

ROUND 7A

TOSS-UP

1) Math – *Short Answer* A scientist is designing an experiment in which she will determine if there is a correlation between drinking tea and contracting cancer. What statistical term is used to describe the assumption that drinking tea does not correlate with contracting cancer?

ANSWER: NULL HYPOTHESIS

BONUS

1) Math – *Short Answer* Subtracting a certain positive number from its square gives 110. Find the number.

ANSWER: 11

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### TOSS-UP

2) Physics – *Short Answer* Two point charges, Q1 and Q2, that have charges of +8 nanocoulombs and -8 nanocoulombs, respectively, are placed at two vertices of an equilateral triangle. If a third charge, Q3, of +3 nanocoulombs is placed at the third vertex, what is the potential energy associated with Q3?

ANSWER: ZERO

### BONUS

2) Physics – *Short Answer* Identify all of the following four reference frames that can be considered approximately inertial: 1) A stationary book; 2) A car coasting along at a steady speed; 3) A sky diver at terminal velocity; 4) A rocket taking off.

ANSWER: 1, 2, AND 3

### TOSS-UP

3) Earth and Space – *Multiple Choice* All the elements that are more massive than iron were formed by what astronomical phenomenon?

- W) Nova
- X) White dwarf
- Y) Supernova
- Z) Black hole

ANSWER: Y) SUPERNOVA

### BONUS

3) Earth and Space – *Multiple Choice* In a stable atmosphere, which of the following properties of an unsaturated air parcel will increase as the parcel is forced aloft?

- W) Relative humidity
- X) Mixing ratio
- Y) Saturation vapor pressure
- Z) Barometric pressure

ANSWER: W) RELATIVE HUMIDITY

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TOSS-UP

4) Chemistry – *Multiple Choice* Which of the following acids is stronger than hydrofluoric acid?

- W) Iodic acid
- X) Formic acid
- Y) Acetic acid
- Z) Hypochlorous acid

ANSWER: W) IODIC ACID

BONUS

4) Chemistry – *Multiple Choice* Which of the following statements is NOT true regarding alkaline earth metals?

- W) Calcium burns brick-red in a flame test
- X) Magnesium has no naturally occurring radioisotopes
- Y) Radium is found in all uranium-bearing ores
- Z) Radium has 3 stable isotopes

ANSWER: Z) RADIUM HAS 3 STABLE ISOTOPES

TOSS-UP

5) Biology – *Multiple Choice* Which of the following amino acids is non-polar?

W) Glutamine [*gloo-tuh-meen*]

X) Histidine

Y) Leucine [*loo-seen*]

Z) Lysine

ANSWER: Y) LEUCINE

BONUS

5) Biology – *Short Answer* Insects and reptiles excrete nitrogenous [*nigh-traw-jen-uhs*] waste in what nontoxic form?

ANSWER: URIC ACID

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### TOSS-UP

6) Energy – *Short Answer* During physics lab, you create a graph of the kinetic energy of a bouncing ball versus time. What physical quantity is represented by the slope of the graph?

ANSWER: POWER

### BONUS

6) Energy – *Short Answer* Identify all of the following four processes that result in a decrease in entropy: 1) freezing of water; 2) vaporization of water; 3) extraction of magnesium and pure water from sea water; 4) sublimation of dry ice.

ANSWER: 1 AND 3

### TOSS-UP

7) Math – *Multiple Choice* Which of the following is NOT equal to  $a \times \log$  base  $b$  of  $c$ ?

W)  $1/a \times \log$  base  $b$  of the fraction  $a/c$

X)  $-a \times \log$  base  $b$  of the fraction  $1/c$

Y)  $-\log$  base  $b$  of open parenthesis  $c^{-a}$  close parenthesis

Z) Natural log of  $(e^a) \times \log$  base  $b$  of  $c$

ANSWER: W)  $1/a \times \log$  BASE  $b$  OF THE FRACTION  $a/c$

### BONUS

7) Math – *Multiple Choice* It takes 3 painters 4 hours to paint one house. How many hours does it take one painter to paint two houses of the same size?

W) 12

X) 24

Y) 36

Z) 48

ANSWER: X) 24

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TOSS-UP

8) Physics – *Short Answer* Identify all of the following three particles that are considered leptons: 1) Protons; 2) Electrons; 3) Neutrons.

ANSWER: 2

BONUS

8) Physics – *Short Answer* A figure skater is holding his hands outstretched as he spins at 180 rotations per minute. If his hands are 180 centimeters apart, what is the speed in meters per second of his hands in terms of π ?

ANSWER: 5.4π (ACCEPT: $27/5\pi$)

TOSS-UP

9) Earth and Space – *Multiple Choice* A lunar eclipse can occur only during what phase of the moon?

- W) Full moon
- X) New moon
- Y) First quarter
- Z) Last quarter

ANSWER: W) FULL MOON

BONUS

9) Earth and Space – *Multiple Choice* At what altitude does the greatest variation in daily temperature occur?

- W) Near the ground
- X) 10 meters above the ground
- Y) 50 meters above the ground
- Z) 100 meters above the ground

ANSWER: W) NEAR THE GROUND

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### TOSS-UP

10) Chemistry – *Short Answer* What major organic product is produced when an ethene and hydrogen gas are reacted on Raney [*ray-nee*] nickel?

ANSWER: ETHANE

### BONUS

10) Chemistry – *Multiple Choice* To measure the number of moles of barium in a solution containing both magnesium 2+ and barium 2+ ions, a student added sodium sulfate and collected the precipitate. Then, he weighed the precipitate, and used stoichiometric conversions to estimate the number of moles of barium, and discovered that his method over-reported the actual value stated by his teacher. Which of the following plausibly explains the discrepancy?

- W) The student precipitated both magnesium and barium when adding sodium sulfate
- X) The student used a molar mass for barium that was 10% too high
- Y) The student used a molar mass for sulfur that was 10% too high
- Z) The student didn't properly dry his precipitate before weighing

ANSWER: Z) THE STUDENT DIDN'T PROPERLY DRY HIS PRECIPITATE BEFORE WEIGHING

### TOSS-UP

11) Biology – *Multiple Choice* Which of the following types of cells has the longest lifespan in circulation?

- W) Erythrocyte [*uh-ree-throh-sight*]
- X) Platelet
- Y) Monocyte
- Z) Neutrophil [*nyoo-troh-fil*]

ANSWER: W) ERYTHROCYTE

### BONUS

11) Biology – *Short Answer* What model in population genetics predicts that allele frequencies will stay constant from generation to generation, assuming that the population remains free of other evolutionary influences?

ANSWER: HARDY-WEINBERG PRINCIPLE

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TOSS-UP

12) Math – *Multiple Choice* The average value of a continuous function $f(x)$ on a closed interval from 2 to 6 is 8. What is the value of the definite integral from 2 to 6 of $f(x) dx$?

- W) 4
- X) 8
- Y) 24
- Z) 32

ANSWER: Z) 32

BONUS

12) Math – *Short Answer* $f(x)$ is a twice differentiable function where f' prime of x is less than 0 and f'' double prime of x is less than 0 for all real numbers. If $f(4) = 12$ and $f(5) = 9$, what is the largest possible integer value for $f(6)$?

ANSWER: 5

TOSS-UP

13) Physics – *Short Answer* The equations $x\text{-prime} = x - vt$ and $t\text{-prime} = t$ represent what mathematical conversion, used between two reference frames traveling at speeds much less than the speed of light?

ANSWER: GALILEAN TRANSFORMATION

BONUS

13) Physics – *Multiple Choice* An electromagnetic wave that has a wavelength of 10 meters would be best classified as is in which of the following regions of the electromagnetic spectrum?

- W) Microwave
- X) Ultraviolet
- Y) Visible
- Z) Radio

ANSWER: Z) RADIO



TOSS-UP

14) Earth and Space – *Multiple Choice* A wind blowing from 135° equates to the wind coming from which direction?

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

ANSWER: Y) Southeast

BONUS

14) Earth and Space – *Multiple Choice* Meteorologists use the Enhanced Fujita Scale to determine the strength of a tornado by assessing which of the following?

- W) Winds of the tornado
- X) Minimum barometric pressure of the tornado
- Y) Vorticity of the tornado
- Z) Damage left behind from the tornado

ANSWER: Z) DAMAGE LEFT BEHIND FROM THE TORNADO

TOSS-UP

15) Energy – *Short Answer* High power density, low electrical energy capacity, and long cycle life describe what type of battery found in most cars in the United States?

ANSWER: LEAD ACID BATTERY

BONUS

15) Energy – *Short Answer* If a solar farm has a nameplate capacity of 50 mega-watts, what is its capacity factor, to the nearest tenth, if it generates an average of 40 mega-watts for 12 hours each day?

ANSWER: 0.4



TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following methods would be most accurate when determining the molecular weight of a polymer?

- W) Freezing-point depression analysis
- X) Gravimetry
- Y) Titration
- Z) Osmometry

ANSWER: Z) OSMOMETRY

BONUS

16) Chemistry – *Short Answer* Chromium metal crystallizes in a body-centered cubic lattice. What is the coordination number of each chromium atom in this lattice?

ANSWER: 8

TOSS-UP

17) Math – *Short Answer* For the equation $y = 15 + 45 \times \log_{10}(\text{open parenthesis } 10x \text{ close parenthesis})$, where x is the number of years after 2000, find the value of y in 2010.

ANSWER: $y = 105$

BONUS

17) Math – *Short Answer* Find the smallest three-digit positive integer not ending in zero such that the product of the digits is double the square of the ones-digit.

ANSWER: 121

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### TOSS-UP

18) Biology – *Multiple Choice* Which of the following diseases is caused by a virus?

- W) Acne
- X) Shingles
- Y) Impetigo
- Z) Necrotizing fasciitis [*fash-ee-eye-tis*]

ANSWER: X) SHINGLES

### BONUS

18) Biology – *Multiple Choice* Which of the following compounds would one use to detect the presence of DNA in an agarose gel?

- W) Ethidium bromide [*eth-ih-dee-um broh-myde*]
- X) Coomassie Blue [*coo-mah-see*]
- Y) Rhodamine 2 [*row-duh-meen*]
- Z) Fluorescein [*flow-ruh-seen*]

ANSWER: W) ETHIDIUM BROMIDE

### TOSS-UP

19) Physics – *Multiple Choice* Which of the following is NOT true regarding semiconductors?

- W) Doping is used to modulate the electrical properties of a semiconductor
- X) Silica glass is a semiconductor
- Y) Silicon is the most commonly used semiconductor in electronics
- Z) Light emitting diodes can be made of semiconductors

ANSWER: X) SILICA GLASS IS A SEMICONDUCTOR

### BONUS

19) Physics – *Multiple Choice* A 50 gram ball moving to the right at 4 meters per second overtakes and collides perfectly elastically with a 100 gram ball moving to the right at 2 meters per second. Which of the following is true after the collision?

- W) Both balls are moving to the left at 1.33 meters per second and 3.33 meters per second, respectively
- X) Both balls are moving to the right at 1.33 meters per second and 3.33 meters per second, respectively
- Y) Both balls are moving to the left at 1.66 and 3.00 meters per second, respectively
- Z) Both balls are moving to the right at 1.66 and 3.00 meters per second, respectively

ANSWER: X) BOTH BALLS ARE MOVING TO THE RIGHT AT 1.33 AND 3.33 METERS PER SECOND, RESPECTIVELY

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TOSS-UP

20) Energy – *Multiple Choice* Which of the following types of fuel is extracted by hydraulic fracturing?

- W) Geothermal
- X) Coal
- Y) Natural Gas
- Z) Hydrothermal energy

ANSWER: Y) NATURAL GAS

BONUS

20) Energy – *Multiple Choice* Which of the following represents a negative feedback process regarding climate change?

- W) Increasing temperature of the Earth causes more water vapor to enter the atmosphere
- X) As ice melts, the albedo of the Earth decreases
- Y) As the temperature of the Earth increases, more radiation is radiated into space
- Z) As the temperature of the Earth increases, methane clathrates release more methane into the atmosphere

ANSWER: Y) AS THE TEMPERATURE OF THE EARTH INCREASES, MORE RADIATION IS RADIATED INTO SPACE

TOSS-UP

21) Biology – *Multiple Choice* If a protein contains a signal peptide, in which of the following locations would it LEAST likely be found?

- W) Cytosol
- X) Golgi Body
- Y) Rough ER
- Z) Lysosome

ANSWER: W) CYTOSOL

BONUS

21) Biology – *Multiple Choice* Which of the following eye adaptations allows nocturnal animals to see better in dim light when compared to diurnal animals?

- W) Relatively higher numbers of cone cells
- X) Presence of a tapetum [*tuh-pee-tum*] that reflects rather than absorbs light
- Y) Chemically distinctive vitreous humor that better supports the retina
- Z) A less convex lens that facilitates an ideal focal length in dim light

ANSWER: X) PRESENCE OF A TAPETUM THAT REFLECTS RATHER THAN ABSORBS LIGHT



TOSS-UP

22) Earth and Space – *Multiple Choice* Which of the following does not occur after the passage of a cold front?

- W) Wind direction shift
- X) Drop in relative humidity
- Y) Drop in barometric pressure
- Z) Clearing skies

ANSWER: Y) DROP IN BAROMETRIC PRESSURE

BONUS

22) Earth and Space – *Short Answer* What is the name for the opening found on the surface of volcanic systems that vents volcanic gases?

ANSWER: FUMAROLE

TOSS-UP

23) Chemistry – *Short Answer* For a given reaction, the rate constant is equal to 93 liters squared per moles squared per second. What is the order of this reaction?

ANSWER: THREE

BONUS

23) Chemistry – *Short Answer* A closed vessel contains nitrogen gas, oxygen gas, and nitrogen dioxide gas. Nitrogen dioxide has a positive enthalpy of formation. Identify all of the following three changes that would shift the equilibrium to the products: 1) Increasing the temperature; 2) Increasing the pressure by adding nitrogen dioxide gas; 3) Increasing the pressure by adding an inert gas.

ANSWER: 1