

ROUND 11A

TOSS-UP

1) Earth and Space – *Multiple Choice* A line with alternating blue triangles and red semicircles on a weather map indicates:

- W) A warm front
- X) A cold front
- Y) A stationary front
- Z) An occluded front

ANSWER: Y) A STATIONARY FRONT

BONUS

1) Earth and Space – *Multiple Choice* Which of the following is closest to the average pH of marine water?

- W) 4.18
- X) 6.19
- Y) 7.56
- Z) 8.16

ANSWER: Z) 8.16

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### TOSS-UP

2) Biology – *Multiple Choice* Which of the following types of epithelial tissue would most likely be found lining the lungs and blood vessels?

- W) Stratified columnar
- X) Simple squamous
- Y) Simple cuboidal
- Z) Simple columnar

ANSWER: X) SIMPLE SQUAMOUS

### BONUS

2) Biology – *Multiple Choice* Which of the following could occur due to a mutation in a Hox gene in a human embryo?

- W) Polydactyly [*poly-dak-til-ee*]
- X) Sickle cell anemia
- Y) Phenylketonuria [*fee-nil-kee-toe-noo-ree-uh*]
- Z) Chronic myelogenous [*my-uhl-aw-jen-us*] leukemia

ANSWER: W) POLYDACTYLY

### TOSS-UP

3) Math – *Short Answer* What is the limit as  $x$  approaches zero of the fraction with numerator  $x + 1$  and denominator  $x$ ?

ANSWER: DOES NOT EXIST (ACCEPT: DNE, NON-EXISTANT; DO NOT ACCEPT: INFINITY, MINUS INFINITY, PLUS or MINUS INFINITY)

### BONUS

3) Math – *Short Answer* Two integers between 1 and 10, inclusive, are selected at random, noting that the two numbers may be the same. What is the probability that both numbers selected are prime, and their product is odd?

ANSWER: 9/100 (ACCEPT: 0.09 OR 9%)

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TOSS-UP

4) Physics – *Multiple Choice* In a graph of stopping potential versus frequency, what is the slope of the straight line obtained?

- W) Work function over Planck's constant
- X) Planck's constant over work function
- Y) Elementary charge over Planck's constant
- Z) Planck's constant over elementary charge

ANSWER: Z) PLANCK'S CONSTANT OVER ELEMENTARY CHARGE

BONUS

4) Physics – *Short Answer* Identify all of the following three statements that are true regarding electric motors: 1) Back EMF in a motor arises because of Lenz's law; 2) Commutators periodically reverse the direction of current in an electric motor; 3) In an electromechanical machine, the armature generates the EMF.

ANSWER: 1, 2, AND 3

TOSS-UP

5) Chemistry – *Multiple Choice* A supersaturated solution of sodium nitrate was prepared at 80 degrees Celsius but cooled to room temperature. Which of the following statements describes the addition of a seed crystal?

- W) Delta H is negative and Delta S is negative
- X) Delta H is positive and Delta S is negative
- Y) Delta H is negative and Delta S is positive
- Z) Delta H is positive and Delta S is positive

ANSWER: W) DELTA H IS NEGATIVE AND DELTA S IS NEGATIVE

BONUS

5) Chemistry – *Short Answer* Rank the following three 0.1 molar solutions from the least basic to most basic: 1) Urea; 2) Ammonia; 3) Barium hydroxide.

ANSWER: 1, 2, 3



TOSS-UP

6) Math – *Short Answer* How many sides does a regular polygon have if each interior angle equals 172 degrees?

ANSWER: 45

BONUS

6) Math – *Short Answer* Simplify the fraction with numerator 3 raised to the $2k + 1$ power and denominator 243 raised to the negative k power.

ANSWER: 3 raised to the $(7k + 1)$ power

TOSS-UP

7) Earth and Space – *Short Answer* What is the term for the vertical motions that occur when the atmosphere is unstable?

ANSWER: CONVECTION

BONUS

7) Earth and Space – *Multiple Choice* An isobar on a weather map is a line that connects equal points of:

- W) Wind speed
- X) Pressure
- Y) Temperature
- Z) Relative humidity

ANSWER: X) PRESSURE

TOSS-UP

8) Biology – *Short Answer* What pentameric antibody is generally the first to be secreted during primary immune response and is responsible for promoting agglutination reactions?

ANSWER: IgM (ACCEPT: IMMUNOGLOBULIN M)

BONUS

8) Biology – *Multiple Choice* Which of the following roles does creatine play in the human body?

- W) Intermediate in protein synthesis
- X) Coenzyme associated with purine breakdown
- Y) Energy source in muscles
- Z) Enzyme in the urea cycle

ANSWER: Y) ENERGY SOURCE IN MUSCLES

TOSS-UP

9) Energy – *Multiple Choice* Which of the following thermal reactors was found in the Three Mile Island reactor complex?

- W) Breeder reactor
- X) Fast neutron reactor
- Y) Pressurized water reactor
- Z) Liquid fluoride thorium reactor

ANSWER: Y) PRESSURIZED WATER REACTOR

BONUS

9) Energy – *Multiple Choice* Which of the following is not true of the Advanced Light Source at Lawrence Berkeley National Lab?

- W) It uses accelerated protons to produce light
- X) It primarily produces x-rays
- Y) It is a cyclotron
- Z) Photons from it can be used to solve protein crystal structures

ANSWER: W) IT USES ACCELERATED PROTONS TO PRODUCE LIGHT

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### TOSS-UP

10) Physics – *Short Answer* What type of scattering generally involves the elastic scattering of electromagnetic radiation by a free charged particle and generally occurs as long as the incident photon energy is much less than the mass energy of the particle?

ANSWER: THOMSON SCATTERING

### BONUS

10) PHYSICS – *Multiple Choice* A spherical grain of sand falls into a pool. As the grain falls through the water, its terminal velocity is independent of which of the following?

- W) The temperature of the water
- X) The radius of the grain
- Y) The density of the grain
- Z) The height above the pool from which it fell

ANSWER: Z) The height above the pool from which it fell

### TOSS-UP

11) Chemistry – *Multiple Choice* Which of the following molecules is NOT matched correctly to its central atom hybridization?

- W) Xenon tetrafluoride and  $d_2sp_3$
- X) Phosphorous pentachloride and  $d_2sp_3$
- Y) Krypton difluoride and  $dsp_3$
- Z) Bromine trifluoride and  $dsp_3$

ANSWER: X) PHOSPHOROUS PENTACHLORIDE AND  $D_2SP_3$

### BONUS

11) Chemistry – *Short Answer* Identify all of the following three statements that characterize  $SN_1$  reactions: 1) They have single-step mechanisms; 2) Their rate is strongly dependent on nucleophile strength; 3) They are faster in polar, protic solvents like water or ethanol.

ANSWER: 3



### TOSS-UP

12) Physics – *Multiple Choice* In which of the following ranges of the electromagnetic spectrum are the Paschen series hydrogen lines found?

- W) Ultraviolet
- X) Visible
- Y) Infrared
- Z) X-Ray

ANSWER: Y) INFRARED

### BONUS

12) Physics – *Multiple Choice* Which of the following is NOT true regarding electric fields?

- W) The strength of an electric field associated with a point charge varies with the inverse square of distance.
- X) The strength of an electric field associated with a dipole varies with the inverse cube of distance
- Y) If a point charge is placed inside a hollow, uncharged, conducting shell, there will be no net electric field outside of the shell
- Z) The electric field inside of a hollow, uncharged conductor is always zero

ANSWER: Y) IF A POINT CHARGE IS PLACED INSIDE A HOLLOW, UNCHARGED CONDUCTING SHELL, THERE WILL BE NO NET ELECTRIC FIELD OUTSIDE OF THE SHELL

**TOSS-UP**

13) Earth and Space – *Short Answer* What is the name of the graben [*grah-ben*] that has the highest recorded temperature on Earth?

ANSWER: DEATH VALLEY

**BONUS**

13) Earth and Space – *Multiple Choice* When using a psychrometer and the two temperatures read are nearly identical, what conclusion would you reach?

- W) Your instrument reading is accurate
- X) A change in temperature is forecast
- Y) The air has a high relative humidity
- Z) The dew point temperature is very low

ANSWER: Y) THE AIR HAS A HIGH RELATIVE HUMIDITY



**TOSS-UP**

14) Math – *Short Answer* The inverse of the function  $f(x) = x^4 + x^3 + x^2 + x + 1$  is not itself a function, but how many distinct zeroes does the inverse have?

ANSWER: 1

**BONUS**

14) Math – *Multiple Choice* Consider a 2 by 2 matrix with first row 2, A and second row B, 3, where A and B are integers. How many different combinations exist of the values of A and B so that the matrix is singular?

- W) 4
- X) 6
- Y) 8
- Z) 10

ANSWER: Y) 8

### TOSS-UP

15) Chemistry – *Short Answer* Identify all of the following three statements regarding galvanic cells that are true: 1) The anode is the site of oxidation; 2) A salt bridge or semipermeable membrane is required to complete the circuit; 3) Batteries consist of multiple galvanic cells connected in a series.

ANSWER: 1, 2, 3

### BONUS

15) Chemistry – *Short Answer* Identify all of the following three processes that would have a negative change in Gibbs free energy when conducted at atmospheric pressure: 1) Boiling of water at 95 degrees Celsius; 2) Freezing of water at 5 degrees Celsius; 3) Sublimation of ice at 105 degrees Celsius.

ANSWER: 3



### TOSS-UP

16) Biology – *Short Answer* Identify all of the following three statements that are true of fixed action patterns: 1) They are highly instinctive behaviors; 2) Once begun, they always continue until completion; 3) They can be triggered by inappropriate stimuli.

ANSWER: 1, 2, 3

### BONUS

16) Biology – *Multiple Choice* The terms frustule [*fruh-stool*], epitheca [*epi-thek-uh*], and silica apply to which of the following organisms?

- W) Diatoms
- X) Cocolithophors
- Y) Dinoflagellates
- Z) Foraminifera

ANSWER: W) DIATOMS



### TOSS-UP

17) Math – *Short Answer* Classify the roots of the equation  $2x^2 - 4x - 3 = 0$  as imaginary, rational, or irrational.

ANSWER: IRRATIONAL

### BONUS

17) Math – *Short Answer* Determine the limit as  $x$  approaches negative  $\pi$  of the fraction with numerator  $\cos$  of the fraction  $x/2$  and denominator  $\pi$  plus  $x$ .

ANSWER:  $\frac{1}{2}$

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TOSS-UP

18) Physics – *Short Answer* What is the name of the force that accounts for the deflection of a moving object due to the Earth's rotation?

ANSWER: Coriolis

BONUS

18) Physics – *Short Answer* Identify all of the following three statements that are true regarding charged coupled devices: 1) Charged coupled devices can often be found in cameras; 2) Charged coupled devices operate via the photoelectric effect; 3) Pixels in charged coupled devices are made of metal conductors.

ANSWER: 1 AND 2

TOSS-UP

19) Energy – *Short Answer* What is the change in internal energy, delta U, in joules, of a system that absorbs 4000 joules of heat and that does 2000 joules of work on the surroundings?

ANSWER: 2000

BONUS

19) Energy – *Short Answer* What is the emerging class of fuels produced by non-photosynthetic microorganisms that directly harness chemical and electrical energy to turn carbon dioxide into fuels?

ANSWER: ELECTROFUELS

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### TOSS-UP

20) Biology – *Multiple Choice* Which of the following vitamins is not fat soluble?

- W) Tocopherol [*toh-cof-uh-rol*]
- X) Phylloquinone [*fy-loh-kwih-nohn*]
- Y) Pyridoxine [*pie-rih-dox-een*]
- Z) Calciferol [*cal-sihf-uh-rol*]

ANSWER: Y) PYRIDOXINE

### BONUS

20) Biology – *Short Answer* In C4 photosynthesis, carbon dioxide is fixed to phosphoenolpyruvate [*fos-foh-ee-nol-pie-roo-vate*] instead of RuBisCo, which forms oxaloacetate. Oxaloacetate is then converted into what organic compound before it is transported to the bundle-sheath cells?

ANSWER: MALATE (ACCEPT: MALIC ACID)

### TOSS-UP

21) Energy – *Short Answer* What is the type of tissue found in the neck and between the shoulders of some mammals that specializes in rapid heat production by producing a molecule that uncouples the ATP synthase, and causes cells to produce heat instead of ATP?

ANSWER: BROWN FAT

### BONUS

21) Energy – *Short Answer* What country is the world's top ethanol fuel producer?

ANSWER: UNITED STATES



### TOSS-UP

22) Chemistry – *Short Answer* When methyl propanoate [*pro-pah-noh-ate*] reacts with sodium hydroxide and the reaction is heated, sodium propanoate [*pro-pah-noh-ate*] and methanol form. What is the name of this type of reaction?

ANSWER: SAPONIFICATION (ACCEPT: BASE HYDROLYSIS OF AN ESTER; BASIC HYDROLYSIS)

### BONUS

22) Chemistry – *Short Answer* How many vibrational degrees of freedom does a molecule of ethyne have?

ANSWER: 7

### **TOSS-UP**

23) Physics – *Short Answer* What interpretation of quantum mechanics states that quantum mechanics does not provide objective descriptions, but instead probabilities of observing specific quantum phenomena?

ANSWER: COPENHAGEN INTERPRETATION

### **BONUS**

23) Physics – *Short Answer* A 2.5 Volt battery and a 1.5 Volt battery, each with an internal resistance of 1 Ohm, are connected in parallel such that their positive terminals are connected by a wire and their negative terminals are connected by a wire. What is the terminal voltage of the 1.5 Volt battery?

ANSWER: 2