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TOSS-UP

1) PHYSICS *Short Answer* According to the Standard Model of Elementary Particles, what is the charge of the particle that carries out the electromagnetic force?

ANSWER: 0 (Photon charge is 0)

BONUS

1) PHYSICS *Multiple Choice* For the hydrogen atom, which series describes electron transitions to the $N=1$ orbit, the lowest energy electron orbit?

W) Pfund Series

X) Paschen Series

Y) Lyman Series

Z) Balmer Series

ANSWER: Y) Lyman Series

TOSS-UP

2) CHEMISTRY *Multiple Choice* The molecule BF_3 has what type of molecular geometry?

W) Linear

X) Trigonal planar

Y) Bent

Z) Tetrahedral

ANSWER: X) Trigonal Planar

BONUS

2) CHEMISTRY *Short Answer* The decomposition of CaCO_3 will yield what products?

ANSWER: Carbon dioxide and Calcium oxide

TOSS-UP

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3) EARTH AND SPACE *Short Answer* Known as an extension of the corona, what is the name of the highly ionized gas emitted from the sun that permeate the solar system, and is a primary method of the Sun's mass loss?

ANSWER: Solar Wind

BONUS

3) EARTH AND SPACE *Multiple Choice* Which of the following sequences of metamorphic facies would most likely occur at a subduction zone?

W) Hornfels, Granulite, Eclogite

X) Zeolite, Hornfels

Y) Zeolite, Greenschist, Amphibolite, Granulite

Z) Zeolite, Blueschist, Eclogite

ANSWER: Z) Zeolite, Blueschist, Eclogite

TOSS-UP

4) MATH *Multiple Choice* Given that $\frac{1}{1^2} + \frac{1}{2^2} + \frac{1}{3^2} \dots = \frac{\pi^2}{6}$, find $\frac{1}{1^2} + \frac{1}{3^2} + \frac{1}{5^2} \dots$

W) $\frac{\pi^2}{24}$

X) $\frac{\pi^2}{12}$

Y) $\frac{\pi^2}{8}$

Z) $\frac{\pi^2}{6}$

ANSWER: Y) $\frac{\pi^2}{8}$

BONUS

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4) MATH *Short Answer* Bobby is flipping a coin and stops when he gets 2 consecutive heads or tails. What is the probability that his first coin flip and his last coin flip have the same result?

ANSWER: 2/3

TOSS-UP

5) BIOLOGY *Short Answer* In prokaryotes, which amino acid does the start codon, AUG, code for?

ANSWER: FORMYL-METHIONINE

BONUS

5) BIOLOGY *Multiple Choice* If the 28S RNA in a eukaryotic cell is destroyed, which of the following cellular processes would be most affected?

W) Elongation during transcription

X) Termination during transcription

Y) Elongation during translation

Z) Termination during translation

ANSWER: Y) ELONGATION DURING TRANSLATION

TOSS-UP

6) PHYSICS *Short Answer* Tim the Biker is going 30 m/s in the desert when he spots a yardang in the distance. Assuming his brakes can only slow him down 5 m/s/s, at what distance will Jim the Biker need to brake to not hit the yardang?

ANSWER: 90m

BONUS

6) PHYSICS *Multiple Choice* Tim accidentally drops his 1kg Earth Science textbook from the roof directly into his pool, which exerts an upwards force of 9.8N on the textbook. Which of the

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following best describes the velocity of the textbook, assuming it never hits the bottom of the pool?

W) Increases, then increases

X) Increases, then decreases

Y) Increases, then remains constant

Z) Increases, then decreases, then increases

ANSWER: Y) Increases, then remains constant

TOSS-UP

7) CHEMISTRY *Multiple Choice* Two samples of liquid water are present in two containers of different volumes. When temperature is constant, the water in the larger container has a vapor pressure that is

W) Higher than the smaller container

X) Lower than the smaller container

Y) Equal to the smaller container

Z) Vapor pressure does not apply to liquids

ANSWER: Y) Both containers will have the same vapor pressure

BONUS

7) CHEMISTRY *Multiple Choice* By name or number, order the following molecules in order of increasing vapor pressure:

1: CBr₄

2: CH₄

3: CCl₄

ANSWER: 1, 3, 2

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TOSS-UP

8) EARTH AND SPACE *Short Answer* You view three different nebulae through a telescope. Give the associated type of nebula with each of the following descriptions:

- I. Pink-colored, ionized hydrogen
- II. Clouds of gas and dust obstructing starlight
- III. Blue-colored, neutral hydrogen

ANSWER: I. emission II. dark III. reflection

BONUS

8) EARTH AND SPACE *Multiple Choice* Tim is standing so that a surface westerly wind is blowing directly on his back. Where would the center of lowest pressure be located?

W) 30 degrees East of North

X) 30 degrees West of South

Y) 60 degrees East of South

Z) 60 degrees West of North

ANSWER: W) 30 degrees East of North

TOSS-UP

9) MATH *Short Answer* What is the $\int \frac{\ln x}{x} dx$ (read as the indefinite integral of the fraction with numerator natural log of x and denominator x dx)

ANSWER: $(\ln x)^2/2 + C$ (Do not accept $(\ln x)^2/2$)

BONUS

9) MATH *Short Answer* Evaluate $\int_0^{\pi/3} \sec(x) dx$. (read as the definite integral from zero to the fraction with numerator pi and denominator three of secant of x dx)

ANSWER: $\ln(2+\sqrt{3})$

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TOSS-UP

10) BIOLOGY *Multiple Choice* Which of the following distinguishes cycads from other gymnosperms?

W) They are pollinated by birds

X) They are pollinated by beetles

Y) They are pollinated by bees

Z) They are pollinated by butterflies

ANSWER: X) THEY ARE POLLINATED BY BEETLES

BONUS

10) BIOLOGY *Short Answer* What is the common name of the only living species in the phylum ginkgophyta?

ANSWER: MAIDENHAIR TREE (DO NOT ACCEPT: GINKGO BILOBA)

TOSS-UP

11) PHYSICS *Short Answer* A force with an unknown value is applied on a 2 kg block for 5 seconds. At $t=0$, the velocity of the block was 2 m/s. At $t=5$, the velocity of the block is 12 m/s. What is the value of the unknown force in Newtons?

ANSWER: 4

BONUS

11) PHYSICS *Short Answer* What is the name of the experiment that showed light did not pass through a continuous medium using an interferometer?

ANSWER: Michelson-Morley Experiment

TOSS-UP

12) CHEMISTRY *Multiple Choice* Boron nitride forms what class of crystalline solid?

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W) Ionic

X) Molecular covalent

Y) Network covalent

Z) Metallic

ANSWER: Y) Network covalent

BONUS

12) CHEMISTRY *Short Answer* What is the complete electron configuration for a Zn^{2+} ion?

ANSWER: $1s^2 2s^2 2p^6 3s^2 3p^6 3d^{10}$

TOSS-UP

13) EARTH AND SPACE *Multiple Choice* What is the type of rock texture that consists of large crystals embedded into a cluster of small crystals?

W) Aphanitic Texture

X) Phaneritic Texture

Y) Porphyritic Texture

Z) Pyroclastic Texture

ANSWER: Y) Porphyritic Texture

BONUS

13) EARTH AND SPACE *Short Answer* Which of the following minerals are dominant in peridotite?

I. Olivine

II. Pyroxene

III. Amphibole

ANSWER: I and II

TOSS-UP

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14) MATH *Short Answer* Daniel's math test scores are of the increasing sequence 1, 3, 4, 9, 10, 12, 13...(etc), which consists of all the positive integers which are powers of 3 or sums of distinct powers of 3. Find the 44th term of this sequence.

ANSWER: 765

BONUS

14) MATH *Short Answer* Evaluate $\sin(75 \text{ degrees}) - \sin(15 \text{ degrees})$

ANSWER: $\sqrt{6}/2$

TOSS-UP

15) BIOLOGY *Short Answer* Name the only amino acid that binds to the P site of the ribosome during translation.

ANSWER: METHIONINE

BONUS

15) BIOLOGY *Short Answer* Which of the following wobble tRNA bases are correctly matched with their possible wobble mRNA base pairs, respectively?

1. Inosine with Cytosine, Adenine, Uracil
2. Adenine with Uracil and Cytosine
3. Guanine with Cytosine and Adenine
4. Uracil with Adenine and Guanine

ANSWER: 1 AND 4

TOSS-UP

16) PHYSICS *Multiple Choice* The splitting of spectral lines in an **electrical** field is known as:

W) Stark effect

X) Karaman effect

Y) Zeeman effect

Z) Iron man's effect

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ANSWER: W) Stark effect

BONUS

16) PHYSICS *Multiple Choice* For an object moving in uniform circular motion, the direction of the instantaneous acceleration vector is:

W) tangent to the path of motion

X) equal to zero

Y) directed radially outward

Z) directed radially inward

ANSWER: Z) directed radially inward

TOSS-UP

17) CHEMISTRY *Multiple Choice* Which of the following molecules is NOT an exception to the octet rule?

W) BeH_2

X) SF_6

Y) XeF_4

Z) CCl_4

ANSWER: Z) CCl_4

BONUS

17) CHEMISTRY *Multiple Choice* By name or number, identify all of the following four molecules have a central atom with at least one lone electron pair:

1: SO_2

2: PCl_5

3: CH_4

4: H_2O

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ANSWER: 1 and 4

TOSS-UP

18) EARTH AND SPACE *Multiple Choice* Which of the following minerals can be scratched by a glass plate, but cannot be scratched by a copper penny?

W) Quartz

X) Potassium Feldspar

Y) Apatite

Z) Calcite

ANSWER: Y) Apatite

BONUS

18) EARTH AND SPACE *Short Answer* In an alternate universe, Earth has a new moon 1030 arc seconds wide and 100,000 km away from Earth. Assuming that there are 2.06×10^5 arc seconds in a radian, what is the linear diameter of this new moon in km?

ANSWER: 500 km

TOSS-UP

19) MATH *Short Answer* In Daniel's biology class, 62 students including Daniel are seated in 7 rows of 9 chairs. The place at the center of class/grid is unoccupied. The teacher decides to reassign seats so that each student will occupy a chair adjacent to their current one (forward, back, left, or right). In how many ways can this reassignment be made?

ANSWER: 0

BONUS

19) MATH *Short Answer* If $\sec x + \tan x = 11/3$, find $\csc x + \cot x$.

ANSWER: 7/4

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TOSS-UP

20) BIOLOGY *Multiple Choice* Which of the following terms does not match their function:

W) DNA Helicase: unwinds the DNA strands

X) DNA Topoisomerase: prevents over coiling of DNA

Y) RNA Primase: places an RNA primer so the DNA polymerase III can begin replication

Z) DNA Polymerase I: Connects two okazaki fragments together

ANSWER: Z) DNA Polymerase I: Connects two okazaki fragments together

BONUS

20) BIOLOGY *Short Answer* Which of the following can cause a proto-oncogene to turn into an oncogene?

- I. Translocation
- II. Gene Amplification
- III. Point Mutation

ANSWER: I,II, and III (ACCEPT: ALL)

TOSS-UP

21) PHYSICS *Short Answer* Known as the “God particle,” what is the name of the boson theorized to be responsible for the masses of elementary particles and was recently discovered at the Large Hadron Collider?

ANSWER: Higgs Boson

BONUS

21) PHYSICS *Short Answer* What is the isospin of a nucleon and the force/interaction under which isospin is conserved?

ANSWER: $\frac{1}{2}$, Strong Force/Interaction

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TOSS-UP

22) CHEMISTRY *Multiple Choice* Which of the following molecules condenses at the lowest pressure?

W) CH₄

X) C₂H₆

Y) C₃H₈

Z) C₄H₁₀

ANSWER: Z) C₄H₁₀

BONUS

22) CHEMISTRY *Multiple Choice* In a phase diagram, the solid-liquid line has a negative slope for which of the following molecules?

W) CO₂

X) CH₄

Y) H₂O

Z) Ar

ANSWER: Y) H₂O

TOSS-UP

23) EARTH AND SPACE *Short Answer* By name of number, indicate which of the following organisms primarily compose calcareous ooze:

I. Coccolithophores

II. Diatoms

III. Foraminifers

ANSWER: I, III

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BONUS

23) EARTH AND SPACE *Multiple Choice* On a clear sunny afternoon with no wind, a cumulus cloud forms. Given that the dew point is 15 C and the temperature is 30 C, what is the approximate height of the cloud base in meters?

W) 825 m

X) 1255 m

Y) 1875 m

Z) 3420 m

ANSWER: Y) 1875 m

TOSS-UP

24) MATH *Short Answer* Bob likes punching walls, however he is a very weak man. When punching walls, he has a 36% chance to hurt his hand and feel sad and a 64% chance to not hurt his hand and feel happy. If Bob punches the wall 100 times, what is the standard deviation of happiness?

ANSWER: 4.8

BONUS

24) MATH *Short Answer* What is the derivative of $\sin(x)\tan(x)$?

ANSWER: $\sin(x) + \tan(x)\sec(x)$

TOSS-UP

25) BIOLOGY *Short Answer* Name all of the following amino acids that are purely ketogenic.

- I. Leucine
- II. Isoleucine
- III. Lysine
- IV. Tyrosine

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ANSWER: I AND III (LEUCINE AND LYSINE)

BONUS

25) BIOLOGY *Multiple Choice* The rough endoplasmic reticulum is highly concentrated in neurons due to the presence of what large granular bodies?

ANSWER: NISSL BODIES
