TOSS-UP

1) Chemistry - *Multiple Choice* - Which of the following halides is the strongest nucleophile in DMSO?

W) F-
X) Cl-
Y) Br-
Z) I-

ANSWER: W) F-

BONUS

1) Chemistry - *Short Answer* – Identify all of the following reagents that would yield a majority of Hofmann product in an E2 reaction: 1) Potassium tert-butoxide; 2) Sodium methoxide; 3) Triethylamine

ANSWER: 1 and 3

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TOSS-UP

2) Biology - *Short Answer* - The QRS complex on an EKG diagram is representative of depolarization in what structures of the heart?

ANSWER: Ventricles

BONUS

2) Biology - *Short Answer* - Order the following steps of heart beating in temporal order: 1) Atrial depolarization, 2) Ventricular depolarization, 3) Ventricular repolarization.

ANSWER: 1, 2, 3

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TOSS-UP

3) Earth and Space - *Multiple Choice* - Which of the following water masses is the most saline?

W) Antarctic Bottom Water
X) North Atlantic Deep Water
Y) Mediterranean Intermediate Water
Z) Antarctic Intermediate Water

ANSWER: Y) Mediterranean Intermediate Water

BONUS

3) Earth and Space - *Short Answer* - In iron meteorites, exsolution lamellae of kamacite and taenite form a distinct weaved pattern known as what?

ANSWER: Widmanstätten patterns (accept Thomson structures)

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TOSS-UP

4) Math - *Short Answer* - How many ways are there for someone to pick a face card and then a 2 from a standard 52 deck of cards?

ANSWER: 48

BONUS

4) Math - *Short Answer* - If a dartboard has a radius of 9 inches and the bull's eye has a radius of 1 inch, what is the probability of hitting a bull's eye? Assume that the dart always hits the board.

ANSWER: 1/81

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TOSS-UP

5) Physics - *Short Answer* - Which fundamental force violates parity symmetry?

ANSWER: weak interaction (accept: weak nuclear force, weak force, etc.)

BONUS

5) Physics - *Short Answer* - Identify all of the following particles that can be considered fermions: 1) proton; 2) boron-11; 3) deuterium; 4) charm quark

ANSWER: All

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TOSS-UP

6) Biology - *Short Answer* - Chaperonins promote proper interactions to support protein folding; what molecules prevent undesired interactions?

ANSWER: Chaperones

BONUS

6) Biology - *Multiple Choice* - Which of the following is not a component of microvilli?

W) Formin
X) Fimbrin
Y) Myosin
Z) Keratin

ANSWER: Z) Keratin

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TOSS-UP

7) Chemistry - *Short Answer* – How many normal modes of vibration does benzene have?

ANSWER: 30

BONUS

7) Chemistry - Which of the following complexes would you expect to be a low spin complex
l) $Fe(NH_3)_6^{3+}$, 2) $Mn(H_2O)_6^{2+}$ 3) $Fe(CN)_6^{3-}$

ANSWER: 1 and 3

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TOSS-UP

8) Earth and Space - *Short Answer* - Which of the following is true about Venusian volcanism? 1) almost all flows are nonexplosive due to high atmospheric pressure; 2) long planetary volcanic arcs are present, hinting at past tectonic movement; 3) shield volcanoes are the dominant volcano morphology

ANSWER: 1 and 3

BONUS

8) Earth Science - *Short Answer* - Mantle minerals are neat! As an effort to study them, Yuchen drills down from the surface all the way until he hits the D double prime layer. Order the following minerals as they would appear during Yuchen's expedition: 1) wadsleyite; 2) bridgmanite; 3) ringwoodite; 4) forsterite

ANSWER: 4, 1, 3, 2

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TOSS-UP

9) Math - *Short Answer* - What is the probability of rolling a sum of 14 on two fair 8 sided dice?

ANSWER: 3/64

BONUS

9) Math - *Short Answer* - Mary lives 3 blocks west and 2 blocks south of her school. How many paths are there from her house to her school that is 5 blocks long? Assume she cannot cross across blocks.

ANSWER: 10

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TOSS-UP

10) Physics - *Short Answer* - If the moment of inertia of a disk perpendicular to the plane is 50 kg m^2, what is the moment of inertia through a diameter of the disk?

ANSWER: 25

BONUS

10) Physics - *Multiple Choice* - If a disk is pivoted parallel to its diameter a distance r/2 from its center, what is its moment of inertia through that pivot?

W) (¼)mr^2
X) (1/2)mr^2
Y) (1/3)mr^2
Z) (2/3)mr^2

ANSWER: X) (1/2)mr^2

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TOSS-UP

11) Biology - *Short Answer* - A man with an X-linked recessive disease has three children with a woman who has the same disease. What is the probability that all of their children are carriers of the disease?

ANSWER: 0

BONUS

11) Biology - Which of the following is not a name for the meristematic tissue that gives rise to the periderm?

W) Cork cambium
X) Bark cambium
Y) Phellogen
Z) Wood Cambium

ANSWER: Z) Wood Cambium

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TOSS-UP

12) Chemistry - *Multiple Choice* - Which of the following statements about catalytic hydrogenation is correct?

W) Iron is commonly used as a catalyst in hydrogenation
X) Chiral modifications of Wilkinson's catalyst, like $Ru(BINAP)Cl_2$, can be used to obtain enantiomeric excess
Y) The alkene reactant undergoes anti-addition of hydrogen across its pi bond
Z) The pi bond in the alkene reactant acts as an electrophile

ANSWER: X) Chiral modifications of Wilkinson's catalyst, like Ru(BINAP)Cl2, can be used to obtain enantiomeric excess

BONUS

12) Chemistry - *Multiple Choice* – Which of the following cations is the most stable?

W) Al+
X) Ga+
Y) In+
Z) Tl+

ANSWER: Z) Tl+

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TOSS-UP

13) Earth and Space - *Multiple Choice* - Which metamorphic texture is characterized by euhedral crystals in a mostly anhedral to subhedral matrix?

W) Idioblastic
X) Porphyroblastic
Y) Porphyroclastic
Z) Poikiloblastic

ANSWER: W) Idioblastic

BONUS

13) Earth and Space - *Short Answer* - An AGB star usually experiences three periods where the convective zone extends down to the core, mixing the fusion products into the outer layers of the stellar atmosphere. These events are collectively known as what?

ANSWER: Dredge-ups

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TOSS-UP

14) Math - *Short Answer* – 5 students are sitting at a round table. How many seatings are possible if rotations are indistinct?

ANSWER: 24

BONUS

14) Math - *Short Answer* - What is the area of a triangle with side lengths of 13, 14, and 15?

ANSWER: 84

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TOSS-UP

15) Physics - *Short Answer* – An ideal refrigerator is operating between temperatures of 27 degrees celsius and 77 degrees celsius. What is the coefficient of performance of this refrigerator?

ANSWER: 6

BONUS

15) Physics - *Short Answer* - A gas expands isobarically from 2 liters to 4 liters at 1 atm. What is the work done by the gas in Joules? Give your answer to the nearest hundred.

ANSWER: 200 J

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TOSS-UP

16) Biology - *Short Answer* - If the A gene of a flower have a loss-of-function mutation, Which of the following flower parts will not be present: 1) Sepal, 2) Stamen, 3) Carpel

ANSWER: 1 only

BONUS

16) Biology - *Multiple Choice* - Which of the following most accurately describes the structure of a phytochrome?

W) Two proteins, each with two domains, and a chromophore bound to each protein
X) Two proteins, each with one domain, and a chromophore bound to each protein
Y) One protein with two domains and a bound chromophores
Z) One protein with one domain and two bound chromophores

ANSWER: W) Two proteins, each with two domains, and a chromophore bound to each protein

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TOSS-UP

17) Chemistry - *Short Answer* - Rank the following metal-carbonyl complexes in increasing metal to carbonyl bond length (read slowly): 1) Chromium hexacarbonyl; 2) Nickel tetracarbonyl; 3) Dicobalt octacarbonyl

ANSWER: 1, 3, 2

BONUS

17) Chemistry - *Short Answer* - What is the coordination number of the potassium in potassium fluoride?

ANSWER: 6

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TOSS-UP

18) Math - *Short Answer* - Evaluate the slope of the tangent line at $(2,3)$ of the graph $y = x^3 + x^2 + x - 3$.

ANSWER: 17

BONUS

18) Math - *Short Answer* - Evaluate the indefinite integral of the expression $\frac{1}{1+x^2}$dx. Take the constant of integration to be 0.

ANSWER: $arctan(x)$ [Accept: inverse tangent of x]

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TOSS-UP

19) Physics - *Multiple Choice* - If a simple pendulum has length of 98 cm, what is the angular frequency of this pendulum? Assume that this is for small angles.

W) 10

X) $\sqrt{1/10}$
Y) $\sqrt{10}$
Z) 1/10

ANSWER: Y) $\sqrt{10}$

BONUS

19) Physics - *Short Answer* - A sphere with moment of inertia (⅖)mr^2 is rolling without slipping down an incline of 30°. Find the acceleration of the sphere down the plane in terms of g.

ANSWER: (5/14)g

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TOSS-UP

20) Earth Science - *Multiple Choice* - Which of the following factors would likely promote Atlantic hurricane formation?

W) La Niña conditions
X) Strong trade wind inversion near the Azores High
Y) Westward extension of the Saharan Air Layer
Z) Strong upper altitude wind shear

W) La Niña conditions

BONUS

20) Earth Science - *Short Answer* - Yuchen is in the field, trying to identify a rock. He's narrowed it down to either limestone or dolostone and brings some hand samples to analyze in the lab. Which of the following would indicate that the rock is dolomite? 1) weak effervescence in dilute hydrochloric acid; 2) a Mohs hardness of approximately 3.5 to 4; 3) very low magnesium content

ANSWER: 1, 2
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