Round 10

1. MATHEMATICS

Writer: Siam Muquit

Toss Up: Short Answer

Given y = | x - 6 | , what is the derivative at x = 6?

Bonus Answer: The derivative does not exist

Bonus: Short Answer

Find the derivative of x^3 / x^2

Bonus Answer: 1

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2. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

The constant potential difference across a 2 ohm resistor is 20 volts. How many watts of power are dissipated by this resistor?

W) 150 watts
X) 200 watts
Y) 250 watts
Z) 2000 watts

Toss Up Answer: X

Bonus: Short Answer

The potential difference across a 4 ohm resistor is 20 volts. Assuming that all of the energy dissipated by this resistor is in the form of heat, how many joules of heat are radiated in 10 seconds?

Bonus Answer: 1000 J (joules)

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3. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What spectral type does the star Betelgeuse fall into?

Bonus Answer: M

Bonus: Multiple Choice

When was the last major supernova in the Milky Way detected?
W) 1604
X) 1863
Y) 1973
Z) 1989

Bonus Answer: W

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4. BIOLOGY

Writer: Sean Vaysburd

Toss Up: Short Answer

What is the most current model of the cell membrane called?

Bonus Answer: Fluid Mosaic Model

Bonus: Short Answer

Who came up with the fluid mosaic model?

Bonus Answer: SJ Singer and GL Nicolson

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5. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

In which atmospheric level does the "good" ozone preside?

Bonus Answer: Stratosphere

Bonus: Short Answer

In which atmospheric level does the "bad" ozone preside?

Bonus Answer: Troposphere

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6. CHEMISTRY

Writer: Jason Mohabir

Toss Up: Multiple Choice

For the unfolding reaction of Protein G, ΔH° =210.6 kJ/mol, this means that

W) unfolding is favored enthalpically

X) unfolding is favored enthalpically

Y) the entropy is positive at all temperatures

Z) the entropy is negative at all temperatures

Toss Up Answer: X

Bonus: Multiple Choice

At the midpoint of a temperature transition curve,

W) half of the protein is denatured

X) Keq = 1.0 and $\Delta G = 0$

Y) [Native] = [Unfolded] (Read as concentration of Native = concentration of Unfolded)

Z) All of these

Bonus Answer: Z

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7. PHYSICS

Writer: Aaron Gee

Toss Up: Multiple Choice

The force acting between two point charges can be computed using which of the following laws?

W) Ohm's Law

X) Ampere's Law

Y) Coulomb's Law

Z) Newton's Second Law

Toss Up Answer: Y

Bonus: Short Answer

Five volts are applied across the plates of a parallel plate capacitor. The distance of separation of the plates is .02 meters. What is the magnitude of the electric field inside the capacitor?

Bonus Answer: 250 volts per meter

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8. CHEMISTRY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The Standard Gibb's free energy, ΔG°, is

W) the residual energy present in the reactants at equilibrium

X) the residual energy present in the products at equilibrium

Y) the energy required to convert one mole of reactants to one mole of products

Z) the difference in the residual energy of reactants and products at equilibrium

Toss Up Answer: X

Bonus: Multiple Choice

If the enthalpy change for a reaction is zero, ΔG° is equal to

W) TΔS°

X) TΔS°

Y) -ΔH°

Z) lnKeq

Bonus Answer: X

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9. EARTH and SPACE

Writer: Jan Wojcik

Toss Up: Short Answer

Name the soil horizon that contains a mixture of organic matter and highly altered mineral matter and is dark in color.

Bonus Answer: A-horizon

Bonus: Short Answer

By name or number, which of the following phenomena cause acidification in agricultural soils:

1) Leaching of excess nitrate

2) Build-up in mostly plant-based organic matter

3) Removal of plant and animal products

4) Addition of nitrogen based fertilisers

Bonus Answer: All of them (accept 1,2,3,4)

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10. PHYSICS

Writer: Jason Mohabir

Toss Up: Multiple Choice

NMR spectroscopy is

W) diffraction

X) absorption

Y) radiation

Z) emission

Toss Up Answer: X

Bonus: Multiple Choice

NMR is based on

W) nuclear fission

X) charge of nucleus

Y) magnetically moment of the nucleus
Z) electrical moment of the nucleus

Bonus Answer: Y

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11. MATHEMATICS

Writer: Ahmad Alnasser

Toss Up: Short Answer

Find the derivative of: 4x^3 + 18x + 2

Bonus Answer: 8x^2 + 18

Bonus: Short Answer

At what point is the slope of the tangent line to the parabola y= 3x^2 + 5x + 23 equal to 0?

Bonus Answer: (-5/6 , 441/36)

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12. PHYSICS

Writer: George Papastefanou

Toss Up: Multiple Choice

What is the fundamental frequency, in Hz, for a string with a Tension of 250 N, a mass per length of .25 grams per meter, and a length of 50 cm?

W) 1200
X) 5000
Y) 1000
Z) 250

Toss Up Answer: Y

Bonus: Short Answer

Will a projectile fired at a 30 degree angle at 55 m/s clear a 25-meter fence located 50 meters away?

Bonus Answer: No (height at that point is ~23.5 m)

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13. BIOLOGY

Writer: Sean Vaysburd

Toss Up: Short Answer

What is the name of the proteins in cell membranes that allow for rapid transport of water into and out of the cell?

Bonus Answer: Aquaporins

Bonus: Short Answer

What membrane bound structures in cells are important for exocytosis?

Bonus Answer: transport vesicles

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14. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

What is the oxidation state of Manganese in the permanganate ion?

W) +5
X) +7
Y) +2
Z) -2

Toss Up Answer: X

Bonus: Short Answer

What is the oxidation state of molecular oxygen?

Bonus Answer: 0

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15. BIOLOGY

Writer: Olivia Gallager

Toss Up: Multiple Choice

Which of the following enzymes makes C4 and CAM species more efficient in hotter, dryer climates?

W) phosphofructokinase

X) Rubisco

Y) DNA polymerase

Z) PEP Carboxylase

Toss Up Answer: Z

Bonus: Short Answer

During the light dependent reactions, on what membrane does ATP synthesis take place via ATP Synthase?

Bonus Answer: thylakoid, thylakoid membrane

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16. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

Which of the following hydrocarbons have the highest boiling point.

W) CH4

X) C2H6

Y) C3H8

Z) C4H10

Toss Up Answer: Z

Bonus: Multiple Choice

Alloys are mixtures of metallic substances. Which of the following pairs are matched INCORRECTLY?

W) Steel - iron and copper

X) Brass - copper and zinc

Y) Pewter - tin, copper, bismuth, and antimony

Z) Sterling silver - silver and copper

Bonus Answer: W

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17. BIOLOGY

Writer: Olivia Gallager

Toss Up: Short Answer

What part of the brain controls the interaction between the two hemispheres?

Bonus Answer: corpus callosum

Bonus: Short Answer

Which lobe of the brain is known for spatial reasoning and navigation?

Bonus Answer: parietal lobes

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18. CHEMISTRY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which is the strongest type of intermolecular force?

W) Hydrogen bonding

X) Dipole-dipole

Y) Van der Waals

Z) Metallic bonding

Toss Up Answer: X

Bonus: Short Answer

By name or number, which of the following elements can form hydrogen bonds?

Oxygen, Chlorine, Fluorine, Nitrogen, Sulfur

Bonus Answer: Oxygen, Fluorine, Nitrogen or (1, 3, and 4)

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19. MATHEMATICS

Writer: Ahmad Alnasser

Toss Up: Short Answer

Write an equation for a sine function with an amplitude of 5/3 , a period of pi/2, and a vertical shift of 4 units up.

Bonus Answer: y = (5/3)sin(4 x) + 4

Bonus: Short Answer

Two large and 1 small pumps can fill a swimming pool in 4 hours. One large and 3 small pumps can also fill the same swimming pool in 4 hours. How many hours will it take 4 large and 4 small pumps to fill the swimming pool.

Bonus Answer: 1 hour and 40 minutes

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20. PHYSICS

Writer: Jan Wojcik

Toss Up: Multiple Choice

There is a 4kg block at rest. It spontaneously explodes into two pieces traveling in opposite directions. One piece weighing 1 kilogram travels to the left at 4 m/s. What direction and speed was the other block traveling in?

W) 4/3 m/s to the left

X) 3/4 m/s to the right

Y) 4/3 m/s to the right

Z) 4 m/s to the left

Toss Up Answer: Y

Bonus: Multiple Choice

Under small velocities, objects that collide do not conserve their total energy. However, under relativistic velocities, collisions always conserve their total energy. Why is this so?

W) Under relativistic velocities, mass and energy are interchangeable, and since mass can't be destroyed, neither can initial nor final energy.

X) Under small velocities, the frictional force during collision felt by two objects is large, whereas under relativistic velocities, the frictional force is negligible and energy is conserved.

Y) Under relativistic velocities, objects obtain relativistic masses which makes them gain more mass and makes up the lost energy in a regular collision.

Z) Under small velocities, particles lose parts of their masses while in motion, leading to a loss of energy after collision.

Bonus Answer: W

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21. BIOLOGY

Writer: Olivia Gallager

Toss Up: Short Answer

Defects in the myelin sheath lead to what disease?

Bonus Answer: Multiple Sclerosis

Bonus: Short Answer

From which parent do we inherit mitochondrial DNA?

Bonus Answer: Mothers, maternal

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22. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

What is the magnitude of a vector 4 meters in the x direction, 1 meter in the y direction, and 8 meters in the z direction?

W) 7 meters

X) 9 meters

Y) 11 meters

Z) 13 meters

Toss Up Answer: X

Bonus: Short Answer

Unit X equals "sqrt(A / B)" and is in units "(Mass*Time) / Length^2". If A has units "Length / Time", what are the units of B?

Bonus Answer: Length^5 / (Mass^2 * Time^3)

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23. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

Metastasis involves

W) decreased levels of proteins that regulate metalloproteins

X) programmed cell death

Y) closing of aromatic rings

Z) bioinformatic analysis of clinical trial

Toss Up Answer: W

Bonus: Multiple Choice

BRACI, an inherited form of breast cancer, regulates cell division by

W) binding to a DNA sequence

X) binding to the protein RAD 51 which repairs DNA damage

Y) complexing with cyclins

Z) binding to the cell outer membrane

Bonus Answer: X

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24. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The BLAST program is used in

W) Bioinformatics
X) DNA Sequencing
Y) Amino acid Sequencing
Z) DNA Barcoding

Toss Up Answer: W

Bonus: Multiple Choice

Phylogenetic relationships can be shown by
W) Dendrogram
X) Gene bank
Y) Data retrieving tool
Z) Data search tool

Bonus Answer: W

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25. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

Which protein did Nobel Laureate Christian Anfinsen characterize to come to the conclusion that the native structure is determined only by the protein's amino acid sequence?
W) catalase
X) ribonuclease A
Y) luciferase
Z) amylase

Toss Up Answer: X

Bonus: Short Answer

What is the name of the thought experiment that postulates that because of the very large number of degrees of freedom in an unfolded polypeptide chain, the molecule has an astronomical number of possible conformations?

Bonus Answer: Levinthal's paradox OR Levinthal

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