

HIGH SCHOOL - ROUND 6A

TOSS-UP

1) Energy – *Short Answer* Researchers at Brookhaven National Lab are studying the replisome, which replicates DNA. What protein in the replisome is responsible for unwinding the DNA double helix?

ANSWER: HELICASE

BONUS

1) Energy – *Short Answer* Scientists at SLAC National Accelerator Lab are analyzing data from the Fermi space telescope that performs astronomy in what part of the electromagnetic spectrum?

ANSWER: GAMMA RAY (ACCEPT: GAMMA)

TOSS-UP

2) Earth and Space – *Multiple Choice* What is the name for slow and gradual displacement of rock layers that occurs without the accumulation of significant strain?

- W) Fault rupture
- X) Fault break
- Y) Fault creep
- Z) Fault walk

ANSWER: Y) FAULT CREEP

BONUS

2) Earth and Space – *Short Answer* Identify all of the following three physical properties that are exhibited by both gypsum and halite [*HAY-lite*]: 1) Glassy or vitreous luster; 2) White streak; 3) Three cleavage planes at right angles to one another.

ANSWER: 1, 2

TOSS-UP

3) Math – *Short Answer* What is the distance between the points $(-1, 4)$ and $(-10, 6)$?

ANSWER: $\sqrt{85}$

BONUS

3) Math – *Short Answer* A triangle with integer side lengths has longest side that is 4 times as long as a second side, and the third side has length 30. What is the greatest possible perimeter of the triangle?

ANSWER: 75

TOSS-UP

4) Biology – *Short Answer* A sphygmomanometer [*sfig-moh-man-AW-meh-tur*] is a medical device that measures what vital sign?

ANSWER: BLOOD PRESSURE

BONUS

4) Biology – *Short Answer* In mRNA synthesis, what enzyme reads the DNA and synthesizes the strand of RNA?

ANSWER: RNA POLYMERASE [*pah-LIM-er-ace*]

TOSS-UP

5) Chemistry – *Multiple Choice* Which of the following is closest to the percent by mass of chloroform that is carbon?

- W) 10
- X) 16
- Y) 20
- Z) 25

ANSWER: W) 10

BONUS

5) Chemistry – *Multiple Choice* A buffered aqueous system contains 0.02 molar ammonia and 0.2 molar ammonium. Which of the following is closest to the pH of this system?

- W) 8.3
- X) 9.3
- Y) 10.3
- Z) 12.3

ANSWER: W) 8.3

TOSS-UP

6) Physics – *Short Answer* In meters, how far does a 10-kilogram mass that is dropped from rest travel in 10 seconds?

ANSWER: 490

BONUS

6) Physics – *Short Answer* A positively charged particle is traveling in the positive direction along the line $y = x$ in the presence of a constant B field pointing in the positive x direction. In what direction is the Lorentz [*lohr-ENZ*] force on the particle pointing?

ANSWER: NEGATIVE Z

TOSS-UP

7) Energy – *Multiple Choice* Researchers at Oak Ridge National Lab use pulsed laser light to induce thermal stress. This enables them to study the behavior of what type of excitation that plays an important role in many of the physical properties of solids?

- W) Photon
- X) Phonon
- Y) Neutron
- Z) X-ray

ANSWER: X) PHONON

BONUS

7) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab are revisiting the BaBar [**BAH-bur**] collaboration to look for data pertaining to the material that is thought to compose 85% of the mass in the universe. What is the term for this material?

ANSWER: DARK MATTER

TOSS-UP

8) Earth and Space – *Multiple Choice* What kind of trajectory will a comet follow if it has the minimum amount of energy needed to escape its star?

- W) Circular
- X) Elliptical
- Y) Parabolic
- Z) Hyperbolic

ANSWER: Y) PARABOLIC

BONUS

8) Earth and Space – *Short Answer* In what layer of the Earth's atmosphere do auroras primarily occur?

ANSWER: THERMOSPHERE

TOSS-UP

9) Chemistry – *Short Answer* What is the chemical formula of ethylene, the simplest alkene [*al-KEEN*]?

ANSWER: C₂H₄

BONUS

9) Chemistry – *Short Answer* What is the maximum number of stereoisomers [*stereo-EYE-soh-murs*] possible for a molecule that contains 6 stereocenters?

ANSWER: 64

TOSS-UP

10) Biology – *Short Answer* Dinoflagellates [*DYE-no-FLAJ-ihl-ates*] have been identified as one of the main sources of what deadly marine phenomenon?

ANSWER: RED TIDE (ACCEPT: HARMFUL ALGAL BLOOM)

BONUS

10) Biology – *Short Answer* Order the following four sections of the spine from the most superior to the most inferior: 1) Lumbar; 2) Cervical; 3) Sacral; 4) Thoracic [*thor-ASS-ik*].

ANSWER: 2, 4, 1, 3

TOSS-UP

11) Math – *Multiple Choice* Which of the following is equivalent to $\sin 47^\circ \cos 11^\circ - \cos 47^\circ \sin 11^\circ$?

- W) $\sin 36^\circ$
- X) $\cos 36^\circ$
- Y) $\sin 58^\circ$
- Z) $\cos 58^\circ$

ANSWER: W) $\sin 36^\circ$

BONUS

11) Math – *Short Answer* What is the remainder when $2x^4 + 3x^3 - 7x - 3$ is divided by $x + 3$?

ANSWER: 99

TOSS-UP

12) Physics – *Short Answer* Winds flowing from high to low pressures on the Earth appear to be deflected to the right in the Northern hemisphere because of what effect?

ANSWER: CORIOLIS

BONUS

12) Physics – *Short Answer* How much elastic energy, in joules, is stored in a spring that is displaced 10 centimeters from the equilibrium point, if its natural frequency of oscillation is 10 radians per second and the mass on its end is 1 kilogram?

ANSWER: 0.5 (ACCEPT: 1/2)

TOSS-UP

13) Energy – *Short Answer* Scientists at Lawrence Livermore National Lab have devised an improved method for hydrogen production from water by using cheap transition-metal dichalcogenides [*dye-KAL-koh-jen-eyeds*]. What is the name of this process for hydrogen production that involves splitting water into its components?

ANSWER: ELECTROLYSIS

BONUS

13) Energy – *Short Answer* Scientists at Princeton Plasma Physics Lab are building the world's largest stellarator, which is used to confine what phase of matter?

ANSWER: PLASMA

TOSS-UP

14) Earth and Space – *Multiple Choice* Which of the following minerals is not typically found in granite?

- W) Olivine [*AW-liv-een*]
- X) Plagioclase [*PLAY-jee-oh-klaze*]
- Y) Quartz
- Z) Hornblende

ANSWER: W) OLIVINE

BONUS

14) Earth and Space – *Short Answer* Arrange the following three colors of light in order of increasing depth of penetration in average seawater: 1) Violet; 2) Red; 3) Yellow.

ANSWER: 2, 3, 1

TOSS-UP

15) Physics – *Short Answer* If silicon is doped with boron, it becomes what type of semiconductor?

ANSWER: P-TYPE (ACCEPT: P)

BONUS

15) Physics – *Short Answer* A rocket propels itself with 50 newtons of force directed completely horizontally. If its net acceleration is directed 30 degrees downward with respect to the horizontal, then to the nearest kilogram, what is the mass of the rocket?

ANSWER: 3

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**TOSS-UP**

16) Biology – *Short Answer* What type of RNA carries amino acids to the ribosomes?

ANSWER: tRNA (ACCEPT: TRANSFER RNA, TRANSFER)

**BONUS**

16) Biology – *Multiple Choice* Which of the following best describes the reason for the similarity between the wing of a bird and the wing of an insect?

- W) Convergent evolution
- X) Divergent evolution
- Y) Adaptive selection
- Z) Stabilizing selection

ANSWER: W) CONVERGENT EVOLUTION



**TOSS-UP**

17) Math – *Short Answer* Six is one-third percent of what number?

ANSWER: 1800

**BONUS**

17) Math – *Short Answer* A student club sells tickets to a school play. They sell 683 tickets, averaging 14.8 tickets per member, rounded to the nearest tenth. How many members are in the club?

ANSWER: 46

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**TOSS-UP**

18) Chemistry – *Short Answer* What is the name of the ionic salt with chemical formula  $\text{Fe}(\text{IO}_4)_3$ ?

ANSWER: IRON(III) PERIODATE (ACCEPT: FERRIC PERIODATE)

**BONUS**

18) Chemistry – *Short Answer* Identify all of the following three sulfate salts that are soluble in water: 1) Zinc sulfate; 2) Aluminum sulfate; 3) Iron(III) sulfate.

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

### TOSS-UP

19) Earth and Space – *Short Answer* Edwin Purcell won the Nobel Prize in Physics for detecting the 21-centimeter spectral line originating from what element?

ANSWER: HYDROGEN

### BONUS

19) Earth and Space – *Short Answer* What planet in our solar system is the only planet to have an orbital inclination to the ecliptic of greater than 4 degrees?

ANSWER: MERCURY

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### TOSS-UP

20) Physics – *Short Answer* What physical quantity is defined as force integrated over a time interval?

ANSWER: IMPULSE

### BONUS

20) Physics – *Short Answer* Two capacitors, both with capacitance  $C$ , are initially charged such that they have voltages of 1.5 volts and 3.5 volts, respectively. If the positive plates are connected to each other, and the negative plates are also connected to each other, then, in volts, what is the total voltage across the system?

ANSWER: 2.5

**TOSS-UP**

21) Math – *Short Answer* In the integers mod 8, what is  $7 + 5$ ?

ANSWER: 4

**BONUS**

21) Math – *Short Answer* If the line tangent to the graph of the differentiable function  $f$  of  $x$  at the point  $(-3, 5)$  passes through the point  $(4.5, -4)$ , then what is  $f'$  of  $x$  when  $x = -3$ ?

ANSWER:  $-6/5$  (ACCEPT:  $-1\ 1/5$ ,  $-1.2$ )

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**TOSS-UP**

22) Chemistry – *Short Answer* Benzene demonstrates what special type of conjugation due to its 6 pi [*pie*] electrons?

ANSWER: AROMATICITY (ACCEPT: AROMATIC)

**BONUS**

22) Chemistry – *Short Answer* Which of the electron's quantum numbers corresponds to the size and energy of the orbital?

ANSWER: PRINCIPAL (ACCEPT: N)

### TOSS-UP

23) Biology – *Short Answer* In female mammals, one of the two X chromosomes will be deactivated to form what structure?

ANSWER: BARR BODY

### BONUS

23) Biology – *Short Answer* How many different human aminoacyl [*ah-MEE-no-ASS-il*]-tRNA synthetases are there to charge the 45 different tRNA molecules?

ANSWER: TWENTY