Round 12

1. PHYSICS

Writer: Jan Wojcik

Toss Up: Short Answer

What is the equivalent capacitance in Farads of two capacitors connected in series, one with a capacitance of 4 microFarads and the other with a capacitance of 2 microFarads?

Bonus Answer: 4/3 microFarads

Bonus: Short Answer

Give your answer in scientific notation, in Farads, rounded to the nearest tenth. What is the approximate capacitance between two parallel plates of surface area 10cm squared, separated by a distance of 1 meter?

Bonus Answer: 8.9*10^-14 Farads

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2. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

In the capacitor discharge formula q = q0e^(−t/(RC)) (read as q naught times e raised to the power of negative t over quantity R times C) the term RC is more commonly referred to as:

W) The time limit

X) The time of charge

Y) The time constant

Z) It does not have a specific name

Toss Up Answer: Z

Bonus: Short Answer

Resistor 1 has twice the resistance of resistor 2. They are connected in parallel to a battery.The ratio of the thermal energy generation rate in 1 to that in 2 is:

Bonus Answer: 1:2

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3. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

The Laplacian of an electric potential field is equal to the negative free charge density over this quantity. This quantity is equal to the negative time derivative of the magnetic flux, and in an inductor, it is equivalent to the inductance multiplied by the negative time derivative of the current. It is classically defined as Coulomb's constant multiplied by the sum of charge over distance, and also as the line integral of the electric field "dot dl." When it is multiplied by current, it gives power dissipated by a resistor. Kirchoff's Loop Rule states that the sum of this value around a loop in a circuit is zero. Name this quantity this is equal to the current times resistance by Ohm's Law.

Bonus Answer: Voltage (accept electric potential)

Bonus: Multiple Choice

A certain capacitor, in series with a 720-Ω resistor, is being charged. At the end of 10 ms(milliseconds) its charge is half the final value. The capacitance is about:

W) 9.6 μF

X) 14 μF

Y) 20 μF

Z) 7.2F

Bonus Answer: Y

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4. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

A non-relativistic free electron has kinetic energy K. If its wavelength doubles, what is its kinetic energy in terms of K?

W) 4K

X) K/4

Y) K

Z) K/2

Toss Up Answer: X

Bonus: Short Answer

A molecule with a magnetic moment of 83 N*m/T(read as Newton-meters per Tesla) experiences what amount of torque in N*m (read as Newton-meter) when subjected to an external magnetic force of 120 teslas?

Bonus Answer: 9960 N*m

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5. PHYSICS

Writer: Charles Zhang

Toss Up: Multiple Choice

If the wave function ψ is spherically symmetric then the radial probability density is given by:If the wave function ψ is spherically symmetric then the radial probability density is given by:

W) 4πr^2*ψ

X) |ψ|^2

Y) 4πr^2|ψ|^2

Z) 4π|ψ|^2

Toss Up Answer: Y

Bonus: Short Answer

Maxwell's equations are to electric and magnetic fields as [ ] equation is to the wave function for a particle.

Bonus Answer: Schrodinger's

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6. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Multiple Choice

If θ is an angle such that sin(θ) < 0 and cos (θ) = 0, where in the coordinate plane is it located?

W) Between the 2nd and 3rd quadrants

X) Between the 3rd and 4th quadrants

Y) Between the 1st and 4th quadrants

Z) Between the 1st and 2nd quadrants

Toss Up Answer: Y

Bonus: Short Answer

What is the remainder of x^10+x+1 divided by (x-1)^2 ?

Bonus Answer: 11x-8

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7. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

What is the inverse of the 2x2 matrix (row 1: 6 10), (row 2: 3 5)?

Bonus Answer: The matrix has no inverse (b.c. determinant = 0).

Bonus: Short Answer

The legs of an isosceles triangle have a length of 10, and the altitudes to the legs have a length of 6. In simplified radical form, what is the length of the altitude to the base of the triangle?

Bonus Answer: 3 * sqrt(10) (Do not accept sqrt(90))

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8. MATHEMATICS

Writer: Seiji Yawata

Toss Up: Short Answer

If n is a positive integer, what is the smallest value of n such that n! + 1 is a perfect square?

Bonus Answer: 4

Bonus: Short Answer

If z1 = 3 - 4i and z2 = 7 + i, find the absolute value of z1z2 in simplest terms.

Bonus Answer: 25*sqrt(2)

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9. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Multiple Choice

Compute 3C1+4C2+5C3+6C4+7C5. [3 choose 1 + 4 choose 2 + 5 choose 3 + 6 choose 4 + 7 choose 5]

W) 55

X) 336

Y) 240

Z) 56

Toss Up Answer: W

Bonus: Short Answer

Compute the square root of 5476

Bonus Answer: 74

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10. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

The strongest known biological oxidizing agent plays a key role in photosynthesis. What is it called?

Bonus Answer: P680

Bonus: Short Answer

What was the phage that Hershey and Chase used in their experiments, and what two radioactive substances did they tag it with?

Bonus Answer: T2, S35 and P32 (Do NOT accept Sulfur and Phosphorus)

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11. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which is not associated with the proteasomal degradation pathway?

W) Response to oxidative stress

X) Regulation of gene expression

Y) Kinetochore attachment

Z) The Cell cycle

Toss Up Answer: Y

Bonus: Short Answer

If a reaction with a Delta G of +3.4 kcal/mol is coupled with ATP hydrolysis, what is the net Delta G?

Bonus Answer: -3.9 kcal/mol

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12. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which process is in play when we respond less strongly to repeated stimuli over time?

W) Sensory Adaptation

X) Habituation

Y) Accomodation

Z) Maturation

Toss Up Answer: X

Bonus: Multiple Choice

The learning phase during which a conditioned response is established is called:

W) Learning

X) Possession

Y) Acquisition

Z) Incubation

Bonus Answer: Y

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13. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

Which amino acid would constitute a disulfide bridge?

Bonus Answer: Cysteine

Bonus: Short Answer

What is the name of the cellular machinery that removes introns?

Bonus Answer: Spliceosome

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14. CHEMISTRY

Writer: William Chan

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

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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15. CHEMISTRY

Writer: William Chan

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

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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16. CHEMISTRY

Writer: William Chan

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

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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17. CHEMISTRY

Writer: William Chan

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

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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18. CHEMISTRY

Writer: William Chan

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

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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19. CHEMISTRY

Writer: William Chan

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

Bonus: Multiple Choice

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

W) C2H6
X) C6H6
Y) CCl4
Z) CaF2

Bonus Answer: X

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20. EARTH and SPACE

Writer: Amrit Hingorani

Toss Up: Multiple Choice

Light from distant galaxies comes mostly from which of the following?
W) Planets
X) Low mass stars
Y) High mass stars
Z) Black holes

Toss Up Answer: Y

Bonus: Multiple Choice

Which planet has the highest escape velocity?
W) Mercury
X) Earth
Y) Uranus
Z) Jupiter

Bonus Answer: Z

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21. EARTH and SPACE

Writer: Amrit Hingorani

Toss Up: Multiple Choice

What percent of Sun-like stars in the sky that appear to be single stars are actually binary stars?
W) About 25%
X) About 35%
Y) About 50%
Z) About 60%

Toss Up Answer: Y

Bonus: Short Answer

What is the 29 ½ days it takes the Moon to complete an orbit around the Earth called?

Bonus Answer: Synodic month

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22. EARTH and SPACE

Writer: Amrit Hingorani

Toss Up: Short Answer

A solar eclipse can only occur at what phase of the moon?

Bonus Answer: New Moon

Bonus: Short Answer

What constellation cannot be seen in the summer sky of the northern hemisphere?

Bonus Answer: Orion

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23. EARTH and SPACE

Writer: Amrit Hingorani

Toss Up: Short Answer

What mountain has the highest point in the Western Hemisphere?

Bonus Answer: Mt. Aconcagua

Bonus: Multiple Choice

Which of the following describes how sea ice is different from continental ice?

W) Continental ice is denser than sea ice

X) Sea ice is saline while continental ice is fresh

Y) Sea ice floats on the water while continental ice sits on land

Z) Sea ice is constantly changing while continental ice remains the same

Bonus Answer: Y

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24. EARTH and SPACE

Writer: Amrit Hingorani

Toss Up: Short Answer

What is the second longest Peninsula in the world?

Bonus Answer: Baja California

Bonus: Short Answer

What is a system or group of parallel mountain ranges together with the intervening plateaus and other features?

Bonus Answer: Cordillera

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25. ENERGY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

In a conventional light bulb, what is the ratio of light energy to the heat energy produced?

W) 1:9

X) 3:2

Y) 1:1

Z) 7:3

Toss Up Answer: W

Bonus: Multiple Choice

The arctic is estimated to hold what percent of the worlds what percent of the world’s undiscovered oil and natural gas reserves?

W) 7%

X) 13%

Y) 22%

Z) 35%

Bonus Answer: Y

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