

ROUND 9A

TOSS-UP

1) Physics – *Short Answer* A difference of 10 decibels corresponds to what ratio of sound intensities?

ANSWER: 10 (ACCEPT: 10:1)

BONUS

1) Physics – *Short Answer* A battery produces an electrical current of 100 milliamps when connected to a circuit with a resistance of 60 Ohms. The battery is then connected to a 250 millifarad capacitor. How many joules of energy are stored by the capacitor?

ANSWER: 4.5

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### TOSS-UP

2) Math – *Short Answer* In a triple-elimination tournament with 512 contestants, what is the maximum numbers of games played if there are no ties?

ANSWER: 1535

### BONUS

2) Math – *Multiple Choice* A square ABCD has a side length of 10. Point E lies on BC and the area of the triangle ABE is 40. What is the length of BE?

- W) 5
- X) 6
- Y) 7
- Z) 8

ANSWER: Z) 8

### TOSS-UP

3) Energy – *Multiple Choice* A force is conservative when the work done by the force:

- W) On a closed path is zero
- X) On an open path is zero
- Y) Is dependent on the path
- Z) Conserves energy

ANSWER: W) ON A CLOSED PATH IS ZERO

### BONUS

3) Energy – *Short Answer* Consider 0.5 moles of an ideal gas undergoing isobaric expansion from 253 to 353 Kelvin. Assuming that the ideal gas constant is 8.314 joules per mole Kelvin, how much work, in joules rounded to the nearest tenth, is done by the gas?

ANSWER: 415.7

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TOSS-UP

4) Earth and Space – *Short Answer* On a weather map, what type of front is represented by a line with red semicircles extending from one side?

ANSWER: WARM FRONT

BONUS

4) Earth and Space – *Short Answer* What are the two most abundant elements in the Earth's crust?

ANSWER: OXYGEN AND SILICON

TOSS-UP

5) Biology – *Short Answer* What chemical element, that occurs in various forms, is used as a mordant in Gram testing, is used as a method of detecting sugar in Lugol's solution, and is required for proper thyroid function?

ANSWER: IODINE

BONUS

5) Biology – *Short Answer* What specific cell type in the stomach is responsible for production of hydrochloric acid in response to stimulation by gastrin?

ANSWER: PARIETAL CELLS

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### TOSS-UP

6) Chemistry – *Short Answer* What is the chemical formula of baking soda?

ANSWER:  $\text{NaHCO}_3$

### BONUS

6) Chemistry – *Multiple Choice* Which of the following elements can stably bond with three atoms, leaving it with an empty *p* orbital?

- W) Sulfur
- X) Oxygen
- Y) Boron
- Z) Helium

ANSWER: Y) BORON

### TOSS-UP

7) Physics – *Short Answer* If a particle's position is defined by the functions  $x = \cos(t)$  and  $y = \sin(t)$ , what conic section describes the overall shape of the particle's path?

ANSWER: CIRCLE

### BONUS

7) Physics – *Short Answer* A 6 kilogram box slides from rest down a frictionless ramp with an incline of 30 degrees. If the box descends a vertical height 1.20 meters to reach the bottom, to the nearest meter per second, what is the speed of the box at the bottom of the ramp?

ANSWER: 5

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TOSS-UP

8) Energy – *Multiple Choice* Which of the following is the primary form through which energy is stored in the liver?

- W) Triglycerides
- X) Glucose
- Y) Amylose
- Z) Glycogen

ANSWER: Z) GLYCOGEN

BONUS

8) Energy – *Short Answer* Betz's Law is used to determine the theoretical power captured by a turbine for what natural resource?

ANSWER: WIND

TOSS-UP

9) Biology – *Multiple Choice* MRSA is an infection by which of the following?

- W) A rod shaped bacteria
- X) A rigid helical bacteria
- Y) A non-rigid helical bacteria
- Z) A spherical bacteria

ANSWER: Z) A SPHERICAL BACTERIA

BONUS

9) Biology – *Short Answer* What type of intercellular junction is used to bind intestinal epithelia so that fluids will not seep between them?

ANSWER: TIGHT JUNCTION

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### TOSS-UP

10) Physics – *Short Answer* For a Ferris wheel that rotates clockwise, what are the directions of the centripetal acceleration and the linear velocity of a cart at the top of the Ferris wheel?

ANSWER: DOWN AND RIGHT

### BONUS

10) Physics – *Short Answer* What is the name of the experiment conducted in the early 1900's, in which electrons were directed at a crystal and then scattered by it, leading to the determination of the wavelength, which agreed with the de Broglie formula?

ANSWER: DAVISSON GERMER EXPERIMENT

### TOSS-UP

11) Math – *Multiple Choice* How many values of  $x$  satisfy the equation  $x - 2$  equals the fraction with numerator  $2x^2 - 8x$  and denominator  $x^2 - 4x$ ?

- W) Zero
- X) One
- Y) Two
- Z) Three

ANSWER: W) ZERO

### BONUS

11) Math – *Short Answer* If July had five Mondays, August must have had five of what day?

ANSWER: THURSDAY

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TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following statements regarding reaction intermediates is true?

- W) There is precisely one reaction intermediate in a one step reaction
- X) Reaction intermediates are local minima on the reaction coordinate scheme
- Y) Reaction intermediates are synonymous with activated complexes
- Z) The concentrations of reaction intermediates cannot influence reaction rate

ANSWER: X) REACTION INTERMEDIATES ARE LOCAL MINIMA ON THE REACTION COORDINATE SCHEME

BONUS

12) Chemistry – *Multiple Choice* Which of the following compounds is produced by the Haber process?

- W) Sulfuric acid
- X) Ammonia
- Y) Sulfur dioxide
- Z) Nitric acid

ANSWER: X) AMMONIA

TOSS-UP

13) Earth and Space – *Multiple Choice* Which of the following types of lava flows results when a volcano erupts underwater?

- W) Pahoehoe lava
- X) A'a lava
- Y) Pillow lava
- Z) Block lava

ANSWER: Y) PILLOW LAVA

BONUS

13) Earth and Space – *Multiple Choice* In which city would you be able to see cirrus clouds at an altitude of 3,000 meters above the surface?

- W) Ft. Lauderdale, Florida
- X) Honolulu, Hawaii
- Y) Barrow, Alaska
- Z) New York, New York

ANSWER: Y) BARROW, ALASKA

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### TOSS-UP

14) Biology – *Short Answer* Identify all of the following three compounds that one would find in an animal cell: 1) D-glucose; 2) L-alanine; 3) L-trehalose.

ANSWER: 1 AND 2

### BONUS

14) Biology – *Multiple Choice* Which of the following is not true regarding the development of multicellular organisms?

- W) Homeotic genes control pattern formation in the late embryo
- X) Proto-oncogenes are often involved in regulation of the cell cycle
- Y) Mutations in proto-oncogenes prevent cancer
- Z) Mutations in tumor suppressor genes often result in cancer

ANSWER: Y) MUTATIONS IN PROTO-ONCOGENES PREVENT CANCER

### TOSS-UP

15) Chemistry – *Multiple Choice* An aqueous solution of dissolved silver nitrate is added to an aqueous solution of dissolved potassium iodide. Which of the following species will not be in the net ionic equation?

- W) Aqueous silver plus one ions
- X) Aqueous nitrate ions
- Y) Solid silver iodide
- Z) Aqueous iodide

ANSWER: X) AQUEOUS NITRATE IONS

### BONUS

15) Chemistry – *Multiple Choice* At which of the following pH values is zinc hydroxide likely to be most soluble?

- W) 2
- X) 4
- Y) 6
- Z) 8

ANSWER: W) 2

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TOSS-UP

16) Math – *Multiple Choice* Which of the following functions will have its n^{th} derivative equal to 0 over its entire domain for sufficiently large values of n ?

- W) $f(x) = x^{100} + \sin x$
- X) $f(x) = x - x^{-1}$
- Y) $f(x) = x^{1001} + x^{1000} + \dots + x^2 + x$
- Z) $f(x) = \ln x - x^2$

ANSWER: Y) $f(x) = x^{1001} + x^{1000} + \dots + x^2 + x$

BONUS

16) Math – *Multiple Choice* The values of y that will satisfy the system of equations $2x^2 + 6x + 5y + 1 = 0$ and $2x + y + 3 = 0$ can be found by solving which of the following equations?

- W) $y^2 + 14y - 7 = 0$
- X) $y^2 + 10y - 7 = 0$
- Y) $y^2 + 8y + 1 = 0$
- Z) $y^2 + y - 12 = 0$

ANSWER: X) $y^2 + 10y - 7 = 0$

TOSS-UP

17) Earth and Space – *Short Answer* Using carbon-14 decay to determine the date of a material is an example of what technique?

ANSWER: RADIOCARBON DATING (ACCEPT: RADIOMETRIC DATING, RADIOACTIVE DATING, CARBON DATING)

BONUS

17) Earth and Space – *Multiple Choice* If you are located at 40° North latitude, when will the Sun appear directly overhead?

- W) Never
- X) Once a year
- Y) Twice a year
- Z) Four times a year

ANSWER: W) NEVER

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### TOSS-UP

18) Energy – *Multiple Choice* A gas expands isothermally against a vacuum, where external pressure equals zero. Which of the following statements is not true regarding this process?

- W)  $\Delta E$  equals zero
- X)  $\Delta H$  equals zero
- Y)  $\Delta S$  equals zero
- Z) No work is done by the gas

ANSWER: Y)  $\Delta S$  EQUALS ZERO

### BONUS

18) Energy – *Short Answer* By what factor will the net power radiated by a spherical blackbody be multiplied when the temperature is tripled?

ANSWER: 81

### TOSS-UP

19) Biology – *Multiple Choice* Which of the following types of animal viruses is responsible for hepatitis C?

- W) Papovirus
- X) Adenovirus [*add-en-o-virus*]
- Y) Retrovirus
- Z) Flavivirus [*flay-vee-virus*]

ANSWER: Z) FLAVIVIRUS

### BONUS

19) Biology – *Multiple Choice* Which of the following is true regarding the neural crest cells in the amphibian embryo?

- W) They induce formation of the notochord
- X) They develop into the main sections of the brain
- Y) They produce cells that migrate to form teeth and skull bones in the embryo
- Z) They roll up and form the neural tube

ANSWER: Y) THEY PRODUCE CELLS THAT MIGRATE TO FORM TEETH AND SKULL BONES IN THE EMBRYO

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TOSS-UP

20) Physics – *Multiple Choice* A positively-charged tabletop may be approximated as an infinite plane producing a uniform electric field. A positively-charged metal sphere levitates motionlessly above the surface of the table. While keeping the rest of the system unchanged, which of the following parameters may be varied without changing the cancelation of gravity by the electrostatic repulsion?

- W) The mass of the sphere
- X) The radius of the sphere
- Y) The charge of the sphere
- Z) The strength of the electric field produced by the table

ANSWER: X) THE RADIUS OF THE SPHERE

BONUS

20) Physics – *Short Answer* A loop conductor lies partially in a magnetic field. Identify all of the following three changes to this system with a conductor and a magnetic field that would produce a change in the magnetic flux of the system: 1) Increase the strength of the magnetic field; 2) Rotate the conductor, changing the angle between it and the magnetic field; 3) Increase the area of the conductor that is in the field.

ANSWER: ALL OF THEM

TOSS-UP

21) Chemistry – *Short Answer* A student is working up a reaction and discovers, via thin layer chromatography on a silica plate, that there are many side products in her reaction mixture. The student decides to use column chromatography on her reaction mixture, using the same mobile phase as she did for her TLC plate. What stationary phase should she use in order to keep the conditions as similar as possible to the TLC plate?

ANSWER: SILICA (Accept: SILICON DIOXIDE)

BONUS

21) Chemistry – *Multiple Choice* Which of the following is the molecular orbital theory prediction for the bond order of ozone?

- W) 1
- X) 1.5
- Y) 2
- Z) 2.5

ANSWER: X) 1.5

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### TOSS-UP

22) Earth and Space – *Short Answer* What term is used to describe snow that has been left over from the previous year's snowfall and can be considered as an intermediate stage between snow and glacial ice?

ANSWER: FIRN

### BONUS

22) Earth and Space – *Short Answer* For every 10 degree increase on the Celsius temperature scale, how many degrees does the temperature increase on the Fahrenheit scale?

ANSWER: 18

### TOSS-UP

23) Math – *Short Answer* Evaluate the limit, as  $n$  approaches infinity, of the sequence whose  $n^{\text{th}}$  term is  $n^2/3^n$ .

ANSWER: 0

### BONUS

23) Math – *Short Answer* What is the sum of the digits of the square of 111,111,111?

ANSWER: 81