

## ROUND 11A

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### TOSS-UP

1) BIOLOGY *Multiple Choice* If a person has consumed too much alcohol and is showing signs of ataxia [**uh-TAK-see-uh**], what portion of the brain is being inhibited?

- W) Left hemisphere of the cerebrum
- X) Tectum
- Y) Thalamus
- Z) Cerebellum [**ser-uh-BEL-uhm**]

ANSWER: Z) CEREBELLUM

### BONUS

1) BIOLOGY *Multiple Choice* Which of the following drugs is mismatched to its action on neurotransmission?

- W) Benzodiazepines: Increases inhibitory neurotransmission [**ben-zoh-dy-AZ-uh-pyns**]
- X) Cocaine: inhibits release of dopamine and norepinephrine [**nohr-ep-uh-NEF-rin**]
- Y) LSD: Binds to serotonin receptors
- Z) Nicotine: decreases brain dopamine levels

ANSWER Z) NICOTINE DECREASES BRAIN DOPAMINE LEVELS

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### TOSS-UP

2) CHEMISTRY *Multiple Choice* Which of the following molecules exhibits intermolecular attractions commonly referred to as hydrogen bonding?

- W) H<sub>2</sub>
- X) HBr [**H-B-R**]
- Y) HCN [**H-C-N**]
- Z) HCOOH [**H-C-O-O-H**]

ANSWER: Z) HCOOH

### BONUS

2) CHEMISTRY *Multiple Choice* The Heisenberg Uncertainty Principle implies that it is impossible to simultaneously obtain exact measurements for what two properties of a particle?

- W) Mass & velocity
- X) Charge & spin
- Y) Energy & wavelength
- Z) Position & momentum

ANSWER: Z) POSITION & MOMENTUM

### TOSS-UP

3) MATH *Multiple Choice* Which of the following functions has the greatest number of discontinuities?

W)  $\frac{3x+5}{x-4}$  [*quantity three x plus five, divided by quantity x minus 4*]

X)  $\left(\frac{1}{x-1}\right) + x$  [*open parenthesis one, divided by quantity x minus 1, close parenthesis, plus x*]

Y)  $\frac{1}{x^2}$  [*one divided by x squared*]

Z)  $\frac{1}{x^2-1}$  [*one, divided by quantity x squared minus one*]

ANSWER: Z)  $\frac{1}{x^2-1}$

### BONUS

3) MATH *Short Answer* Compute the probability of getting a “blackjack” (two cards totaling 21 points) from a standard deck of cards, given that an ace counts as 11, a face card counts as 10, and all others count as their numerical values.

ANSWER: 32/663

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### TOSS-UP

4) PHYSICS *Multiple Choice* The electric field of a given charge is measured to be 1 newton per coulomb at a distance 10 centimeters away from the charge. According to Gauss’s Law, what would the field be in newtons per coulomb at the same location if we were to double the charge?

W) 0.1

X) 2

Y) 10

Z) 20

ANSWER: X) 2

### BONUS

4) PHYSICS *Short Answer* A uniform magnetic field is applied perpendicularly to the velocity vector of a moving charged particle. What shape will the path of the charged particle be?

ANSWER: CIRCLE (DO NOT ACCEPT: HELICAL)

### TOSS-UP

5) EARTH AND SPACE *Multiple Choice* Which of the following volcanic features would be most closely associated with a high rating on the Volcanic Explosivity Index scale?

W) Pahoehoe lava [*pah-HOH-ee-hoh-ee*]

X) High temperature flows

Y) Flood basalts

Z) Widespread ash fallout

ANSWER: Z) WIDESPREAD ASH FALLOUT

### BONUS

5) EARTH AND SPACE *Short Answer* What is the currently most accepted hypothesis for the observed acceleration of the expansion of the universe?

ANSWER: DARK ENERGY

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### TOSS-UP

6) CHEMISTRY *Short Answer* Identify all of the following three compounds that are capable of hydrogen bonding with themselves: 1) hydrogen bromide; 2) hydrogen cyanide; 3) butanol.

ANSWER: 3 (ACCEPT: BUTANOL)

### BONUS

6) CHEMISTRY *Short Answer* For a particular reaction,  $\Delta H = +10$  [*delta H equals positive ten*] kilojoules per mole and  $\Delta S = +40$  [*delta S equals positive forty*] joules per mole Kelvin. At what temperature, in Kelvin, does the reaction transition from being spontaneous to nonspontaneous?

ANSWER: 250 Kelvin

### TOSS-UP

7) BIOLOGY *Multiple Choice* What are the most important sensory receptors for the monitoring and regulation of blood pressure in mammals?

- W) Statocysts
- X) Baroreceptors
- Y) Nocireceptors [**NOH-si-SEP-tuhrs**]
- Z) Chemoreceptors

ANSWER: X) BARORECEPTORS

### BONUS

7) BIOLOGY *Short Answer* Early in the evolution of modern day fish, the superclass Osteichthyes [**os-tee-IK-thee-eez**] split into two groups, one of which includes fish such as the Coelocanth [**see-LUH-kahnth**] and lungfish. What is the name for this group of fish?

ANSWER: SARCOPTERYGII (ACCEPT: LOBE FINNED FISH)

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### TOSS-UP

8) ENERGY *Multiple Choice* How much energy in tons of coal equivalent can be released by using deuterium in 50 cups of sea water in a deuterium – tritium fusion reactor?

- W) 2
- X) 200
- Y) 2,000
- Z) 2,000,000

ANSWER: W) 2

### BONUS

8) ENERGY *Short Answer* Fluorescence can be understood as the emission of a photon as a molecule transitions from a singlet excited state to a singlet ground state. What phenomenon is understood as a molecule transitioning from a triplet excited state to a singlet ground state and generally takes place on a much longer time scale than fluorescence?

ANSWER: PHOSPHORESCENCE

**TOSS-UP**

9) EARTH AND SPACE *Short Answer* The Milky Way and the Andromeda Galaxy are the primary constituents of what structure?

ANSWER: THE LOCAL GROUP

**BONUS**

9) EARTH AND SPACE *Multiple Choice* Which of the following statements about the moon is NOT correct?

- W) Moonquakes are due to tidal stresses from the Earth and meteorite impacts
- X) The moon formed during the late heavy bombardment
- Y) Lunar basalts contain fewer volatiles than basalts on Earth
- Z) The moon has no global magnetic field

ANSWER: X) THE MOON FORMED DURING THE LATE HEAVY BOMBARDMENT

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**TOSS-UP**

10) MATH *Short Answer* What is the polar form of the equation:  $y = x$ ?

ANSWER:  $\theta = 45^\circ$  or  $\theta = \frac{\pi}{4}$

**BONUS**

10) MATH *Short Answer* What is the sum of the numbers of faces of each of the unique Platonic solids?

ANSWER: 50

### TOSS-UP

11) BIOLOGY *Multiple Choice* What complex in oxidative phosphorylation [**FOS-for-uh-lay-shuhn**] moves protons into rather than out of the mitochondrial [**my-tuh-KON-dree-uhl**] matrix?

- W) Cytochrome oxidase
- X) Cytochrome b-c1
- Y) ATP synthase
- Z) NAD dehydrogenase [**dee-HY-druh-juh-nays**]

ANSWER Y) ATP SYNTHASE

### BONUS

11) BIOLOGY *Multiple Choice* Which of the following eye adaptations allows birds of prey like raptors to maintain high visual sensitivity when diving for prey?

- W) Presence of a tapetum lucidum [**tuh-PEE-tuhm loo-SEE-duhm**]
- X) Retina with two foveas [**FOH-vee-uhs**]
- Y) Ability to change relative amounts of cis and trans retinal
- Z) Monocular vision

ANSWER: X) RETINA WITH TWO FOVEAS

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### TOSS-UP

12) CHEMISTRY *Multiple Choice* If a molecule is known to have a trigonal bipyramidal shape such that "M" is the central atom and "L" is each of the five substituents, which of the following statements is NOT true about this particular molecule?

- W) It has a 3-fold rotation axis
- X) It has at least two mirror planes
- Y) It has an inversion center
- Z) It has at least one improper rotation possible

ANSWER: Y) IT HAS AN INVERSION CENTER

### BONUS

12) CHEMISTRY *Short Answer* What is the theoretical yield, in moles, of ammonia when 4 moles of nitrogen are reacted with 9 moles of hydrogen in the Haber process?

ANSWER: 6

**TOSS-UP**

13) PHYSICS *Short Answer* What is the name for the resistive force that is related to Reynolds number and acts on objects in the direction of relative fluid flow velocity?

ANSWER: DRAG FORCE

**BONUS**

13) PHYSICS *Multiple Choice* The period of oscillation of a given simple pendulum on a grandfather's clock here on earth is 1 second. What would be the period in seconds of the same pendulum on another planet where the gravitational acceleration is  $1/4$  that of the earth?

- W) 0.25
- X) 1
- Y) 2
- Z) 4

ANSWER: Y) 2

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**TOSS-UP**

14) EARTH AND SPACE *Multiple Choice* What are the bright outbursts in flare stars due to?

- W) Raleigh-Taylor instabilities
- X) Magnetic field reconnections
- Y) Unstable nuclear reactions
- Z) Convective overshoots

ANSWER: X) MAGNETIC FIELD RECONNECTIONS

**BONUS**

14) EARTH AND SPACE *Short Answer* What is the term for a large planet found in very close orbit to its host star?

ANSWER: HOT JUPITER

### TOSS-UP

15) BIOLOGY *Multiple Choice* Within the human forebrain, which of the following structures does not belong to the telencephalon [*tel-en-SEF-uh-lon*] ?

- W) Basal nuclei
- X) Hippocampus [*hip-uh-KAM-puhs*]
- Y) Hypothalamus [*hy-puh-THAL-uh-muhs*]
- Z) Cerebral cortex

ANSWER: Y) HYPOTHALAMUS

### BONUS

15) BIOLOGY *Multiple Choice* Which of the following pairs of echinoderms [*ih-KY-nuh-durms*] have respiratory structures that could be characterized as lungs rather than gills, since they are formed from invaginations of the body surface?

- W) Sea star and sea urchin
- X) Sea urchin and brittle star
- Y) Sea star and brittle star
- Z) Sea cucumber and brittle star

ANSWER: Z) SEA CUCUMBER AND BRITTLE STAR

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### TOSS-UP

16) MATH *Short Answer* If it takes you 20 seconds to solve a math problem and your friend 30 seconds to solve a math problem, how many can the two of you solve in 6 minutes?

ANSWER: 30

### BONUS

16) MATH *Short Answer* Two integers between 1 and 10, inclusive, are selected at random with replacement. What is the probability that both numbers selected are prime and their product is odd?

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

### TOSS-UP

17) ENERGY *Multiple Choice* According to the U.S. Energy Information Administration, energy consumption per capita in the U.S. is expected to change at what annual percentage from now until 2035?

- W) -0.12
- X) -0.5
- Y) +0.5
- Z) +0.12

ANSWER: X) -0.5

### BONUS

17) ENERGY *Short Answer* What crystalline solid consists of a methane molecule surrounded by a cage of interlocking water molecules and is typically found on sea floors and under permafrost?

ANSWER: METHANE HYDRATE (ACCEPT: METHANE CLATHRATE)

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### TOSS-UP

18) CHEMISTRY *Multiple Choice* London dispersion forces increase as which of the following molecular properties also increases?

- W) Dipole moment
- X) Polarizability
- Y) Bond angle
- Z) Ionization energy

ANSWER: X) POLARIZABILITY

### BONUS

18) CHEMISTRY *Short Answer* Suppose the atoms of a polar diatomic molecule have partial charges of  $\pm 0.25 e$  [**plus or minus zero point two five e**], equivalent to  $\pm 4.0 \times 10^{-20}$  [**plus or minus four point zero times ten to the negative twentieth**] coulombs. If the bond length is 1.5 angstroms, to two significant figures, what is the dipole moment of the molecule in coulomb-meters?

ANSWER:  $6.0 \times 10^{-30}$

### TOSS-UP

19) BIOLOGY *Multiple Choice* Which of the following is NOT a direct requirement for dinoflagellates [*din-uh-FLAJ-uh-layts*] to carry out bioluminescence?

- W) Luciferyl adenylate [*loo-sif-UH-ril uh-de-ni-layt*]
- X) Oxygen
- Y) Inorganic pyrophosphate
- Z) Carbon dioxide

ANSWER: Z) CARBON DIOXIDE

### BONUS

19) BIOLOGY *Multiple Choice* All of the following distinguish actin filaments from microtubules and intermediate filaments except which characteristic?

- W) Promotion of muscle contraction
- X) Ability to create amoeboid [*uh-MEE-oid*] cell movement
- Y) Spiral structure
- Z) Intracellular movement of cargo

ANSWER Z) INTRACELLULAR MOVEMENT OF CARGO

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### TOSS-UP

20) PHYSICS *Multiple Choice* Which of the following is a consequence of the exclusion principle?

- W) Electrons bound in an atom can only occupy orbits for which the angular momentum is quantized
- X) An electron in a stationary state emits no radiation
- Y) No two electrons in a single atom can have an identical set of quantum numbers
- Z) Only when an electron jumps to a lower state does it emit a photon

ANSWER: Y) NO TWO ELECTRONS IN A SINGLE ATOM CAN HAVE AN IDENTICAL SET OF QUANTUM NUMBERS

### BONUS

20) PHYSICS *Multiple Choice* Which of the following is closest to the value of free-fall acceleration, in meters per second squared, at an altitude distance of  $2R_{Earth}$  [*two times the radius of earth*] above the surface of the Earth?

- W) 1
- X) 2.5
- Y) 4.9
- Z) 9.8

ANSWER: W) 1

### TOSS-UP

21) ENERGY *Short Answer* Most companies pursuing algae as a source of biofuels are pumping nutrient-laden water through plastic or borosilicate glass tubes that are exposed to sunlight. What is the name of the device being used in this algae fuel production process?

ANSWER: BIOREACTOR (ACCEPT: PHOTOBIOREACTOR, ALGAE BIOREACTOR)

### BONUS

21) ENERGY *Multiple Choice* Which of the following is NOT true regarding catalysis?

- W) Biological catalysts are called enzymes
- X) Catalysts lower the activation energy of chemical reactions
- Y) A catalyzed reaction always has the same transition state as the uncatalyzed reaction
- Z) Catalysts have no effect on the equilibrium constant

ANSWER: Y) A CATALYZED REACTION ALWAYS HAS THE SAME TRANSITION STATE AS THE UNCATALYZED REACTION

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### TOSS-UP

22) MATH *Short Answer* What is the two-digit square number with the largest sum of its own digits?

ANSWER: 49

### BONUS

22) MATH *Short Answer* Determine  $\lim_{x \rightarrow -\pi} \frac{\cos(x/2)}{\pi+x}$  [the limit as  $x$  approaches minus pi of the fraction with numerator cosine of the quantity  $x$  divided by two and denominator pi plus  $x$ ].

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

### TOSS-UP

23) CHEMISTRY *Short Answer* A particular reaction involves only one reactant, which decomposes into products. This reactant is also a strong absorber of yellow light, which allows a scientist to use a spectrometer to measure the reactant concentration as a function of time. The scientist then plots the natural logarithm of the reactant concentration as a function of time, and notices that the plot is linear. What is the order of the kinetics of this reaction?

ANSWER: FIRST (ACCEPT: ONE)

### BONUS

23) CHEMISTRY *Multiple Choice* For a hypothetical diatomic molecule, which of the following combinations of properties would result in the largest dipole moment?

- W) Short bond length, small difference in electronegativity between atoms
- X) Long bond length, large difference in electronegativity between atoms
- Y) Long bond length, small difference in electronegativity between atoms
- Z) Short bond length, large difference in electronegativity between atoms

ANSWER: X) LONG BOND LENGTH, LARGE DIFFERENCE IN ELECTRONEGATIVITY BETWEEN ATOMS