TOSS UP

1) BIOLOGY *Multiple Choice* Which of the following animals would have the longest alimentary canal relative to its body size?

W) Brown Bear
X) Human
Y) Tiger
Z) Koala

ANSWER: Z) Koala

BONUS

1) BIOLOGY *Short Answer* By name or number, state all of the following hormones which are secreted by the anterior pituitary gland:

1: Luteinizing Hormone
2: Prolactin
3: Oxytocin
4: Vasopressin

ANSWER: 1 and 2

TOSS-UP

2) PHYSICS *Multiple Choice* Two constants are introduced into the Van der Waals equation in order to account for what two factors of real gas molecules?

W) Mass and Volume
X) Intermolecular Attraction and Rotational Energy
Y) Volume and Intermolecular Attraction
Z) Mass and Rotational Energy

ANSWER: Y) Volume and Intermolecular Attraction

BONUS

2) PHYSICS *Short Answer* What is the ideal Carnot efficiency of an engine if the temperatures of its cold and hot reservoirs are 27º Celsius and 227º Celsius, respectively?

ANSWER: 40%

TOSS-UP

3) EARTH AND SPACE *Multiple Choice* Which of the following methods is most appropriately used for determining the distance to a galaxy which is Megaparsecs away from Earth?

W) Parallax
X) Type Ia Supernovae
Y) Cepheid Variables
Z) Radar

ANSWER: X) Type Ia Supernova

BONUS

3) EARTH AND SPACE *Short Answer* If a Type Ia supernova observed in a far off galaxy has an apparent magnitude of -9.5 at its brightest, what is the distance to the galaxy in parsecs?

ANSWER: 1000 parsecs
(Solution: Absolute magnitude of a supernova at brightest = -19.5. $d= 10^{1+0.2(m-M)}$)

TOSS-UP

4) CHEMISTRY *Multiple Choice* Which of the following functional groups is not paired with its appropriate IUPAC ending?

W) Aldehydes; -ol
X) Ketones; -one
Y) Amides; -amide
Z) Carboxylic Acids; -oic acid

ANSWER: W) Aldehydes; ol

BONUS

4) CHEMISTRY *Question Type* What is the IUPAC nomenclature of the organic molecule that results from the reaction of 3-ethyl-1-butanoic acid with 2-methyl-1-pentanol?

ANSWER: 2-methyl-1-pentyl 3-ethyl-butanoate

TOSS-UP

5) MATH *Multiple Choice* A conic section with a ratio of the distance to the focus and the directrix greater than 1 is also known as what?

W) Circle
X) Elipse

Y) Parabola
Z) Hyperbola

ANSWER: Z) Hyperbola

BONUS

5) MATH *Short Answer* Calculate the length of the minor axis of an ellipse with vertices at the points (1, 1) and (7, 1) and one focus at (6, 1).

ANSWER: $2\sqrt{5}$

TOSS-UP

6) ENERGY *Multiple Choice* Researchers at the Oak Ridge National Laboratory are conducting a study on how the fungus *Mortierella elongata* affects the growth of Black cottonwood trees. Which of the following best describes the symbiotic relationship between the two organisms if the presence of the fungus encourages growth?

W) Commensalism
X) Ammensalism
Y) Mutualism
Z) Parasitism

ANSWER:Y) Mutualism

BONUS

6) ENERGY *Short Answer* Researchers at Pacific Northwest National Laboratory conducted a study of RNA viruses living in soils that can infect fungi. What is the term used to describe such viruses?

ANSWER: Mycoviruses

TOSS UP

7) BIOLOGY *Multiple Choice* According to the ABC Hypothesis, what would the order of whorls be for flowers lacking the A gene, from outside to inside?

W) Sepal-Petal-Stamen-Carpel
X) Sepal-Sepal-Carpel-Carpel
Y) Sepal-Carpel-Carpel-Sepal

Z) Carpel-Stamen-Stamen-Carpel

ANSWER: Z) Carpel-Stamen-Stamen-Carpel

BONUS

7) BIOLOGY *Short Answer* Ein mutants will fail to undergo the triple response even in the presence of what hormone?

ANSWER: Ethylene

TOSS-UP

8) PHYSICS *Short Answer* A force of 100 N is applied to stretch a spring 50 cm. What is the spring constant, in Newtons per meter?

ANSWER: 200

BONUS

8) PHYSICS *Short Answer* A 20 kilogram bowling ball is rolled toward a 5 kg bowling pin at 20 meters per second. Assuming a perfectly elastic collision, what is the velocity of the bowling pin after the collision, in meters per second?

ANSWER: 32

TOSS-UP

9) EARTH AND SPACE *Multiple Choice* Absolute stability in clouds occurs under what condition?

W) Environmental lapse rate is greater than the wet adiabatic rate
X) Environmental lapse rate is equal to the wet adiabatic rate
Y) Environmental lapse rate is less than the wet adiabatic rate
Z) Environmental lapse rate is less than the dry adiabatic rate

ANSWER: Y) Environmental lapse rate is less than the wet adiabatic rate

BONUS

9) EARTH AND SPACE *Short Answer* What is the name of the process that creates precipitation in clouds located in the tropics?

ANSWER: Collision-Coalescence Process

TOSS-UP

10) CHEMISTRY *Multiple Choice* What kind of colloid is shaving cream?
W) Gel
X) Sol
Y) Aerosol
Z) Foam

ANSWER: Z) Foam

BONUS

10) CHEMISTRY *Short Answer* Put the following steps in the correct order in the process of making a supersaturated solution.

1: Heat solution to boiling point, then saturate
2: Saturate solution at room temperature
3: Slowly cool solution
4: Filter excess, undissolved solute crystals

ANSWER: 2, 1, 4, 3

TOSS-UP

11) MATH *Short Answer* What is the sum of the first 15 odd integers?

ANSWER: 225

BONUS

11) MATH *Short Answer* If John takes 4 hours to paint a house, Sally takes 6 hours, and Terry takes 10 hours, then how long will it take for all three of them working together to paint the house, in hours? Leave your answer as a simplified fraction.

ANSWER: 60/31

TOSS-UP

12) ENERGY *Multiple Choice* Researchers at Lawrence Berkeley National Laboratory investigated how the flow of solar neutrinos changes over time in the SNO+ experiment. What process in the sun is responsible for the creation of the majority of solar neutrinos?

W) Proton-Proton Chain Reaction
X) CNO Cycle
Y) Triple Alpha Process
Z) Sunspot Cycle

ANSWER: W) Proton-Proton Chain Reaction

BONUS

12) ENERGY *Multiple Choice* What is the explanation for why neutrinos are so hard to detect?

W) They have an extremely small mass
X) They only interact with normal matter through the weak force and gravity
Y) They only interact with normal matter through the strong force and gravity
Z) They are electrically neutral

ANSWER: X) They only interact with normal matter through the weak force and gravity

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TOSS UP

13) BIOLOGY *Short Answer* What structure in sperm becomes a centriole for the new zygote and anchors the flagella to the cell?

ANSWER: Basal Body

BONUS

13) BIOLOGY *Short Answer* How many net ATP molecules would you expect from glycolysis in a cell where isomerase is non-functional?

ANSWER: 0 (Aldolase splits Fructose 1,6-bisphosphate into G3P and DHAP. Isomerase allows for DHAP to be converted to G3P. Each G3P creates 2 ATP from substrate level phosphorylation, but 2 ATP must be invested to split the initial glucose.)

TOSS-UP

14) PHYSICS *Multiple Choice* According to the Standard Model of particle physics, what particle is responsible for mass generation?

W) W Boson
X) Higgs Boson

Y) Gluon
Z) Z Boson

ANSWER: X) Higgs Boson

BONUS

14) PHYSICS *Short Answer* Arrange the following particles in increasing charge value:

1: Up
2: Electron
3: Down
4: Gluon

ANSWER: 2, 3, 4, 1

TOSS-UP

15) EARTH AND SPACE *Multiple Choice* The steep side of a drumlin faces northeast, whereas the shallow side of the drumlin points southwest. From what direction did the glacier that formed it come from?

W) Northeast
X) Northwest
Y) Southeast
Z) Southwest

ANSWER: W) Northeast

BONUS

15) EARTH AND SPACE *Short Answer* By name or number, state all of the following which contribute to the Milankovitch Cycles.

1: Eccentricity
2: Obliquity
3: Precession
4: Orbital Velocity

ANSWER: 1, 2, 3

TOSS-UP

16) CHEMISTRY *Multiple Choice* According to VSEPR theory, what is the bond angle between a hydrogen atom, the nitrogen atom, and another hydrogen atom in ammonia?

W) 109.5º
X) 107º
Y) 104.5º
Z) 102º

ANSWER: X) 107º

BONUS

16) CHEMISTRY *Short Answer* How many sigma bonds does 3-ethyl-3,4-dimethyl-1-pentyne have?

ANSWER: 24

TOSS-UP

17) MATH *Multiple Choice* What are the values of x for which the equation $3^{2x} + 5 = 2 \cdot 3^{x}$ is true?

W) $\log_3 5$, 0
X) $\log_4 5$, 0
Y) $\log_2 3$, 0
Z) $\log_9 2$, 0

ANSWER: W) $\log_3 5$, 0

BONUS

17) MATH *Short Answer* It is known that 2 is a root of the equation $6x^3 - 25x^2 + 21x + 10 = 0$. Find the other two roots.

ANSWER: 5/2, -1/3

TOSS-UP

18) ENERGY *Short Answer* Researchers at Brookhaven National Laboratory developed a catalyst to split water. What is the analogous structure in chloroplasts that splits water?

ANSWER: Photosystem II

BONUS

18) ENERGY *Multiple Choice* Researchers at Brookhaven National Laboratory intentionally designed their catalyst to function in acidic pH. What would be the importance of the catalyst being able to operate under acidic conditions?

W) To enhance the rate of oxidation
X) To enhance the rate of reduction
Y) To prevent the reverse reaction from occurring
Z) To prevent self-inhibition

ANSWER: Z) To prevent self-inhibition

TOSS UP

19) BIOLOGY *Multiple Choice* What kind of cleavage would you expect in a deuterostome embryo?

W) Radial and Determinate
X) Radial and Indeterminate
Y) Spiral and Determinate
Z) Spiral and Indeterminate

ANSWER: X) Radial and Indeterminate

BONUS

19) BIOLOGY *Short Answer* The clade containing both Arthropoda and Nematoda is named for what shared process between the two phyla?

ANSWER: Ecdysis (Do not accept moulting)

TOSS-UP

20) PHYSICS Light travels from Pyrex glass into vegetable oil. Assuming that the index of refraction for both media is 1.47, what is Brewster's Angle in degrees?

ANSWER: 45

BONUS

20) PHYSICS *Short Answer* Three polarizers are placed in sequence. The second polarizer is tilted 30º with respect to the first polarizer, and the third polarizer is tilted 60º with respect to the second polarizer. What fraction of the original light makes it through the third polarizer?

ANSWER: 3/32

TOSS-UP

21) EARTH AND SPACE *Short Answer* A wave has a wavelength of 10 meters. In meters, at what depth would the wave base be located?

ANSWER: 5

BONUS

21) EARTH AND SPACE *Short Answer* Highest overall primary productivity occurs in which oceans?

ANSWER: Midlatitude

TOSS-UP

22) CHEMISTRY *Short Answer* What is the pH for a solution of a .100 M solution of KOH?

ANSWER: 13

BONUS

22) CHEMISTRY *Multiple Choice* Which of the following is an Arrhenius, Bronsted-Lowry, and Lewis Base?

W) CN^-
X) NH_3
Y) CO
Z) NaOH

ANSWER: Z) NaOH

TOSS-UP

23) MATH *Short Answer* If the sine of theta is equal to ⅗, what is the cosine of theta + π/2?

ANSWER: -⅗

BONUS

23) MATH *Multiple Choice* What is the value of $\sin[\sin^{-1}(-\frac{4}{5}) - \tan^{-1}(\frac{3}{4})]$?

W) 1/2
X) 1
Y) -1/2
Z) -1

ANSWER: Z) -1

TOSS-UP

24) ENERGY *Multiple Choice* Researchers at Lawrence Berkeley National Laboratory investigated mechanisms around glacier retreating in the West Antarctic Ice Sheet. What conditions create a retreating glacier?

W) Accumulation is greater than wastage
X) Accumulation is equal to wastage
Y) Accumulation is less than wastage
Z) There is no accumulation or wastage

ANSWER: Y) Accumulation is less than wastage

BONUS

24) ENERGY *Short Answer* In their study, researchers discovered that the meltwater of a glacier may contribute to increased melting of the ice. This is an example of what kind of process?

ANSWER: Positive Feedback Loop

TOSS-UP

25) BIOLOGY *Multiple Choice* A certain mRNA has the codon “CGA”. Which point mutation would be most detrimental to the function of the polypeptide?

W) Conversion of Cytosine to Uracil
X) Conversion of Guanine to Uracil
Y) Conversion of Adenine to Guanine
Z) Conversion of Adenine to Uracil

ANSWER: W) Conversion of Cytosine to Uracil

BONUS

25) BIOLOGY *Short Answer* If a bacterial plasmid undergoing replication has 1 million nucleotides, and if DNA Polymerase III can replicate 1000 nucleotides per second, how long would replication of the entire plasmid take, in seconds?

ANSWER: 500 (Replication occurs in two directions from origin replication.)