a root

II. There must be a real, positive root

III. There must be three real roots

Bonus Answer: I

Bonus: Short Answer

Solve the following linear system of equations in 3 variables:

$$2x + y + 4z = 9$$

$$-x + 2y + 5z = -11$$

$$5x + 3y + 3z = -4$$

Bonus Answer: $x=4, y=-11, z=3$

Also accept (4,-11,3)

10. BIOLOGY

Writer: Amrit Hingorani

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

Bonus: Short Answer

What are the units of inheritance?

Bonus Answer: Genes (accept DNA)

11. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

Researchers in 2015 reported that resistance to a certain antibiotic was found in a growing number of bacteria from meat samples in China. What is the name of this antibiotic that treats Gram-negative bacteria?

W) Colistin

X) Carbapenems

Y) Linezolid

Z) Vancomycin

Toss Up Answer: W

Bonus: Short Answer

What is the name of polymer in bacterial walls not found in Gram-negative bacteria?

Bonus Answer:

Peptidoglycan

12. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

What is MYC?

W) Holoenzyme

X) Oncogene

Y) DNA

Z) Scientist name

Toss Up Answer: X

Bonus: Short Answer

What is the pacemaker of the heart?

Bonus Answer: SA (sinoatrial) node

13. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

What is another name for the cell body of neurons?

W) Stroma

X) Soma

Y) Cellulite

Z) Thylakoid

Toss Up Answer: X

Bonus: Short Answer

What molecule do Ras protein's hydrolyze?

Bonus Answer: GTP

14. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Although water molecules are locked together by strong hydrogen bonds, they can reconfigure themselves through which phenomena:

W) Adhesion

X) Brownian Motion

Y) Quantum Tunneling

Z) The Mpemba Effect

Toss Up Answer: Y

Bonus: Short Answer

Superfluidity is a state of matter which exhibits which of the following properties:

Extreme surface tension

Near-zero viscosity

High electrical conductivity

High thermal conductivity

Bonus Answer: 2 and 4

15. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Vacuum systems require materials with very low outgassing rates. Which of these metals would be suitable for use in a vacuum chamber?

W) Cadmium

X) Zinc

Y) Magnesium

Z) Aluminum

Toss Up Answer: Z

Bonus: Multiple Choice

Which one of these crystal lattice structures best describes the networking of Ti, Zn, and Mg?

W) BCC

X) FCC

Y) HCP

Z) LFC

Bonus Answer: Y

16. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Short Answer

What principle states that an electron will occupy the lowest energy orbital that can receive it?

Bonus Answer: Aufbau Principle

Bonus: Short Answer

What is the name of the radioactive decay chain for uranium-235?

Bonus Answer: Actinium series or Plutonium cascade.

17. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Which of the following molecules has a lewis structure that is a resonance hybrid?

W) C₂H₆

X) HBr

Y) SO₂

Z) CH₄

Toss Up Answer: Y

Bonus: Short Answer

What mass of HCL dissolved to make a 1 liter solution will give a PH of 1? Give your answer in grams rounded to the nearest hundredth.

Bonus Answer: 0.37

18. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

A tetrahedral molecule, XY₄ would be formed if X were using the orbital hybridization:

W) p²

X) s²

Y) sp²

Z) sp³

Toss Up Answer: Z

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

19. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Short Answer

What is the halide with no known stable isotopes?

Bonus Answer: Astatine

Bonus: Multiple Choice

Which of the following molecules is a saturated hydrocarbon?

W) C₂H₄

X) C₃H₈

Y) CH₃OH

Z) C₄H₆

Bonus Answer: X

20. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

What is defined to be the distance from the Sun, to a body whose stellar parallax is one arcsecond?

W) astronomical unit

X) Schwarzschild radius

Y) parsec

Z) light-second

Toss Up Answer: Y

Bonus: Multiple Choice

An amateur astronomer observes a star over the course of a year and finds that from January 1 to June 1, the star's position on the celestial sphere shifts by 3 arcseconds. How far is the star from the Earth, to the nearest tenth of a parsec?

- W) 3
- X) 0.3
- Y) 1.5
- Z) 0.7

Bonus Answer: Z

21. EARTH and SPACE

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

What is the name for the apparent line dividing night and day

- W) Seperator
- X) Day-Night Meridian
- Y) Terminator
- Z) Prime Meridian

Toss Up Answer: Y

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

22. EARTH and SPACE

Writer: Ahmad Alnasser

Toss Up: Short Answer

What star has the greatest apparent magnitude

Bonus Answer: Sun

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

23. EARTH and SPACE

Writer: Raafiul Hossain

Toss Up: Short Answer

Which planet has the least eccentric orbit?

Bonus Answer: Venus

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

Writer: Raafiul Hossain

Toss Up: Short Answer

What type of rock comes in layers?

Bonus Answer: Sedimentary

Bonus: Short Answer

What color is a flame of lithium?

Bonus Answer: red

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25. ENERGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

Using current technologies, which of the following sources of energy is nonrenewable?

W) Geothermal

X) Wind

Y) Nuclear

Z) Solar

Toss Up Answer: Y

Bonus: Multiple Choice

Which of the following is NOT a fossil fuel?

W) Coal

X) Petroleum

Y) Natural gas

Z) Uranium

Bonus Answer: Z

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