

## HIGH SCHOOL - ROUND 14A

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### TOSS-UP

1) Earth and Space – *Short Answer* What was the most abundant atmospheric gas during the Proterozoic [*proh-tair-oh-ZOH-ik*] Eon?

ANSWER: NITROGEN (ACCEPT: DINITROGEN, N<sub>2</sub>)

### BONUS

1) Earth and Space – *Multiple Choice* A transgressive stratigraphic sequence can be related to which of the following events?

- W) Sea-level rise
- X) Orogeny [*or-AW-jeh-nee*]
- Y) Oxbow lake formation
- Z) Significant rainfall events

ANSWER: W) SEA-LEVEL RISE

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### TOSS-UP

2) Chemistry – *Short Answer* Marie places 4.4 grams of dry ice in a vacuum-sealed 5-liter bag at standard temperature. After the dry ice reaches standard temperature, then, to the nearest tenth of a liter, how much volume will it fill?

ANSWER: 2.2

### BONUS

2) Chemistry – *Short Answer* Identify all of the following three molecules that typically undergo an S<sub>N</sub>1 reaction in the presence of a nucleophile: 1) Methyl-bromide; 2) 2-bromo-propane; 3) Tert-butyl-amine [*turt-BYOO-til-ah-MEEN*].

ANSWER: 2

### TOSS-UP

3) Energy – *Multiple Choice* Scientists at Los Alamos National Lab are measuring the positron flux in Earth's upper atmosphere. Which of the following is NOT TRUE concerning positrons?

- W) They decay into muons
- X) They have a positive charge
- Y) They are first-generation leptons
- Z) They can interact with electrons to generate two gamma rays

ANSWER: W) THEY DECAY INTO MUONS

### BONUS

3) Energy – *Multiple Choice* Lawrence Berkeley National Lab scientists are studying the teeth of parrotfish due to their unique structure. Parrotfish can be classified best as which of the following?

- W) Lobe-finned fish
- X) Hagfish
- Y) Ray-finned fish
- Z) Sharks

ANSWER: Y) RAY-FINNED FISH

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### TOSS-UP

4) Physics – *Short Answer* Consider a circuit in which two light bulbs with equal resistance values are connected in parallel. If one of the light bulbs burns out, by what factor is the brightness of the other bulb multiplied?

ANSWER: ONE

### BONUS

4) Physics – *Short Answer* Consider a 200-newton-meter torque [*tork*] that acts on a solid disk of radius one meter and mass 100 kilograms. What is the angular velocity of the disk after 5 seconds, in radians per second?

ANSWER: 20

### TOSS-UP

5) Math – *Multiple Choice* For a conic section, which of the following values of eccentricity would indicate that the conic section is an ellipse?

- W) 0
- X) 0.5
- Y) 1
- Z) 1.5

ANSWER: X) 0.5

### BONUS

5) Math – *Short Answer* What are the coordinates of the image of the point  $(-1, 5)$  when it is reflected through the line  $y = x - 4$ ?

ANSWER:  $(9, -5)$  (ACCEPT:  $x = 9$  AND  $y = -5$ )

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### TOSS-UP

6) Biology – *Short Answer* What type of connective tissue links muscles to bones?

ANSWER: TENDON

### BONUS

6) Biology – *Short Answer* Identify all of the following three statements that are true of SDS-PAGE: 1) It requires addition of antioxidant to the inner gel chamber; 2) It requires protein denaturation using urea; 3) It relies on SDS binding proportional to protein mass.

ANSWER: 1, 3

### TOSS-UP

7) Earth and Space – *Short Answer* What type of sub-stellar object can fuse deuterium [*doo-TEER-ee-um*] but not hydrogen?

ANSWER: BROWN DWARF

### BONUS

7) Earth and Space – *Short Answer* An asteroid revolves around the Sun every 64 Earth-years. To the nearest whole astronomical unit, what is the semimajor axis of the asteroid?

ANSWER: 16

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### TOSS-UP

8) Physics – *Short Answer* Similar to his famous gold foil experiment, Rutherford bombarded nitrogen-14 atoms with alpha particles, and observed that each event released a proton. Into what isotope was the nitrogen converted?

ANSWER: OXYGEN-17

### BONUS

8) Physics – *Short Answer* A certain steel guitar has strings of length 1 meter and cross sectional area 2 times  $10^{-6}$  square meter. If the Young's modulus of steel is 2 times  $10^{11}$  newtons per square meter, then in newtons, what is the tension in the string when it is stretched 0.02 meter for tuning?

ANSWER: 8000

### TOSS-UP

9) Biology – *Multiple Choice* The organisms that form arbuscular mycorrhizae are part of what group of fungi?

- W) Chytrids [*KIH-trids*]
- X) Glomeromycetes [*glo-mair-oh-MY-seets*]
- Y) Basidiomycetes [*bah-sid-ee-oh-MY-seet*]
- Z) Ascomycetes

ANSWER: X) GLOMEROMYCETES

### BONUS

9) Biology – *Short Answer* Starting with the fixation of atmospheric nitrogen and ending with the assimilation of nitrogen compounds by plants, order the following three ions of the nitrogen cycle chronologically: 1) Ammonium; 2) Nitrate; 3) Nitrite.

ANSWER: 1, 3, 2

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### TOSS-UP

10) Math – *Multiple Choice* The graph of a continuous function  $f$  contains the points  $(3, -6)$  and  $(8, -4)$ . The intermediate value theorem guarantees an  $x$ -value such that  $f$  of  $x$  equals which of the following?

- W)  $-5$
- X)  $-2$
- Y)  $2$
- Z)  $5$

ANSWER: W)  $-5$

### BONUS

10) Math – *Short Answer* How many zeroes occur at the right of the number of permutations of 60 objects taken 20 at a time?

ANSWER: 5

### TOSS-UP

11) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are studying O-linked glycosylation [*glye-kaw-sil-AY-shun*] of the tau protein. This post-translational process plays a role in the pathogenesis [*path-oh-JEN-eh-sis*] of what human disease?

ANSWER: ALZHEIMER'S DISEASE

### BONUS

11) Energy – *Short Answer* Scientists at Pacific Northwest National Lab are studying cytokine [*SIGH-toh-KINE*] production during disease. Identify all of the following three statements that are true of cytokines: 1) They are peptides; 2) They are transcription factors and signal via diffusing through the cell membrane; 3) They can be released by T cells.

ANSWER: 1, 3

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### TOSS-UP

12) Chemistry – *Multiple Choice* Which of the following could be the products of anaerobic fermentation of glucose?

- W) Ethanol and water
- X) Acetone and water
- Y) Ethanol and carbon dioxide
- Z) Acetone and carbon dioxide

ANSWER: Y) ETHANOL AND CARBON DIOXIDE

### BONUS

12) Chemistry – *Short Answer* Identify all of the following three ligands that are considered bidentate: 1) Oxalate; 2) Ethylene-diamine; 3) Cyanide.

ANSWER: 1, 2

### TOSS-UP

13) Biology – *Multiple Choice* Which of the following organisms is the primary infection target of the virus T2?

- W) *E. coli*
- X) *S. cerevisiae*[*sarah-VIH-see-ay*]
- Y) *D. melanogaster*[*meh-LAN-oh-gas-tur*]
- Z) *M. musculus*

ANSWER: W) E. COLI

### BONUS

13) Biology – *Short Answer* What microsatellite genetic markers do forensic scientists typically use for crime scene DNA analysis?

ANSWER: STRs (ACCEPT: SHORT TANDEM REPEATS)

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### TOSS-UP

14) Math – *Short Answer* Find the value of  $a$  for which the following vectors are perpendicular:  $9\mathbf{i} - 3\mathbf{j}$  and  $a\mathbf{i} + 36\mathbf{j}$ .

ANSWER: 12

### BONUS

14) Math – *Short Answer* The graph of  $f$  of  $x =$  the fraction with numerator  $x^2 - 2x - 24$  and denominator  $x^2 - 16$  has a removable discontinuity at  $x = a$  for some real number  $a$ . What is the limit as  $x$  approaches  $a$  of  $f$  of  $x$ ?

ANSWER: 5/4 (ACCEPT: 1¼, 1.25)

### TOSS-UP

15) Energy – *Short Answer* Scientists at Brookhaven National Lab use the Relativistic Heavy Ion Collider to study a state of matter thought to have also existed in the early universe. This matter is composed of quarks and what other strongly-interacting fundamental particles?

ANSWER: GLUONS

### BONUS

15) Energy – *Short Answer* Researchers at Princeton Plasma Physics Lab are studying the Alpha Centauri star system. This system contains how many stars?

ANSWER: THREE

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### TOSS-UP

16) Physics – *Multiple Choice* In a rectifier, which of the following pairs of current types describes the input and output of the device, respectively?

- W) DC-AC
- X) DC-DC
- Y) AC-DC
- Z) AC-AC

ANSWER: Y) AC-DC

### BONUS

16) Physics – *Short Answer* One mole of an ideal monatomic gas has a net energy change of 1245 joules. To one significant figure and in degrees Celsius, how much does its temperature change?

ANSWER: 100



### TOSS-UP

17) Earth and Space – *Multiple Choice* What type of drainage pattern will develop on bedrock that is highly jointed?

- W) Radial
- X) Dendritic [*den-DRIH-dik*]
- Y) Rectangular
- Z) Deltaic [*del-TAY-ik*]

ANSWER: Y) RECTANGULAR

### BONUS

17) Earth and Space – *Multiple Choice* In which of the following locations would histosols most likely be found?

- W) Desert
- X) Peat bog
- Y) Boreal [*BOAR-ee-ul*] forest
- Z) Subhumid climate

ANSWER: X) PEAT BOG

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### TOSS-UP

18) Chemistry – *Multiple Choice* X-rays with a wavelength of 150 picometers are scattered at an angle of 15 degrees by a crystal. Assuming that this was first-degree scattering, which of the following is closest to the spacing in this crystal, in picometers?

- W) 145
- X) 155
- Y) 290
- Z) 589

ANSWER: Y) 290

### BONUS

18) Chemistry – *Short Answer* Identify all of the following three numbers of  $\pi$  [*pie*]-electrons in a conjugated planar cyclic system that would make that system aromatic: 1) Four; 2) Five; 3) Six.

ANSWER: 3

**TOSS-UP**

19) Math – *Short Answer* A prism with 24 edges has how many faces?

ANSWER: 10

**BONUS**

19) Math – *Short Answer* For the arithmetic sequence with first term 2 and fifth term 22, what is the sum of the first 60 terms?

ANSWER: 8970

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**TOSS-UP**

20) Earth and Space – *Short Answer* What stellar spectral class tends to have the strongest singly-ionized helium absorption lines?

ANSWER: O [*Oh*]

**BONUS**

20) Earth and Space – *Short Answer* The C-N-O process in massive stars is responsible for fusing what element into heavier nuclides?

ANSWER: HYDROGEN

### TOSS-UP

21) Physics – *Short Answer* What model of the nucleus, developed by George Gamow [*GAMM-off*], suggested that nucleons were held together primarily by short-range interactions?

ANSWER: LIQUID DROP MODEL

### BONUS

21) Physics – *Short Answer* As the number of degrees of freedom of motion of an ideal gas increases, what does its adiabatic [*ad-ee-ah-BAT-ik*] index asymptotically [*ay-sim-TOT-ik-lee*] tend to?

ANSWER: ONE

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### TOSS-UP

22) Chemistry – *Short Answer* Identify all of the following three chemical reactions that are likely to be spontaneous at room temperature: 1) Solid sodium combines with chlorine gas to form solid sodium chloride; 2) Gaseous nitrogen combines with gaseous hydrogen to form gaseous ammonia; 3) Solid potassium iodide dissolves into potassium and iodide ions.

ANSWER: 1, 3

### BONUS

22) Chemistry – *Short Answer* Consider a reaction that is nonspontaneous at 300 kelvins, but becomes spontaneous when the temperature is raised to 400 kelvins. Identify all of the following three values that are positive for this reaction at 300 kelvins: 1) Delta-H; 2) Delta-S; 3) Delta-G.

ANSWER: 1, 2, AND 3 (ACCEPT: ALL)

### TOSS-UP

23) Biology – *Short Answer* If the sinoatrial *[SIGH-no-AY-tree-ul]* node fails, what tissue will be responsible for setting the pace of the heart?

ANSWER: AV NODE (ACCEPT: ATRIOVENTRICULAR NODE)

### BONUS

23) Biology – *Short Answer* Identify all of the following three statements that are true of eukaryotic mRNA processing: 1) The 5-prime end is capped with a modified cytosine *[sigh-toh-seen]* residue; 2) The 5-prime end is capped in the nucleus; 3) The 3-prime end is adenylated in the cytosol.

ANSWER: 2