

ROUND 12A

TOSS-UP

1) Physics – *Short Answer* Consider a simple parallel RL circuit connected to an AC power source. The peak current through the inductor is 10 milliamps. What will the peak current through the inductor become, in milliamps, if the frequency is halved and the peak voltage is doubled?

ANSWER: 40

BONUS

1) Physics – *Multiple Choice* An object is thrown vertically upward at time $t = 0$, at a speed of 40 meters per second, from the top of a building that has a height of 100 meters. Assuming acceleration due to gravity equals 10 meters per second squared, at what time t in seconds will the object hit the ground?

- W) 4
- X) 8
- Y) 10
- Z) 15

ANSWER: Y) 10

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### TOSS-UP

2) Earth and Space – *Multiple Choice* Why was the 2010 Haiti earthquake registered so high on the Mercalli Intensity Scale despite smaller ratings on the Richter and Moment Magnitude scales?

- W) The earthquake produced a large tsunami
- X) The initial earthquake was followed by many aftershocks
- Y) Haiti is underlain by thrust faults
- Z) Haiti has a poorly developed infrastructure

ANSWER: Z) HAITI HAS A POORLY DEVELOPED INFRASTRUCTURE

### BONUS

2) Earth and Space – *Short Answer* Phosphorus is an essential nutrient for phytoplankton. Identify all of the following three processes that remove phosphorus from the Indian Ocean photic zone: 1) Marine snow; 2) Coastal upwelling; 3) Deposition of windblown dust from Australia.

ANSWER: 1

### TOSS-UP

3) Biology – *Multiple Choice* Your teacher has a passion for studying human immunoglobulins, but they have to be dimers. What immunoglobulin does your teacher study?

- W) IgD
- X) IgA
- Y) IgM
- Z) IgE

ANSWER: X) IgA

### BONUS

3) Biology – *Short Answer* The products of the reaction catalyzed by pancreatic lipase are fatty acids and what other molecule?

ANSWER: GLYCEROL (ACCEPT: MONOACYLGLYCEROL, MONOGLYCERIDE, ACYLGLYCEROL)

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TOSS-UP

4) Energy – *Short Answer* After a nuclear reactor is shut down and fission stops, the fuel continues to produce a lower, but significant, amount of heat for several years. What is the term for this residual heat energy?

ANSWER: DECAY HEAT

BONUS

4) Energy – *Short Answer* Incomplete combustion of coal results in what toxic, carbon-based gas?

ANSWER: CARBON MONOXIDE

TOSS-UP

5) Math – *Multiple Choice* Which of the following best describes the type of conic section represented by the equation $x^2 + 10x + y^2 + 16$ equals zero?

- W) Circle
- X) Ellipse
- Y) Hyperbola
- Z) Parabola

ANSWER: W) CIRCLE

BONUS

5) Math – *Short Answer* If the third derivative of a position function can be described by the function $4t$, what is the coefficient on the highest order term in the position function?

ANSWER: 1/6

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**TOSS-UP**

6) Chemistry – *Short Answer* What class of molecules is characterized by the functional group containing atoms C-O-O-H?

ANSWER: CARBOXYLIC ACID (DO NOT ACCEPT: ORGANIC ACID)

**BONUS**

6) Chemistry – *Short Answer* The reaction of 1 mole of nitrogen gas with 3 moles of hydrogen gas to form two moles of ammonia has an equilibrium constant of  $5 \times 10^{-2}$  at 700 kelvins. What is the equilibrium constant of the decomposition reaction of 4 moles of ammonia to form 6 moles of hydrogen gas and 2 moles of nitrogen gas, at the same temperature and volume?

ANSWER: 400

### TOSS-UP

7) Physics – *Short Answer* What is the effect by which a material with a small positive magnetic susceptibility creates a magnetic field in the direction of an applied field?

ANSWER: PARAMAGNETISM

### BONUS

7) Physics – *Short Answer* Also known as braking radiation, what effect occurs when a charged particle is deflected and undergoes deceleration?

ANSWER: BREMSSTRAHLUNG

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TOSS-UP

8) Chemistry – *Short Answer* What heteroatom is characteristically found in thiols [*THIGH-awls*], thioethers, and thioesters?

ANSWER: SULFUR

BONUS

8) Chemistry – *Short Answer* How many orbitals are in subshells with the azimuthal [*ay-zih-MYOO-tul*] quantum number equal to zero?

ANSWER: ONE

TOSS-UP

9) Math – *Multiple Choice* Which of the following is equivalent to $\cos 56^\circ \cos 23^\circ - \sin 23^\circ \sin 56^\circ$?

- W) $\sin 33^\circ$
- X) $\cos 33^\circ$
- Y) $\sin 79^\circ$
- Z) $\cos 79^\circ$

ANSWER: Z) COSINE 79°

BONUS

9) Math – *Short Answer* What are the mean and the median, respectively, of the prime numbers less than 25?

ANSWER: MEAN 100/9 (ACCEPT: 11 1/9), MEDIAN 11



TOSS-UP

10) Earth and Space – *Short Answer* What fast-flowing, narrow currents form above sharp air mass boundaries in the atmospheres of rotating planets, including Earth?

ANSWER: JET STREAMS

BONUS

10) Earth and Space – *Multiple Choice* Which of the following main-sequence stars are the least massive?

- W) Blue
- X) Red
- Y) Yellow
- Z) White

ANSWER: X) RED

TOSS-UP

11) Biology – *Short Answer* Identify all of the following three structures that can be found in both bacteria and plants: 1) Nucleus; 2) Peroxisome [*per-OX-ih-sowm*]; 3) Mitochondrion.

ANSWER: NONE OF THEM

BONUS

11) Biology – *Short Answer* What vitamin, essential to humans, is involved in collagen synthesis?

ANSWER: VITAMIN C (ACCEPT: ASCORBATE, ASCORBIC ACID)

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### TOSS-UP

12) Energy – *Multiple Choice* Which of the following experimental batteries is able to charge in less than a minute?

- W) Copper ion
- X) Chromium ion
- Y) Aluminum ion
- Z) Silicon

ANSWER: Y) ALUMINUM ION

### BONUS

12) Energy – *Multiple Choice* The Montreal Protocol effectively reduced the use of CFCs that damage the ozone layer. One group of replacements for CFCs has no effect on the ozone layer but is now recognized as greenhouse gases whose use must also be phased out. What group of gases is this?

- W) HFCs
- X) HFOs
- Y) PFCs
- Z) HCFCs

ANSWER: W) HFCs

**TOSS-UP**

13) Earth and Space – *Multiple Choice* Which of the following is NOT true of the lunar maria?

- W) They formed within the first one billion years of the moon's history
- X) They cover about 50% of the moon's surface
- Y) They are composed of iron-rich basalt
- Z) They are more abundant on the near side of the moon

Answer: X) THEY COVER ABOUT 50% OF THE MOON'S SURFACE

**BONUS**

13) Earth and Space – *Short Answer* Order the following three groups of photosynthetic organisms by their time of appearance on Earth, from first to last: 1) Cyanobacteria [*syne-ANNO-bacteria*]; 2) C4 plants; 3) Ferns.

ANSWER: 1, 3, 2 (CYANOBACTERIA, FERNS, C4 PLANTS)



**TOSS-UP**

14) Energy – *Short Answer* The Oak Ridge National Laboratory revealed an electric vehicle, patterned after a Shelby Cobra, at the 2015 North American International Auto Show that was built using what process?

ANSWER: 3D PRINTING (ACCEPT: ADDITIVE MANUFACTURING, ADDITIVE PROCESS)

**BONUS**

14) Energy – *Multiple Choice* Instead of simply storing CO<sub>2</sub> via carbon capture and storage projects, engineers have developed a use for the captured CO<sub>2</sub>. How is the captured CO<sub>2</sub> being used?

- W) Generation of electricity
- X) Heating of homes
- Y) Oil recovery from mature wells
- Z) Plant growth in greenhouses

ANSWER: Y) OIL RECOVERY FROM MATURE WELLS

### TOSS-UP

15) Physics – *Short Answer* A car is traveling at 30 meters per second. After having traveled 160 meters, it has accelerated to 50 meters per second. In meters per second squared, what is its average acceleration during this period?

ANSWER: 5

### BONUS

15) Physics – *Multiple Choice* Eddy currents are circular electric currents induced by a changing magnetic field within conductors. Which of the following is NOT an application that utilizes eddy currents?

- W) Roller coaster braking
- X) Induction heating
- Y) Metal detectors
- Z) Detecting counterfeit bills in vending machines

ANSWER: Z) DETECTING COUNTERFEIT BILLS IN VENDING MACHINES

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TOSS-UP

16) Chemistry – *Multiple Choice* Which of the following is TRUE concerning the hydroxide ion and its sulfur-containing counterpart, hydrosulfide?

- W) Hydrosulfide is more polarizable and more basic than hydroxide
- X) Hydrosulfide is more polarizable and less basic than hydroxide
- Y) Hydrosulfide is less polarizable and less basic than hydroxide
- Z) Hydrosulfide is less polarizable and more basic than hydroxide

ANSWER: X) HYDROSULFIDE IS MORE POLARIZABLE AND LESS BASIC THAN HYDROXIDE

BONUS

16) Chemistry – *Short Answer* Assume that a 0.1 molar solution of a certain weak acid has a pH of 4.0. To the nearest integer, what is the pKa of this weak acid?

ANSWER: 7

TOSS-UP

17) Biology – *Short Answer* Order the following three parts of the digestive tract from first to last to be encountered by a bolus: 1) Ileum [*ILL-ee-um*]; 2) Transverse colon; 3) Pyloric sphincter [*SFEENK-ter*].

ANSWER: 3, 1, 2

BONUS

17) Biology – *Short Answer* What amino acid possesses a secondary amine functionality and as a result, has special constraints on its secondary structure?

ANSWER: PROLINE



TOSS-UP

18) Math – *Short Answer* If an exterior angle adjacent to a base angle of an isosceles [*eye-SOSS-uh-lees*] triangle measures 132° , what is the degree measure of the vertex angle?

ANSWER: 84

BONUS

18) Math – *Multiple Choice* According to the rational root theorem, which of the following is NOT a possible solution to the equation $x^3 - 2x^2 + x - 2 = 0$?

- W) -1
- X) $\frac{1}{2}$
- Y) 1
- Z) 2

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

TOSS-UP

19) Physics – *Multiple Choice* In a DC/DC converter, the electrical energy is stored in which elements of the circuit?

- W) Capacitors and inductors
- X) Resistive elements
- Y) Switching element
- Z) Diodes and protection circuitry

ANSWER: W) CAPACITORS AND INDUCTORS

BONUS

19) Physics – *Multiple Choice* What is the equivalent resistance, to the nearest tenth of an ohm, of a circuit containing 3 resistors in parallel, with resistance values of 5 ohms, 3 ohms, and 6 ohms?

- W) 1.0
- X) 1.4
- Y) 1.8
- Z) 2.2

ANSWER: X) 1.4



TOSS-UP

20) Biology – *Multiple Choice* p53 is a protein associated with which of the following processes?

- W) Cell cycle
- X) Transcription
- Y) Electron transport chain
- Z) Heme synthesis

ANSWER: W) CELL CYCLE

BONUS

20) Biology – *Short Answer* What hormone, secreted by the posterior pituitary, plays a role in water retention in the kidneys?

ANSWER: VASOPRESSIN (Accept: ADH, ANTIDIURETIC HORMONE)

TOSS-UP

21) Chemistry – *Short Answer* How many valence electrons does atomic silicon have?

ANSWER: FOUR

BONUS

21) Chemistry – *Short Answer* Identify all of the following three quantities that increase when the electron in a hydrogen atom transitions from 1s to 2s: 1) Energy of the electron; 2) Value of azimuthal quantum number; 3) Value of principal quantum number.

ANSWER: 1 AND 3



TOSS-UP

22) Math – *Short Answer* What is the 4th term of the geometric series with first term 400 and second term 120?

ANSWER: 10.8 (ACCEPT: 10 4/5, 54/5)

BONUS

22) Math – *Short Answer* Simplify the following expression involving the complex number i :
 $i + 2i^2 + 3i^3 + 4i^4$

ANSWER: $2 - 2i$

TOSS-UP

23) Earth and Space – *Multiple Choice* Which of the following metamorphic rocks cannot originate from shale?

- W) Anthracite
- X) Gneiss [*nice*]
- Y) Slate
- Z) Phyllite [*FILL-lite*]

ANSWER: W) ANTHRACITE

BONUS

23) Earth and Space – *Multiple Choice* Approximately how many meters would global average sea level rise if both the Greenland and Antarctic ice sheets were to completely melt?

- W) 10
- X) 30
- Y) 70
- Z) 120

ANSWER: Y) 70