

HIGH SCHOOL - ROUND 17A

TOSS-UP

1) Earth and Space – *Multiple Choice* Which of the following stars has a positive apparent magnitude?

- W) Polaris
- X) Sirius
- Y) Canopus
- Z) The Sun

ANSWER: W) POLARIS

BONUS

1) Earth and Space – *Multiple Choice* Which of the following assumptions is typically made when performing potassium-argon dating?

- W) Potassium-40 only decays into argon-40
- X) Some percentage of argon-40 produced by decay leaks out of the rock
- Y) Potassium-40 has a half-life of 1.3 million years
- Z) All argon-40 in a rock was produced by potassium-40 decay

ANSWER: Z) ALL ARGON-40 IN A ROCK WAS PRODUCED BY POTASSIUM-40 DECA Y

TOSS-UP

2) Math – *Short Answer* A set of test scores is normally distributed with mean 62 and standard deviation 8. What score corresponds to a Z-score of -1.25 ?

ANSWER: 52

BONUS

2) Math – *Short Answer* What is the sum of the squares of the first 19 positive integers?

ANSWER: 2470

TOSS-UP

3) Chemistry – *Short Answer* Rank the following three atoms in terms of increasing atomic radius: 1) Argon; 2) Fluorine; 3) Lithium.

ANSWER: 2, 1, 3

BONUS

3) Chemistry – *Short Answer* Grignard [*GRIN-yerd*] reagents are generally made in ether-based solvents due to the instability of the metal-organic species. Identify all of the following three solvents that are considered ethereal: 1) Dioxane;
2) Tetrahydrofuran [*tetrah-high-droh-FYOOR-an*]; 3) Dichloromethane.

ANSWER: 1, 2

TOSS-UP

4) Physics – *Multiple Choice* An electron is moving along the x -axis in the positive direction, within a uniform magnetic field that is oriented toward the positive z -axis. In which of the following directions does the Lorentz [*lohr-ENZ*] force act?

- W) Positive y -axis
- X) Negative y -axis
- Y) Positive z -axis
- Z) Negative z -axis

ANSWER: W) POSITIVE y -AXIS

BONUS

4) Physics – *Short Answer* A hollow pipe closed at both ends has a fundamental frequency of 100 hertz. In meters, what is the length of the pipe?

ANSWER: 1.7

TOSS-UP

5) Biology – *Short Answer* What iron-containing proteins are the main enzymes associated with the metabolism of drugs and toxins in the liver?

ANSWER: CYTOCHROME P450 (ACCEPT: CYP)

BONUS

5) Biology – *Multiple Choice* Which of the following amino acids is typically phosphorylated [*faws-FOR-il-ated*] by protein kinase A?

- W) Tyrosine
- X) Serine
- Y) Tryptophan
- Z) Isoleucine

ANSWER: X) SERINE

TOSS-UP

6) Energy – *Short Answer* Oak Ridge National Lab is contributing to the production of cancer radiation treatments by producing actinium-227, which undergoes two decay transitions to become the medically-useful isotope radium-223. What two types of decay does actinium-227 undergo to become radium-223?

ANSWER: BETA AND ALPHA (ACCEPT: ALPHA AND BETA)

BONUS

6) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab have been studying crystallized biomolecules with electron microscopy. In one type of experiment, the samples are immersed in liquid nitrogen to form vitreous ice before imaging. What type of electron microscopy is this?

ANSWER: CRYOELECTRON MICROSCOPY (ACCEPT: CRYO, CRYO-EM)

TOSS-UP

7) Earth and Space – *Multiple Choice* Which of the following geologic phenomena led to the formation of submarine canyons?

- W) Bioturbation
- X) Tsunamis
- Y) Turbidity currents
- Z) Volcanic eruptions

ANSWER: Y) TURBIDITY CURRENTS

BONUS

7) Earth and Space – *Multiple Choice* Which of Earth's Milankovitch [*mil-AYN-koh-vitch*] cycles has a period of approximately one hundred thousand years?

- W) Axial tilt
- X) Precession
- Y) Eccentricity
- Z) Obliquity

ANSWER: Y) ECCENTRICITY

TOSS-UP

8) Biology – *Multiple Choice* Which of the following hormones most directly affects the metabolic rate of the body?

- W) Thyroid-stimulating hormone
- X) Thyrotropin-releasing hormone
- Y) Triiodothyronine [*try-eye-oh-doh-THIGH-roh-noon*]
- Z) Testosterone

ANSWER: Y) TRIIODOTHYRONINE

BONUS

8) Biology – *Multiple Choice* Which of the following medications would likely be most effective in treating a human patient with influenza?

- W) Penicillin
- X) Ampicillin
- Y) Zanamivir [*zeh-NAM-ih-veer*]
- Z) Chloroquine [*KLOR-oh-queen*]

ANSWER: Y) ZANAMIVIR

TOSS-UP

9) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are developing thermoelectric materials that can convert thermal energy to electrical energy via what effect?

ANSWER: SEEBECK EFFECT (ACCEPT: PELTIER-SEEBECK EFFECT, DO NOT ACCEPT: PELTIER EFFECT)

BONUS

9) Energy – *Short Answer* Scientists at Lawrence Berkeley National Lab are part of the CUORE collaboration that is attempting to observe what ghostly leptons?

ANSWER: NEUTRINOS

TOSS-UP

10) Math – *Short Answer* What is the absolute value of the complex conjugate of $-6 + i$?

ANSWER: $\sqrt{37}$

BONUS

10) Math – *Short Answer* f of x is a twice-differentiable function such that f prime of x and f double prime of x are both less than 0 for all real numbers. If f of 3 equals 22 and f of 5 equals 17, what is the largest possible integer value for f of 9?

ANSWER: 6

TOSS-UP

11) Physics – *Short Answer* A reading of zero on what two temperature scales refers to absolute zero?

ANSWER: KELVIN AND RANKINE (IN ANY ORDER)

BONUS

11) Physics – *Short Answer* Identify all of the following three types of imaging that depend on ionizing radiation: 1) Magnetic resonance imaging; 2) Computerized tomography [*tom-AW-grafee*]; 3) Positron emission tomography.

ANSWER: 2, 3

TOSS-UP

12) Chemistry – *Short Answer* An aqueous-phase redox reaction has all of its stoichiometric [*stoy-keeoh-MEH-tric*] coefficients doubled. Identify all of the following three quantities that are exactly doubled: 1) Equilibrium constant; 2) Delta-G; 3) Cell potential.

ANSWER: 2

BONUS

12) Chemistry – *Short Answer* Identify all of the following three statements that are true of bonding: 1) Xenon dichloride has a bent molecular geometry; 2) Sulfur dioxide and carbon disulfide have the same molecular geometry; 3) Krypton tetrafluoride has no net dipole moment.

ANSWER: 3

TOSS-UP

13) Biology – *Short Answer* In seeds, what is the term for the layer of sporophyte tissue that envelops and protects the megasporangium [*mega-spor-AYN-gee-um*]?

ANSWER: INTEGUMENT

BONUS

13) Biology – *Short Answer* If blood from an incompatible ABO group is mistakenly transfused, it can agglutinate. What class of antibodies mediates this process?

ANSWER: IgM (ACCEPT: M, IMMUNOGLOBULIN M)

TOSS-UP

14) Physics – *Short Answer* If the temperature of an ideal gas is quadrupled, by what factor is the speed of sound in that gas multiplied?

ANSWER: 2

BONUS

14) Physics – *Short Answer* The position of a particle in meters is described by the function x of t equals t cubed plus $4t$ squared plus $3t$, where t is expressed in seconds. What is the acceleration, in meters per second squared, at time t equals 5?

ANSWER: 38

TOSS-UP

15) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab have designed a fuel rod cladding alloy made of iron, chromium, and aluminum to replace current zirconium alloys. Which of the following must be a property of this cladding?

- W) Converts fast neutrons into thermal neutrons
- X) Converts thermal neutrons into fast neutrons
- Y) Has a high neutron cross-section
- Z) Has a low neutron cross-section

ANSWER: Z) HAS A LOW NEUTRON CROSS-SECTION

BONUS

15) Energy – *Short Answer* Researchers at Oak Ridge National Lab have been examining how glaucoma drugs interact with a human enzyme that converts carbon dioxide and water to bicarbonate. What is the common name of this enzyme?

ANSWER: CARBONIC ANHYDRASE (ACCEPT: HUMAN CARBONIC ANHYDRASE)

TOSS-UP

16) Chemistry – *Multiple Choice* Adding ethyl-magnesium bromide to which of the following would produce a tertiary [*TUR-shee-ary*] alcohol?

- W) A ketone
- X) An aldehyde
- Y) An alkene [*al-KEEN*]
- Z) An ether

ANSWER: W) A KETONE

BONUS

16) Chemistry – *Multiple Choice* Which of the following statements best describes how chlorine adds to an alkene [*al-KEEN*]?

- W) Both chlorine atoms add to the same carbon atom
- X) Chlorine atoms add with syn-stereoselectivity [*sin-stereo-see-lek-TIV-ih-tee*] to adjacent carbon atoms
- Y) Chlorine atoms add with anti-stereoselectivity to adjacent carbon atoms
- Z) Only one chlorine atom adds to the carbon atoms

ANSWER: Y) CHLORINE ATOMS ADD WITH ANTI-STEREOSELECTIVITY TO ADJACENT CARBON ATOMS

TOSS-UP

17) Math – *Short Answer* If a pyramid has 8 vertices, how many edges does it have?

ANSWER: 14

BONUS

17) Math – *Short Answer* What is the smallest positive zero of the function with equation $y = 2 \sin \left(3x + \frac{3\pi}{5} \right)$?

ANSWER: $2\pi/15$ (ACCEPT: $(2/15)\pi$)

TOSS-UP

18) Earth and Space – *Short Answer* What object, as a result of tidal heating, is the most volcanically active body in the solar system?

ANSWER: IO

BONUS

18) Earth and Space – *Multiple Choice* A galaxy is receding from an observer such that the hydrogen alpha line appears to be at 657 nanometers instead of 656.3 nanometers. Which of the following best describes the changes in the beta and gamma lines for this galaxy?

- W) They will both be shifted longer by 0.7 nanometers
- X) They will both be shifted by slightly less than 0.7 nanometers
- Y) They will both be shifted by slightly more than 0.7 nanometers
- Z) They will both be shifted shorter by 0.7 nanometers

ANSWER: X) THEY WILL BOTH BE SHIFTED BY SLIGHTLY LESS THAN 0.7 NANOMETERS

TOSS-UP

19) Physics – *Short Answer* What boson mediates the strong force?

ANSWER: GLUON

BONUS

19) Physics – *Short Answer* Consider a configuration of two identical point charges that are 1 meter apart, and which has a potential energy of 1 joule. To two significant figures and in joules, what is the potential energy of a configuration where four such point charges are placed in a square with side length 1 meter?

ANSWER: 5.4

TOSS-UP

20) Math – *Short Answer* In the integers mod 12, what is 7 times 11?

ANSWER: 5

BONUS

20) Math – *Short Answer* If a , b , and c are the three zeroes of the polynomial $x^3 - 9x^2 + 26x - 24$, what is the product of the three numbers $1 - a$, $1 - b$, and $1 - c$?

ANSWER: -6

TOSS-UP

21) Biology – *Short Answer* What is the term for small, circular RNA molecules that can infect plants?

ANSWER: VIROIDS

BONUS

21) Biology – *Short Answer* Identify all of the following three types of trees that are considered to be gymnosperms: 1) Cycads [*SIGH-cads*]; 2) Conifers; 3) Ginkgos.

ANSWER: ALL OF THEM

TOSS-UP

22) Chemistry – *Short Answer* What functional group is formed when hot sulfuric acid is used to dehydrate an alcohol?

ANSWER: ALKENE [*al-KEEN*]

BONUS

22) Chemistry – *Short Answer* Pourbaix [*poor-BAY*] diagrams show the most stable species in an aqueous electrolyte as a function of what two variables?

ANSWER: pH AND POTENTIAL (ACCEPT: pH AND VOLTAGE)

TOSS-UP

23) Earth and Space – *Short Answer* Lapilli [*lah-PILL-eye*] and cinders are subtypes of what materials that are ejected from volcanoes?

ANSWER: PYROCLAST (ACCEPT TEPHRA, PYROCLASTIC DEBRIS)

BONUS

23) Earth and Space – *Short Answer* Identify all of the following three characteristics that describe regular satellites: 1) Prograde orbit; 2) Low orbital inclination; 3) Low orbital eccentricity.

ANSWER: ALL OF THEM