

HIGH SCHOOL - ROUND 3A

TOSS-UP

1) Energy – *Short Answer* Scientists at Fermi National Accelerator Lab are upgrading the CMS detector in the LHC. The CMS detector includes a large magnet consisting of a coil wrapped into a tight helix that generates a uniform magnetic field within its coils. What is the general term for this type of magnet?

ANSWER: SOLENOID

BONUS

1) Energy – *Short Answer* Researchers at Pacific Northwest National Lab are studying purple sulfur bacteria, which perform photosynthesis. Unlike in plants, however, their photosynthesis overall reaction does not produce what gas?

ANSWER: OXYGEN (ACCEPT: O₂)

TOSS-UP

2) Earth and Space – *Short Answer* Solar observatories sometimes spot sungrazers, which are manifestations of what type of object?

ANSWER: COMETS

BONUS

2) Earth and Space – *Short Answer* Through how many constellations of the night sky does the ecliptic pass?

ANSWER: 13

TOSS-UP

3) Biology – *Short Answer* What virus is the target of vaccines that are designed to prevent cervical cancer?

ANSWER: HPV (ACCEPT: HUMAN PAPILLOMAVIRUS)

BONUS

3) Biology – *Short Answer* Rotifers can reproduce asexually by having a female organism develop from an unfertilized egg. What is the term for this type of reproduction?

ANSWER: PARTHENOGENESIS

TOSS-UP

4) Chemistry – *Short Answer* What term is used to describe a hydrocarbon that only possesses carbon-carbon single bonds?

ANSWER: SATURATED (ACCEPT: ALKANE)

BONUS

4) Chemistry – *Short Answer* Phosphorous trioxide is misnamed. If the molar mass of phosphorous trioxide is 220 grams per mole and is approximately 56% phosphorous by mass, what is its molecular formula?

ANSWER: P₄O₆

TOSS-UP

5) Physics – *Short Answer* Jan drops a football off a cliff and notes that it takes 4 seconds for it to hit the ground. She throws an identical football from the same height, but with a horizontal velocity of 3.4 meters per second. Assuming the ground is level, how far, in meters, from the base of the cliff will it land?

ANSWER: 13.6

BONUS

5) Physics – *Short Answer* A disk is spinning at 950 rotations per minute. To the nearest ten radians per second, how fast is it spinning?

ANSWER: 100

TOSS-UP

6) Math – *Short Answer* What is $\frac{4}{15}$ divided by $\frac{6}{25}$?

ANSWER: $\frac{10}{9}$ (ACCEPT: $1 \frac{1}{9}$)

BONUS

6) Math – *Short Answer* If x is inversely proportional to y^3 and if $x = 3$ when $y = 4$, what is the value of x when $y = 3$?

Answer: $\frac{64}{9}$ (ACCEPT: $7 \frac{1}{9}$)

TOSS-UP

7) Biology – *Short Answer* Gigantism in humans is typically caused by a tumor in the pituitary gland that produces an excess of what hormone?

ANSWER: HUMAN GROWTH HORMONE (ACCEPT: HGH, GH, GROWTH HORMONE)

BONUS

7) Biology – *Multiple Choice* Alpha- and beta-adrenergic agonists are medications whose structures mimic which of the following hormones?

- W) Insulin
- X) Glucagon
- Y) Acetylcholine
- Z) Epinephrine

ANSWER: Z) EPINEPHRINE

TOSS-UP

8) Chemistry – *Multiple Choice* Which of the following mixtures of solvents would have a negative deviation from Raoult's [*rah-OOLZ*] law?

- W) Water and acetone
- X) Water and ethanol
- Y) Hexane and acetone
- Z) Hexane and pentane

ANSWER: W) WATER AND ACETONE

BONUS

8) Chemistry – *Short Answer* Rank the following three alkanes in increasing order of their melting points: 1) Pentane; 2) Ethane; 3) Nonane.

ANSWER: 2, 1, 3

TOSS-UP

9) Physics – *Short Answer* Identify all of the following three statements that are true of specific gravity: 1) It can be expressed in grams per liter; 2) Some materials can have a negative specific gravity; 3) Aluminum has a positive specific gravity.

ANSWER: 3

BONUS

9) Physics – *Short Answer* Kate pushes a box 3 meters horizontally by applying a 200-newton force at an angle of 60 degrees to the horizontal. In joules, how much work did she do on the box?

ANSWER: 300

TOSS-UP

10) Earth and Space – *Multiple Choice* Which of the following is NOT a geologic period?

- W) Devonian
- X) Jurassic
- Y) Paleogene
- Z) Cenozoic [*SEN-oh-ZOH-ik*]

ANSWER: Z) CENOZOIC

BONUS

10) Earth and Space – *Multiple Choice* Which soil horizon typically contains clay transported from overlying horizons?

- W) A
- X) E
- Y) B
- Z) C

ANSWER: Y) B

TOSS-UP

11) Math – *Short Answer* The graph of the equation $y = 4x + 5$ has points in all quadrants except which one?

ANSWER: 4 (ACCEPT: FOURTH)

BONUS

11) Math – *Short Answer* What is the units digit of 9 to the 66th power?

ANSWER: 1

TOSS-UP

12) Energy – *Short Answer* Researchers at the Joint BioEnergy Institute are searching for temperature-stable cellulase enzymes. What group of extremophiles [*extreme-oh-files*] may contain these enzymes?

ANSWER: THERMOPHILES

BONUS

12) Energy – *Short Answer* Scientists at Oak Ridge National Lab are using neutron spallation to study rocks fractured in the process of fracking. These rocks fractured because they were subjected to what substance at very high pressures?

ANSWER: WATER (ACCEPT: H₂O)

TOSS-UP

13) Chemistry – *Short Answer* What part of a galvanic *[gal-VAN-ik]* cell allows ions to flow between the compartments without mixing of the solutions in those compartments?

ANSWER: SALT BRIDGE (ACCEPT: POROUS DISK)

BONUS

13) Chemistry – *Short Answer* How many radial nodes are in a 5p orbital?

ANSWER: 3

TOSS-UP

14) Math – *Short Answer* What is the second derivative with respect to x of $2x^3 + 4x - 7$?

ANSWER: $12x$

BONUS

14) Math – *Short Answer* A class of 10 students selects a different student of the month each month during February, March, April, and May. In how many different ways can the 4 honored students be selected?

ANSWER: 5040

TOSS-UP

15) Energy – *Short Answer* Observations made with the Laser Interferometer [*inter-feer-AW-meh-ter*] Gravitational-Wave Observatory, or LIGO, mark the dawn of gravitational wave astronomy. What is the ratio of the speed of gravitational waves to the speed of light?

ANSWER: ONE (ACCEPT: ONE TO ONE)

BONUS

15) Energy – *Multiple Choice* In a nuclear reactor, the consumption of uranium fuel results in the production of fission gases. Which of the following noble gases is commonly produced?

- W) Helium
- X) Argon
- Y) Xenon [*ZEE-non*]
- Z) Neon

ANSWER: Y) XENON

TOSS-UP

16) Physics – *Short Answer* Identify all of the following three statements that are true about friction: 1) Friction is a non-conservative force; 2) Tires require friction in order to roll; 3) The coefficient of static friction is typically less than the coefficient of kinetic friction.

ANSWER: 1, 2

BONUS

16) Physics – *Short Answer* Identify all of the following three quantities associated with a test charge in an electrostatic system that are dependent on the magnitude of the charge on the test charge: 1) Electric field; 2) Electrical potential; 3) Electric potential energy.

ANSWER: 3

TOSS-UP

17) Earth and Space – *Multiple Choice* What principle of geology states that sedimentary beds originate as continuous layers that extend in all directions and eventually grade into different sediments or thin out?

- W) Superposition
- X) Original horizontality
- Y) Faunal succession
- Z) Lateral continuity

ANSWER: Z) LATERAL CONTINUITY

BONUS

17) Earth and Space – *Short Answer* Identify all of the following three types of storms that are tropical cyclones: 1) Tornado; 2) Typhoon; 3) Derecho [*de-RAY-cho*].

ANSWER: 2

TOSS-UP

18) Biology – *Short Answer* Pulmonary veins bring blood to what chamber of the mammalian heart?

ANSWER: LEFT ATRIUM

BONUS

18) Biology – *Short Answer* Chytrid [*KIH-trid*] cell walls are supported by what polymer?

ANSWER: CHITIN

TOSS-UP

19) Math – *Short Answer* The point (7, 6) is reflected across the y -axis, and the resulting point is then translated 2 units down. What are the coordinates of the final image point?

ANSWER: (-7, 4) (ACCEPT: $x = -7$ AND $y = 4$)

BONUS

19) Math – *Short Answer* For what values of c is $x = c$ a vertical asymptote for the function f of $x =$ the fraction with numerator $x^2 - 49$ and denominator $2x^2 + 9x - 35$?

ANSWER: $5/2$ (ACCEPT: 2.5, $2\frac{1}{2}$)

TOSS-UP

20) Biology – *Short Answer* The nucleolus in eukaryotic cells is the site of the synthesis of the components of what organelle?

ANSWER: RIBOSOME

BONUS

20) Biology – *Short Answer* Place the following three structures in the order in which air would pass through them during expiration: 1) Pharynx; 2) Larynx; 3) Trachea.

ANSWER: 3, 2, 1

TOSS-UP

21) Physics – *Short Answer* Planet X has the same mass as Earth but one-third of its surface gravitational acceleration. What is the ratio of planet X's radius to Earth's radius?

ANSWER: $\sqrt{3}$ (ACCEPT: $\sqrt{3}$ TO ONE)

BONUS

21) Physics – *Short Answer* Identify all of the following three statements that are true of electric dipoles in an electric field: 1) A non-uniform field can cause translational acceleration; 2) In a uniform field, the net torque is directly proportional to the field strength; 3) In a uniform field, the net force is zero.

ANSWER: ALL OF THEM

TOSS-UP

22) Chemistry – *Short Answer* In organic chemistry, what is the term for a species with empty orbitals that tends to accept electrons in a chemical reaction?

ANSWER: ELECTROPHILE

BONUS

22) Chemistry – *Short Answer* Rank the following three isotopes in terms of increasing number of neutrons; 1) Cobalt-57; 2) Iron-57; 3) Manganese-57.

ANSWER: 1, 2, 3

TOSS-UP

23) Earth and Space – *Short Answer* Ishtar Terra is a surface province on what solar system object?

ANSWER: VENUS

BONUS

23) Earth and Space – *Short Answer* What prominent star in the night sky has the approximate celestial sphere coordinates of 2 hours, 32 minutes right ascension and 89 degrees, 16 minutes declination?

ANSWER: POLARIS (ACCEPT: NORTH STAR, ALPHA URSAE MINORIS)