

Round 33

1. 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

2. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the name for the rule that states that when you have a limit of indeterminate form as a fraction, it is equal to the limit of the derivative of the numerator over the derivative of the denominator?

Bonus Answer: L'hospital's rule

Bonus: Short Answer

What famous function, named after a mathematician, takes the infinite sum of the reciprocals of the natural numbers raised to an argument?

Bonus Answer: Riemann zeta function

3. 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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4. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

The sum $(1+3+3^2+\dots+3^n)$ is equal to which of the following?

W) $2 \cdot 3^n$

X) $4 \cdot 3^n$

Y) $(3^{(n+1)}+1)/2$

Z) $(3^{(n+1)}-1)/2$

Toss Up Answer: Z

Bonus: Short Answer

In space, what is the graph of the equation $x^2 = y$?

Bonus Answer: A parabolic cylinder

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5. 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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6. MATHEMATICS

Writer: George Zhou

Toss Up: Short Answer

What is the solution for square root of the quantity $x+5$ equals $x+3$

Bonus Answer: -1 *(do not except: [-1 and -4] or [-3])

Bonus: Short Answer

In a certain language of a certain people of a certain world, to frack a number is to find the average of the number and its square. For example, the frack of 2 is 3 since it is the average of 2 and 2 squared. what is the frack of 100?

Bonus Answer: 2020

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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

8. MATHEMATICS

Writer: Hanna Yang

Toss Up: Multiple Choice

Which of the following is true?

W) -1 is congruent to 1 modulo 5

X) -1 is congruent to 2 modulo 5

Y) -1 is congruent to 3 modulo 5

Z) -1 is congruent to 4 modulo 5

Toss Up Answer: Z

Bonus: Short Answer

Which is larger, 8^{10} or 3^{30}

Bonus Answer: 3^{30}

9. 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)

10. BIOLOGY

Writer: Siam Muquit

Toss Up: Multiple Choice

Which biome is characterized by population oscillations?

W) Temperate Deciduous

X) Tropical Rainforest

Y) Tundra

Z) Taiga

Toss Up Answer: Y

Bonus: Short Answer

Large-scale population oscillations in the tundra are caused by what abiotic factor?

Bonus Answer: Thawing and freezing of the ice (Also accept: population migrations)

11. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

Which of the following statements is NOT true for the element of sodium?

W) It has an oxidation state of +1

X) It forms a basic solution with water

Y) It gives off a bright red color when burned

Z) It reacts with a halogen to form a salt

Toss Up Answer: Y

Bonus: Short Answer

Which of the following are products made from the reaction $\text{H}_2\text{SO}_4(\text{aq}) + \text{Ba}(\text{OH})_2(\text{aq}) \rightarrow ?$ I) $\text{O}_2(\text{g})$ II) $\text{H}_2\text{O}(\text{l})$ III) $\text{BaSO}_4(\text{s})$

Bonus Answer: II and III

12. BIOLOGY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

Animals and fungi are both characterized as heterotrophic. The distinguishing factor of animal heterotrophy from fungal heterotrophy is that only animals derive their nutrition by

W) consuming living, rather than dead, prey.

X) preying on animals

Y) ingesting it

Z) using enzymes for digestion

Toss Up Answer: Y

Bonus: Multiple Choice

At which developmental stage should one be able to first distinguish a diploblastic embryo from a triploblastic embryo?

W) fertilization

X) gastrulation

Y) coelom formation

Z) cleavage

Bonus Answer: X

13. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Multiple Choice

Which of the following can be precisely determined for a chemical substance?

- W) Entropy
- X) Enthalpy
- Y) Free Energy
- Z) All of the Above

Toss Up Answer: W

Bonus: Short Answer

In a rate law, what are the units of k when the order is 3?

Bonus Answer: $L^2 \text{ mol}^{-2} \text{ s}^{-1}$

14. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

Which of the following phospholipids is released by phagocytic cells and leads to superoxide radical production in alveoli macrophages?

- W) Plasmalogens
- X) Phosphatidylinositol
- Y) Cardiolipin
- Z) Platelet activating factor

Toss Up Answer: Z

Bonus: Short Answer

Which of the following forms of movement do the phospholipids of plasma membranes have routinely exhibit? Answer with the number.

1. Diffusion in the plane of the bilayer
2. Translocation from one side of the bilayer to the other side
3. Rotation of fatty-acid residues around saturated carbon atoms

Bonus Answer: 1 and 3

15. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Multiple Choice

The evaporation of any liquid is expected to have

- W) a positive ΔH and a negative ΔS
- X) a negative ΔH and a negative ΔS
- Y) a positive ΔH and a positive ΔS
- Z) a positive ΔH and a negative ΔS

Toss Up Answer: Y

Bonus: Multiple Choice

The rate of reaction will be large if

- W) ΔG is a large negative number
- X) ΔS is a large negative number
- Y) ΔH is a large negative number
- Z) None of the above

Bonus Answer: Z

16. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

The field of biostatistics is also called

- W) statistics in biology
- X) bionemerology
- Y) biometry
- Z) Both W and X

Toss Up Answer: Y

Bonus: Multiple Choice

The word [must be said in a German accent] "statistik" in German means:

- W) calculation
- X) government
- Y) maths
- Z) classification

Bonus Answer: X

17. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Multiple Choice

Which of these gases is expected to condense at the lowest pressure, assuming that the temperature is constant?

- W) Bromomethane
- X) Dibromomethane
- Y) Tetrabromomethane
- Z) They all condense at the same temperature

Toss Up Answer: Y

Bonus: Short Answer

Which attractive force is the major cause of condensation?

Bonus Answer: London Dispersion Forces (accept: London Forces)

18. BIOLOGY

Writer: Jason Mohabir

Toss Up: Multiple Choice

Proteonomics is the study of

- W) sets of proteins
- X) sets of proteins in a specific organelle
- Y) entire set of expressed proteins in a cell
- Z) none of these

Toss Up Answer: Y

Bonus: Multiple Choice

The computational methodology that tries to find the best matching between two molecules, a receptor and ligand called:

- W) molecular matching

- X) molecular docking
- Y) molecular fitting
- Z) molecule affinity checking

Bonus Answer: X

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19. CHEMISTRY

Writer: Nicholas Adit

Toss Up: Multiple Choice

Which of the following is a nonpolar molecule?

- W) Carbon dioxide
- X) Water
- Y) Ammonia
- Z) Hydrochloric acid

Toss Up Answer: W

Bonus: Short Answer

Which of the following forms of radioactive decay has (or have) no electrical charges? 1) Alpha Decay 2) Beta Decay 3) Gamma Decay

Bonus Answer: 3 only

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20. 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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21. EARTH and SPACE

Writer: George Papastefanou

Toss Up: Short Answer

How long does it take for a satellite in geosynchronous orbit to travel once around the Earth?

Bonus Answer: One day

Bonus: Short Answer

What is the orbital period, to the nearest year, of Halley's Comet?

Bonus Answer: 75 years

22. 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

23. EARTH and SPACE

Writer: Jan Wojcik

Toss Up: Short Answer

Name the wave that you would typically feel during an earthquake if you were standing on the ground after feeling the first primary wave.

Bonus Answer: S-wave (secondary wave)

Bonus: Short Answer

An earthquake is measured to have a Richter scale value of around 4. Another earthquake is measured to have a Richter scale value of 7. How much smaller is the first earthquake to the second earthquake?

Bonus Answer: 1000 times smaller (accept 1000)

24. 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

BRAC1, 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

25. EARTH and SPACE

Writer: George Papastefanou

Toss Up: Multiple Choice

The North Pacific Gyre is mostly located within what latitudinal zone?

W) The North Frigid Zone

X) The Torrid Zone

Y) The Horse Latitudes

Z) The North Temperate Zone

Toss Up Answer: Z

Bonus: Short Answer

What ocean current keeps Western Europe relatively warm for its latitude?

Bonus Answer: North Atlantic Current (accept North Atlantic Drift, but not Gulf Stream)
