

HIGH SCHOOL - ROUND 8A

TOSS-UP

1) Math – *Multiple Choice* Which of the following best describes the relationship between the lines with equations $5x + 4y = 20$ and $16x + 20y = 80$?

- W) Parallel
- X) Perpendicular
- Y) Intersecting but not perpendicular
- Z) Coincident

ANSWER: Y) INTERSECTING BUT NOT PERPENDICULAR

BONUS

1) Math – *Short Answer* A right circular cylinder has height 11 and diameter 18. What is its surface area?

ANSWER: 360π

TOSS-UP

2) Chemistry – *Short Answer* What is the systematic name of the compound N_2O_4 ?

ANSWER: DINITROGEN TETROXIDE

BONUS

2) Chemistry – *Multiple Choice* Which of the following alkali metals has the most negative standard reduction potential?

- W) Sodium
- X) Cesium
- Y) Rubidium [*roo-BID-ee-um*]
- Z) Potassium

ANSWER: X) CESIUM

TOSS-UP

3) Energy – *Short Answer* Scientists at Los Alamos National Lab are studying a group of bacterial pumps known as RND efflux pumps, which improve bacteria's resistance to what?

ANSWER: ANTIBIOTICS

BONUS

3) Energy – *Short Answer* Researchers at Los Alamos National Lab have applied machine learning to seismic monitoring to identify when an earthquake will occur. What is the term for the Earth surface location directly above an earthquake?

ANSWER: EPICENTER

TOSS-UP

4) Physics – *Short Answer* Andrew applies an average acceleration of 5 meters per second squared to increase his vehicular velocity from 15 meters per second to 30 meters per second. How much acceleration, in meters per second squared, would he have to apply to perform the same velocity change in half the time?

ANSWER: 10

BONUS

4) Physics – *Short Answer* Given that the reference sound intensity is defined as ten to the negative twelfth watts per meter squared, what is the decibel value for a sound with an intensity of one watt per meter squared?

ANSWER: 120

TOSS-UP

5) Earth and Space – *Multiple Choice* Which of the following statements regarding Earth's core is NOT true?

- W) It contains a liquid outer core and a solid inner core
- X) The inner core has a higher temperature than the outer core
- Y) The inner core is responsible for Earth's magnetic field
- Z) The inner core has a greater density than the outer core

ANSWER: Y) THE INNER CORE IS RESPONSIBLE FOR EARTH'S MAGNETIC FIELD

BONUS

5) Earth and Space – *Short Answer* Rank the following three types of mass wasting in order of increasing rate of movement: 1) Creep; 2) Slump; 3) Rock fall.

ANSWER: 1, 2, 3

TOSS-UP

6) Biology – *Short Answer* What human organ contains the semicircular canals as well as the cochlea [*KOH-klee-ah*]?

ANSWER: EAR

BONUS

6) Biology – *Short Answer* What is the main anion [*AN-eye-on*] that the pancreas secretes into the small intestine to neutralize stomach acid?

ANSWER: BICARBONATE (ACCEPT: HYDROGENCARBONATE)

TOSS-UP

7) Physics – *Short Answer* What semiconductor device was instrumental in replacing vacuum tubes as the basic logical component in digital electronics?

ANSWER: TRANSISTOR

BONUS

7) Physics – *Short Answer* Kevin is standing on a scale in an elevator. As the elevator starts moving, he notices his apparent weight on the scale decrease. Identify all of the following three statements that are true of this system: 1) The elevator is traveling upwards; 2) Kevin's change in apparent weight is dependent on the acceleration of the elevator; 3) Kevin's apparent weight will increase as the elevator stops moving.

ANSWER: 2, 3

TOSS-UP

8) Earth and Space – *Multiple Choice* Saturn's rings are primarily composed of what material?

- W) Siliceous [*sil-IH-shus*] dust
- X) Ice
- Y) Metallic iron
- Z) Hydrogen gas

ANSWER: X) ICE

BONUS

8) Earth and Space – *Short Answer* A telescope's objective lens has a focal length of 90 centimeters, and its eyepiece has a focal length of one-third of a centimeter. What is the telescope's magnifying power?

ANSWER: 270 (ACCEPT: 270 TIMES, 270X)

TOSS-UP

9) Energy – *Multiple Choice* Scientists at SLAC National Lab have developed a way to use diamond anvils to drive chemical reactions using which of the following?

- W) Temperature
- X) Conductivity
- Y) Pressure
- Z) Malleability

ANSWER: Y) PRESSURE

BONUS

9) Energy – *Short Answer* High atmospheric CO₂ concentrations contribute to death of plants by carbon starvation because the resulting high temperatures cause the plants to close their stomata [*stow-MAH-tah*]. This mechanism is an adaptation to regulate what biological process?

ANSWER: TRANSPIRATION (DO NOT ACCEPT: PHOTORESPIRATION)

TOSS-UP

10) Chemistry – *Short Answer* What is the term for isomers that are non-superimposable mirror images of each other?

ANSWER: ENANTIOMERS

BONUS

10) Chemistry – *Short Answer* What type of solid does carbon dioxide form?

ANSWER: MOLECULAR SOLID

TOSS-UP

11) Biology – *Short Answer* How many different human codons code for methionine [*meth-IOH-noon*]?

ANSWER: ONE

BONUS

11) Biology – *Multiple Choice* Operant and classical conditioning are both examples of which of the following forms of learning?

- W) Sensitization
- X) Habituation
- Y) Associative
- Z) Episodic

ANSWER: Y) ASSOCIATIVE

TOSS-UP

12) Math – *Short Answer* If angle ABC is inscribed in a circle and measures 65 degrees, what is the degree measure of arc ABC?

ANSWER: 230

BONUS

12) Math – *Short Answer* What is the sum of the distinct prime factors of 924?

ANSWER: 23

TOSS-UP

13) Earth and Space – *Short Answer* Into what units of geologic time are periods divided?

ANSWER: EPOCHS

BONUS

13) Earth and Space – *Multiple Choice* Which of the following is an example of a porphyroblast [*poor-feh-ROH-blast*]?

W) A fragment of country rock preserved in a granitic intrusion

X) A well-preserved trilobite [*TRY-low-bite*] fossil in shale

Y) A rock deposited on the seafloor from the melting of sea ice

Z) A large garnet in a fine-grained metamorphic schist

ANSWER: Z) A LARGE GARNET IN A FINE-GRAINED METAMORPHIC SCHIST

TOSS-UP

14) Biology – *Short Answer* A plant that is heterozygous [*hetero-ZYE-gus*] for flower color is self-pollinated. What percentage of the offspring will be true-breeding?

ANSWER: 50

BONUS

14) Biology – *Short Answer* Identify all of the following three statements that are true of mitosis: 1) The mitotic spindle begins to form during prophase; 2) Anaphase is the shortest phase of mitosis; 3) Centrosomes are pushed apart by lengthening microtubules.

ANSWER: ALL OF THEM

TOSS-UP

15) Physics – *Short Answer* A backpack weighs 20 newtons on Earth but only 4 newtons on a certain asteroid. In meters per second squared, what is the acceleration due to gravity on this asteroid?

ANSWER: 1.96 (ACCEPT: 49/25, 1 24/25)

BONUS

15) Physics – *Short Answer* Saturn has mass approximately 90 times that of Earth, and a diameter that is 10 times the diameter of Earth. If the escape velocity on Earth is 11.2 kilometers per second, what is the escape velocity in kilometers per second from Saturn's surface?

ANSWER: 33.6

TOSS-UP

16) Chemistry – *Short Answer* What organic compound, which is planar and stabilized by extensive conjugation, has two resonance structures and chemical formula C_6H_6 ?

ANSWER: BENZENE

BONUS

16) Chemistry – *Short Answer* Suppose that at a certain temperature, one mole of chlorine gas and one mole of PCl_3 gas are placed in a 1-liter container, and then equilibrate to form 0.2 moles of PCl_5 gas. What is the K-sub-C value for the gas-phase reaction $PCl_3 + Cl_2$ yields PCl_5 at this temperature?

ANSWER: 5/16 (ACCEPT: 0.3125)

TOSS-UP

17) Math – *Short Answer* Find the value of a for which the following vectors are parallel:
 $8\mathbf{i} - 2\mathbf{j}$ and $a\mathbf{i} + 12\mathbf{j}$.

ANSWER: -48

BONUS

17) Math – *Short Answer* What are the radius and the coordinates of the center of the circle with equation $x^2 - 8x + y^2 + 22y + 87 = 0$?

ANSWER: RADIUS = $5\sqrt{2}$, CENTER = $(4, -11)$ (ACCEPT: $x = 4$ and $y = -11$ for center)

TOSS-UP

18) Energy – *Short Answer* Researchers at Lawrence Berkeley National Lab have discovered a way to increase the sensitivity of NMR and MRI systems using defects in diamond crystals. These defects are due to substitutions of carbon atoms with atoms of which other element?

ANSWER: NITROGEN

BONUS

18) Energy – *Short Answer* Researchers at Argonne National Lab have developed new understanding of the chemical processes that reduce battery capacity. Identify all of the following four units that could be used to describe battery capacity: 1) Milli-amp-hours; 2) Coulomb-hours per second; 3) Coulombs per volt; 4) Watt-hours per liter.

ANSWER: 1, 2

TOSS-UP

19) Earth and Space – *Short Answer* What quantity did Einstein add to his general theory of relativity to "hold back" universal expansion?

ANSWER: COSMOLOGICAL CONSTANT (ACCEPT: LAMBDA, VACUUM ENERGY)

BONUS

19) Earth and Space – *Short Answer* A certain asteroid is orbiting the Sun and has a semi-major axis of 2.5 astronomical units. To the nearest Earth-year, what is the orbital period of this asteroid?

ANSWER: 4

TOSS-UP

20) Physics – *Short Answer* A water storage tank is 20 meters above a garden faucet. In kilopascals, what is the pressure at the faucet?

ANSWER: 196

BONUS

20) Physics – *Short Answer* The Sun is approximately 400 times further away from the Moon than the Earth is. The Sun is also approximately 300,000 times more massive than the Earth. Given these values, and expressing your answer as a decimal to two significant figures, what is the ratio of the Sun's gravitational force on the Moon to Earth's gravitational force on the Moon?

ANSWER: 1.9

TOSS-UP

21) Chemistry – *Short Answer* A balloon is inflated with 10 grams of helium. Under the same conditions, a second balloon is inflated to the same volume with nitrogen. To the nearest gram, what is the mass of nitrogen in the second balloon?

ANSWER: 70

BONUS

21) Chemistry – *Short Answer* What is the hybridization [*HIGH-brih-dye-ZAY-shun*] state of the central atom in oxygen difluoride?

ANSWER: sp^3

TOSS-UP

22) Math – *Short Answer* Name one of the linear factors of $x^2 - 34x - 72$.

ANSWER: $x + 2$ OR $x - 36$ (must give at least one)

BONUS

22) Math – *Short Answer* What is the slope-intercept equation of the line tangent to the graph of $y = x^3 + x + 4$ at the point (1, 6)?

ANSWER: $y = 4x + 2$

TOSS-UP

23) Biology – *Short Answer* What is the term for the "bead" in the "beads on a string" model of eukaryotic DNA?

ANSWER: NUCLEOSOME

BONUS

23) Biology – *Short Answer* Biopolymers, such as amino acid chains, are created via the removal of what molecule from two monomer subunits?

ANSWER: WATER (ACCEPT: H₂O)