TOSS-UP

1) Physics [] – *Multiple Choice* In a graph of stopping potential vs frequency for the photoelectric effect, the slope of the line formed equals which of the following?

W) Work function over fundamental charge
X) Planck's constant
Y) Planck's constant over cutoff frequency
Z) Planck's constant over fundamental charge

ANSWER: Z) PLANCK'S CONSTANT OVER FUNDAMENTAL CHARGE [GW, Quantum]

BONUS

1) Physics [] – *Multiple Choice* A closed system contains 1 mole of an ideal gas and undergoes an isothermal expansion from 1 liter to 20 liters. Which of the following is closest to the change in entropy of the system?

W) 6
X) 12
Y) 25
Z) 50

ANSWER: Y) 25 [GW, Thermo]

TOSS-UP

2) Biology – *Short Answer* Identify all of the following 3 compounds that the accumulation of would lead to the inhibition of glycolysis: 1) ATP; 2) ADP; 3) AMP.

ANSWER: 1 ONLY [DJ, BIOCHEM]

BONUS

2) Biology – *Multiple Choice* Which of the following types of skeletal muscle fibers has the lowest concentration of mitochondria?

W) Fast Glycolytic
X) Fast Oxidative
Y) Slow Glycolytic
Z) Slow Oxidative

ANSWER: W) FAST GLYCOLYTIC [DJ, MUSCLE]

TOSS-UP

3) Math – *Short Answer* What is the Manhattan distance between the points (0, 6) and (7, 1)?

ANSWER: 12 [LY, cringe]

BONUS

3) Math [] – *Short Answer* On a 3 by 4 chessboard, how many perfect tilings are there with 1x2 indistinguishable dominoes?

ANSWER: 11 maybe [DJ, CHESS]

TOSS-UP

4) Earth and Space – *Multiple Choice* At the end of the sun's lifetime, where will it be on the HR diagram relative to where it is right now?

W) Up and to the left
X) Up and to the right
Y) Down and to the left
Z) Down and to the right

ANSWER: Z) DOWN AND TO THE RIGHT [GW, HR Diagram]

BONUS

4) Earth and Space – *Short Answer* Identify all of the following statements that are true of pegmatites: 1) They form from the solidification of anhydrous melt; 2) They are fine-grained igneous rocks; 3) They contain high amounts of corundum.

ANSWER: 3 ONLY []

TOSS-UP

5) Chemistry – *Multiple Choice* Which of the following molecules is NOT IR active?

W) Carbon dioxide
X) Ethane
Y) Oxygen
Z) Boron trichloride

ANSWER: Y) OXYGEN [BZ, lquestion]

BONUS

5) Chemistry – *Short Answer* The Hunsdiecker reaction produces organic halides when reacting halogens with carboxylate salts of what cation?

ANSWER: SILVER (ACCEPT: AG) [BZ, lazyaf/idkirememberdaviddoingaimlabwiththisreaction]

TOSS-UP

6) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are studying angioblast cell differentiation from the zona pellucida. What process is triggered when the zona pellucida binds with a spermatozoa?

ANSWER: ACROSOME REACTION (ACCEPT: PROCESS OR JUST ACROSOME) [DJ, BIO]

BONUS

6) Energy – *Short Answer* Researchers at Brookhaven National Lab are studying spectroscopic methods for determining the enantiomeric yields of drugs after the production to see which are viable. Identify all of the following 3 compounds that are optically active: 1) Cis 1,2 Dimethylcyclohexane; 2) Propadiene; 3) Succinic acid.

ANSWER: NONE [DJ, CHEM]

TOSS-UP

7) Physics – *Short Answer* Five resistors of resistances 1, 2, 3, 4, and 5 ohms, in that order, are placed in series with a 1 volt battery. What is the voltage difference across the middle resistor?

ANSWER: 0.2 VOLTS [GW, Circuits]

BONUS

7) Physics – *Short Answer* An object's acceleration is *decreasing* at a rate of 2 meters per second cubed. The object is moving at a velocity of –5 meters per second and has an acceleration of +6 meters per second squared at time t = 0. For what positive value of t does the object achieve its largest positive displacement from its starting position?

ANSWER: 5 [GW, Kinematics]

TOSS-UP

8) Biology – *Short Answer* In acyclic electron flow of photosystem I, what compound acts as the final electron acceptor?

ANSWER: FERREDOXIN

BONUS

8) Biology – *Short Answer* Identify all of the following 3 animals that usually follow a type II survivorship curve: 1) Mice; 2) Gopher; 3) Fish.

ANSWER: 1 AND 2 [DJ, DEATH]

TOSS-UP

9) Math – *Short Answer* If Ella has a nonzero amount of pennies and nickels each, how many ways are there for her to have 40 cents?

ANSWER: 7 [LY, mathcounts vibes]

BONUS

9) Math – *Short Answer* A tetrahedron is inscribed in a hemisphere of radius 6. What is the maximum possible volume of that tetrahedron?

ANSWER: 54 ROOT 3 [LY, 3D]

TOSS-UP

10) Earth and Space – *Multiple Choice* Which of the following best describes the components of glacial till?

W) Sorted and stratified
X) Sorted and unstratified
Y) Unsorted and stratified
Z) Unsorted and unstratified

ANSWER: Z) UNSORTED AND UNSTRATIFIED []

BONUS

10) Earth and Space [] – *Short Answer* Order the following 4 epochs of the early Universe in chronological order: 1) Photon epoch; 2) Quark epoch; 3) Planck epoch; 4) Electroweak epoch.

ANSWER: 3, 4, 2, 1 [GW, Cosmology]

TOSS-UP

11) Chemistry – *Short Answer* Rank the following 3 atoms in order of increasing second ionization energy: 1) Magnesium; 2) Aluminum; 3) Silicon.

ANSWER: 1, 3, 2 [BZ, atoms]

BONUS

11) Chemistry – *Short Answer* Given that the standard reduction potential of Fe^{3+} to Fe^{2+} in aqueous solution is 0.75 volts, and the standard reduction potential of Fe^{2+} to Fe is -0.5 volts, then to 2 significant figures, what is the standard reduction potential of Fe^{3+} to Fe in volts?

ANSWER: -0.083 [BZ, electro]

TOSS-UP

12) Energy – *Short Answer* Researchers at SLAC National Lab are using the Large Helical Device to study the efficiency of nuclear reactions. They found that substituting hydrogen for deuterium reduced the rate of a reaction by a factor of 7, which was an example of what effect?

ANSWER: KINETIC ISOTOPE EFFECT (ACCEPT: KIE) [LY, might need rewording]

BONUS

12) Energy – *Short Answer* Researchers at Oakridge National Lab are trying to store their laboratory data in an easily accessible way using trees. Identify all of the following 3 types of trees that are self balancing: 1) Heap; 2) 2-3-4; 3) Red Black.

ANSWER: ALL [DJ, CS]

TOSS-UP

13) Physics [5] – *Multiple Choice* Which of the following quantities is NOT conserved in a nuclear fission reaction?

W) Momentum
X) Nucleon number
Y) Lepton number
Z) Rest mass

ANSWER: Z) REST MASS [GW, Conservation]

BONUS

13) Physics [] – *Short Answer* A box with dimensions of 3 x 4 x 5 meters acts like an ideal spring when compressed and stretched along the direction parallel to its long edges. In this

direction, if the box has a spring constant of 2, then what is the Young's modulus of the box along this direction?

ANSWER: 24/5 (ACCEPT: 4.8) [GW, Materials Science]

TOSS-UP

14) Biology – *Multiple Choice* Which of the following cells are destroyed by a person with multiple sclerosis?

W) Schwann cells
X) Oligodendrocytes
Y) Purkinje cells
Z) Astrocytes

ANSWER: X) OLIGODENDROCYTES [DJ, HOUSE I THINK OR NEURO IDK]

BONUS

14) Biology – *Short Answer* Identify all of the following 3 substances that can cross the glomerulus in Bowman's Capsule: 1) Glucose; 2) Globulin; 3) Water.

ANSWER: 1 AND 3 [DJ, RENAL]

TOSS-UP

15) Math – *Short Answer* Identify all of the following 3 polynomials that are irreducible over the integers: 1) $x^2 + 3x - 12$; 2) $x^2 + 15$; 3) $x^2 - 15$.

ANSWER: ALL [LY, cringe isaac zhu content 1/1]

BONUS

15) Math – *Short Answer* Kevin rolls a 6-sided die. If he rolls x, then he flips x coins. What is the probability that at least half of his flips are heads?

ANSWER: 115/192 [LY, KEVIN]

TOSS-UP

16) Earth and Space – *Short Answer* Order the following three isotopes by increasing ignition temperature of fusion. 1) Deuterium; 2) Protium; 3) Lithium

ANSWER: 3, 1, 2 [SS]

BONUS

16) Earth and Space [] – *Multiple Choice* A 4 solar-mass star would have a lifetime of approximately how many sun lifetimes?

W) 1/32
X) 1/8
Y) 8
Z) 32

ANSWER: W) 1/32 [SS]

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following molecules is the strongest nucleophile?

W) Methanol
X) Dimethylether
Y) Methylamine
Z) Dimethylamine

ANSWER: Z) DIMETHYLAMINE [BZ, assorgo]

BONUS

17) Chemistry – *Short Answer* Identify all of the following 3 elements that have a larger atomic radius than iron: 1) Scandium; 2) Manganese; 3) Nickel.

ANSWER: ALL [BZ, transitionmetal]

TOSS-UP

18) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are measuring recharge rates in aquifers by measuring the permeability of the aquifer and viscosity of the liquids. What equation in hydrology describes the movement of groundwater in porous mediums?

ANSWER: DARCY'S LAW [DJ, ESS]

BONUS

18) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are investigating the impact of asexual reproduction on biodiversity. What general process are they interested in, which describes unfertilized asexual reproduction in plants?

ANSWER: APOMIXIS [LY, sbl rips]

TOSS-UP

19) Physics [] – *Short Answer* A telescope consists of two lenses with powers of 4 diopters and 50 diopters, respectively. What is the magnifying power of this telescope?

ANSWER: 12.5 (ACCEPT: 25/2) [GW, Optics]

BONUS

19) Physics [] – *Short Answer* Identify all of the following 3 statements that are true: 1) Special relativity can be used to analyze accelerating objects; 2) If two events are timelike, then there exists a reference frame where they occur at the same time; 3) The Lorentz force transforms correctly under Lorentz transformations.

ANSWER: 1 AND 3 [GW, Relativity]

TOSS-UP

20) Biology – *Multiple Choice* Which of the following is closest to how far, in base pairs, the TATA box is located upstream of the start of transcription?

W) 25
X) 250
Y) 2,500
Z) 25,000

ANSWER: W) 25 [DJ, DNA]

BONUS

20) Biology [] – *Short Answer* Identify all of the following 3 proteins that are activated in phosphorylation cascade: 1) Protein Phosphatase; 2) Protein Kinase I; 3) Protein Kinase II

ANSWER: 2, 3 [DJ, SIGNAL]

TOSS-UP

21) Math – *Short Answer* 4 people have assigned seats, but everyone has forgotten whose seat belongs to whom. If everyone chooses a seat at random (and no two people sit in the same seat), what is the probability that exactly 2 people choose their own seat?

ANSWER: 1/4 [LY, sit on me]

BONUS

21) Math – *Short Answer* The graph of $x^2 - 3xy + y^2 = 0$ consists of two intersecting lines. What is the slope of the steeper line?

ANSWER: 3 PLUS ROOT 5 ALL OVER 2 [DJ, CRINGE CT SHIT]

TOSS-UP

22) Earth and Space – *Multiple Choice* Which of the following minerals is most resistant to chemical weathering?

W) Quartz
X) Kaolinite
Y) Wulfenite
Z) Muscovite

ANSWER: W) QUARTZ [YL, stolen content]

BONUS

22) Earth and Space – *Multiple Choice* Topaz would most likely form in which of the following environments?

W) Subduction zone
X) Aureole
Y) Geyser
Z) Glacier

ANSWER: Y) GEYSER [SS]

TOSS-UP

23) Chemistry – *Multiple Choice* Which of the following orbitals of carbon monoxide is the HOMO?

W) 2p pi bonding
X) 2p non-bonding
Y) 2p sigma bonding
Z) 2p pi antibonding

ANSWER: Y) 2P SIGMA BONDING [BZ, homo]

BONUS

23) Chemistry – *Short Answer* Rank the following 3 cyclohexane derivatives by increasing rate that they undergo an E2 reaction: 1) cis-1-chloro, 2-tert-butyl cyclohexane; 2) trans-1-chloro, 2-tert-butyl cyclohexane; 3) cis 1-chloro 3-tert-butyl cyclohexane.

ANSWER: 3, 2, 1 [GW, E2]