Round 16

TOSSUP

1) BIOLOGY *Multiple Choice* Which of the following forms of DNA is the most common?

W) A-DNA
X) B-DNA
Y) Y-DNA
Z) Z-DNA

ANSWER: X) B-DNA

BONUS

1) BIOLOGY *Multiple Choice* Which of the following is secreted by cells in the juxtaglomerular apparatus in response to decreased delivery of Na+ and Cl- to the macula densa?

W) antidiuretic hormone
X) angiotensin I
Y) renin
Z) aldosterone

ANSWER: Y) RENIN

TOSSUP

2) PHYSICS *Multiple Choice* What is the difference between neutron diffraction and X-ray diffraction?

W) X-ray diffraction needs large crystallization
X) There is no difference as both can be used to study the structure of nucleic acids
Y) Neutron diffraction is used for the precise structure
Z) Neutron diffraction deals with electron clouds

ANSWER: Y) NEUTRON DIFFRACTION IS USED FOR THE PRECISE STRUCTURE

BONUS

2) PHYSICS *Short Answer* By name or number, identify each of the following 4 particles that do NOT follow Bose-Einstein statistics?

1) alpha particle
2) proton
3) photon
4) neutrino

ANSWER: 2 AND 4 (PROTON AND NEUTRINO)

TOSSUP

3) EARTH AND SPACE *Multiple Choice* Which of the following best describes the placement of the L3 Langrangian point of Earth and the Sun?

W) Between Earth and the Sun
X) On the far side of the Earth from the Sun
Y) On the far side of the Sun from the Earth
Z) On the orbit of the Earth

ANSWER: Y) ON THE FAR SIDE OF THE SUN FROM THE EARTH

BONUS

3) EARTH AND SPACE *Multiple Choice* There are large concentrations of dust collected at the L4 and L5 Lagrangian points of the Earth and the moon. What are these clouds of dust known as?

W) Kordylewski Clouds
X) Van Allen Belts
Y) Gegenschein Clouds
Z) Lagrange Nebulae

ANSWER: W) KORDYLEWSKI CLOUDS

TOSSUP

4) CHEMISTRY *Short Answer* 2,3-dimethylbutan-2-ol undergoes an elimination reaction in the presence of an acid catalyst. What rule determines that the major product will be 2,3-dimethylbut-2-ene rather than 2,3-dimethylbut-1-ene?

ANSWER: Zaitsev's Rule

BONUS

4) CHEMISTRY *Multiple Choice* You microwave a grape to make some plasma, but to save your microwave you place the grape in an upside down laboratory beaker. Which of the following best describes why the observed plasma is green in color?

W) Ions from salts in the grape burn green
X) Boron from the beaker's glass burns green
Y) The frequency of the microwave induce a green color
Z) The plasma is at a temperature where it emits green light

ANSWER: X) BORON FROM THE BEAKER'S GLASS BURNS GREEN

TOSSUP

5) MATH *Multiple Choice* Given x^2-6x+1=0, find x^2 + 1/(x^2).

W) 6
X) 25
Y) 34
Z) 48

ANSWER: Y) 34

BONUS

5) MATH *Short Answer* If for a polynomial P(x), the value P(x)-3P(x+1)+3P(x+2)-P(x+3) is equal to 12 for all values of x, what is the leading term of P?

ANSWER: 2X^3

TOSSUP

6) ENERGY *Short Answer* Scientists at Argonne National Lab are using powerful magnets to measure the g-factor of a certain particle as a way to test the Standard Model of particle physics. What is this particle which they are researching, a heavier analog of the electron?

ANSWER: MUON

BONUS

6) ENERGY *Short Answer* Researchers at Ames and Argonne National Labs have devised a method to transform polyethylene waste products into a liquid by cleaving the long polymer chains. The reaction occurs on the surface of a platinum and strontium titanate catalyst in a high pressure hydrogen atmosphere. What is the type of reaction that occurs in this process?

ANSWER: HYDROGENOLYSIS

TOSSUP

7) PHYSICS *Short Answer* Near light speed muons are formed by cosmic rays in the upper atmosphere and then hit the Earth’s surface. However, based on their half-life and speed, these muons should not be able to reach Earth’s surface. What relativistic effect, from the muons point of view, allows them to reach the surface?

ANSWER: LENGTH CONTRACTION (DO NOT ACCEPT TIME DILATION)

BONUS

7) PHYSICS *Short Answer* A space pilot flies in a spaceship travelling at .6c for 1 minute, to the nearest tenth, how many minutes have passed for a stationary, outside observer?

ANSWER: 1.25 MINUTES

TOSSUP

8) BIOLOGY *Short Answer* By name or number, identify which of the following 4 compounds contains N-acetylglucosamine.

1) Collagen
2) Peptidoglycan
3) Keratin
4) Chitin

ANSWER: 2 AND 4 (PEPTIDOGLYCAN AND CHITIN)

BONUS

8) BIOLOGY *Short Answer* Lynn Margulis first proposed what theory, which provides an explanation for the development of mitochondria and some other organelles in eukaryotic cells.

ANSWER: SYMBIOGENESIS OR ENDOSYMBIOTIC THEORY

TOSSUP

9) CHEMISTRY *Multiple Choice* Which of the following results from mixing equal volumes of 0.1 Molar calcium nitrate and silver fluoride solutions?

W) no precipitate and a colorless solution
X) a white precipitate and a colorless solution
Y) no precipitate and a colored solution
Z) a colored precipitate and a colorless solution

ANSWER: X) A WHITE PRECIPITATE AND A COLORLESS SOLUTION

BONUS

9) CHEMISTRY *Multiple Choice* NO_2, a brown gas, is in equilibrium with colorless N_2O_4 according to the exothermic reaction 2 NO_2 yields N_2O_4. Identify each of the following four changes that would cause a mixture of these gases to darken in color.

1) Heating the mixture
2) Decreasing the volume of the container
3) Injecting argon into the mixture
4) Decreasing the pressure of the container

ANSWER: 1 AND 4

TOSSUP

10) ENERGY *Short Answer* Researchers at Ames Laboratory are studying Homes scaling, which supports the BCS theory of superconductivity. This first microscopic description of superconductivity, explains that superconductivity results from the condensation of what pairs of coupled electrons?

ANSWER: COOPER PAIRS

BONUS

10) ENERGY *Multiple Choice* Researchers at Pacific Northwest National Lab have developed the first forensic proteomics method to quickly detect ricin, a lethal toxin. Which of the following best describes the method by which ricin acts in the human body?

W) Ricin inhibits protein synthesis within cells
X) Ricin binds to acetylcholinesterase
Y) Ricin inhibits certain enzymes important to cellular respiration
Z) Ricin attacks certain amino acids important to cellular respiration

ANSWER: W) RICIN INHIBITS PROTEIN SYNTHESIS WITHIN CELLS

TOSSUP

11) BIOLOGY *Multiple Choice* Which of the following types of drugs is used to treat glaucoma by lowering the intraocular pressure.

W) Androgenic drug
X) Androgenic blocking drug
Y) Cholinergic drug
Z) Anticholinergic drug

ANSWER: Y) CHOLINERGIC DRUG

BONUS

11) BIOLOGY *Multiple Choice* Which of these uncommon amino acids is found in collagen?

W) Carboxyglutamate
X) Desmosine
Y) Hydroxyproline
Z) Selenocysteine

ANSWER: Y) HYDROXYPROLINE

TOSSUP

12) EARTH AND SPACE *Short Answer* Doline karst topography is distinguished by its frequency of what natural feature?

ANSWER: SINKHOLE OR CENOTE

BONUS

12) EARTH AND SPACE *Multiple Choice* Which of the following levels of ground cover would lead to the highest recharge rate for an underlying aquifer, assuming other factors remain constant for each?

W) Land with no tree coverage
X) Land with sparse tree coverage
Y) Land with intermediate tree coverage
Z) Land with very dense tree coverage.

ANSWER: Y) LAND WITH INTERMEDIATE TREE COVERAGE

TOSSUP

13) CHEMISTRY *Multiple Choice* A mixture of two liquids has a very strongly positive deviation from the vapor pressure predicted by Raoult's Law. Which of the following best describes the flow of heat when the two liquids are initially mixed.

W) Exothermic
X) Endothermic
Y) No heat flow
Z) Impossible to determine without the identity of the liquids

ANSWER: X) ENDOTHERMIC

BONUS

13) CHEMISTRY *Short Answer* Hafnium, which is directly below zirconium on the periodic table, has an almost identical radius to zirconium. What phenomenon explains why their radii are so similar despite a large change in atomic mass and number of electrons?

ANSWER: LANTHANIDE CONTRACTION

TOSSUP

14) PHYSICS *Short Answer* What value describes the distance to which a magnetic field can penetrate a superconductor before it is expelled by the Meissner effect?

ANSWER: LONDON PENETRATION DEPTH

BONUS

14) PHYSICS *Short Answer* In the infinite square well model, what is the zero-point energy of a particle in a one-dimensional box? Give your answer in terms of planck's constant, the mass of the particle, and the width of the well.

ANSWER: PLANCK'S CONSTANT SQUARED DIVIDED BY 8 TIMES THE PRODUCT OF THE MASS OF THE PARTICLE AND THE SQUARE OF THE WIDTH OF THE WELL

TOSSUP

15) MATH *Short Answer* If ten desks are in a row, how many ways can one choose 3 of them so that no two are adjacent?

ANSWER: 56

BONUS

15) MATH *Short Answer* 500 chickens sit in a circle. Each one pecks one of its neighbors with equal probability. What is the expected number of chickens that get pecked twice?

ANSWER: 125

TOSSUP

16) ENERGY *Short Answer* Researchers at Brookhaven National Laboratory have accelerated single platinum atoms in order to break what strongest carbon bond in organic chemistry which may be found in teflon?

ANSWER: CARBON-FLUORINE BOND

BONUS

16) ENERGY *Short Answer* The National Energy Technology Laboratory is doing research on gas hydrates, which may be the largest source of organic carbon on earth. What kind of compounds are gas hydrates, where one molecule is contained within the crystal lattice of another?

ANSWER: CLATHRATE COMPOUNDS

TOSSUP

17) BIOLOGY *Multiple Choice* The Ran-GTPase Cycle controls transport in which organelle?

W) mitochondria
X) nucleus
Y) Golgi body
Z) chloroplast

ANSWER: X) NUCLEUS

BONUS

17) BIOLOGY *Short Answer* In this process, petroleum jelly may be used to seal a cover slip over a reservoir. In the reservoir is a substance that can extract water from a nucleic acid on the bottom of the cover slip so that the nucleic acid can crystallize and be studied. What is this method used to observe the crystallization of nucleic acids?

ANSWER: HANGING-DROP METHOD

TOSSUP

18) EARTH AND SPACE *Short Answer* Order, by name or number, the following four eons in chronological order from earliest to latest.

1) Proterozoic

2) Archean
3) Phanerozoic
4) Hadean

ANSWER: 4, 2, 1, 3

BONUS

18) EARTH AND SPACE *Short Answer* The vertices of the Summer Triangle are the brightest stars in three constellations Aquila, Cygnus, and Lyra. What are those three stars?

ANSWER: ALTAIR, DENEB, AND VEGA (ALLOW ANY ORDER)

TOSSUP

19) CHEMISTRY *Multiple Choice* In the Monsanto process, the catalytic carbonylation of methanol is used to produce acetic acid. What gas is methanol reacted with in this carbonylation?

W) Carbon dioxide
X) Carbon monoxide
Y) Ozone
Z) Hydrogen

ANSWER: X) CARBON MONOXIDE

BONUS

19) CHEMISTRY *Short Answer* Order, by name or number, the following 4 gases in order of INCREASING effusion rate.

1) Ammonia
2) Sulfur hexafluoride
3) Xenon
4) Fluorine

ANSWER: 2, 3, 4, 1 (SULFUR HEXAFLUORIDE, XENON, FLUORINE, AMMONIA)

TOSSUP

20) MATH *Short Answer* What is the smallest prime that can be represented as the difference between two cubes?

ANSWER: 7

BONUS

20) MATH *Short Answer* 1017 choose 511 + 1016 choose 511 + 1015 choose 511 + 1015 choose 512 can be written as n choose k where k is greater than 1. What is n + k?

ANSWER: 1530

TOSSUP

21) EARTH AND SPACE *Short Answer* What specific term refers to a vast space between galaxy filaments, which contains essentially no matter?

ANSWER: (COSMIC) VOID

BONUS

21) EARTH AND SPACE *Short Answer* Voids appear to correlate with the temperature of the cosmic microwave background, or CMB. Colder regions correspond to voids and hotter regions correspond to filaments. An interesting aspect of the CMB is that the photons are gravitationally redshifted. What effect describes this property of the CMB?

ANSWER: SACHS-WOLFE (EFFECT)

TOSSUP

22) MATH *Multiple Choice* How many ordered, nonnegative integer triples (x, y, z) satisfy the equation x + y + z = 11?

W) 13! / 3!
X) 13! / 2!
Y) 14! / 3!
Z) 14! / 2!

ANSWER: X) 13! / 2!

BONUS

22) MATH *Short Answer* How many of the numbers, 100, 101,. . . ,999, have three different digits in increasing order or in decreasing order?

ANSWER: 204

TOSSUP

23) PHYSICS *Multiple Choice* What is the product of Coulomb's constant and permittivity of free space equal to?

W) 1/pi
X) 1/(2pi)
Y) 1/(3pi)
Z) 1/(4pi)

ANSWER: Z) 1/4PI

BONUS

23) PHYSICS Given that 20 Volts of emf is induced by an 50 cm long object in a magnetic field of 5 Teslas, calculate the speed of the object relative to the magnetic field.

ANSWER: 8 M/S