

Middle School
Set 8

TOSS-UP

1) Math – *Short Answer* Charlie has a rectangular pool in his backyard, with sides of lengths 12 and 8. He wants to add a concrete sidewalk of width 2 around the pool. When he is finished, what is the total area of the sidewalk?

ANSWER: 96

BONUS

1) Math – *Short Answer* If the graph of y equals the second-degree polynomial p of x contains the 3 points $(0, 0)$, $(4, -24)$, and $(6, 0)$, what is p of x ?

ANSWER: $3x^2 - 18x$ (ACCEPT: $y = 3x^2 - 18x$)

TOSS-UP

2) Physical Science – *Short Answer* How many total electrons does an atom of neutral beryllium possess?

ANSWER: 4

BONUS

2) Physical Science – *Short Answer* A 6-ohm and an 8-ohm resistor are connected in parallel, and then this circuit is connected in series to a 5-ohm resistor. In ohms, what is the equivalent resistance of this circuit?

ANSWER: $59/7$ (ACCEPT: $8\ 3/7$)

TOSS-UP

3) Earth and Space – *Short Answer* The Milky Way and many other spiral galaxies have a linear structure passing through the galactic center that then spawns spiral arms. What is the term for this type of spiral galaxy?

ANSWER: BARRED SPIRAL (ACCEPT: SB, SPIRAL BARRED)

BONUS

3) Earth and Space – *Short Answer* Identify all of the following three stellar arrangements that would produce a continuous spectrum:

- 1) A black body;
- 2) A star that is obscured by a cloud of gas;
- 3) A cloud of gas that is excited by radiation from a nearby star.

ANSWER: 1



TOSS-UP

4) Energy – *Multiple Choice* Scientists supported by the Department of Energy are studying vibrational energy levels in molecules. What region of the electromagnetic spectrum are they using to probe these energy levels?

- W) Visible
- X) Ultraviolet
- Y) Radio
- Z) Infrared

ANSWER: Z) INFRARED

BONUS

4) Energy – *Multiple Choice* Scientists supported by the Department of Energy are studying piezoelectricity, which is a phenomenon typically demonstrated by what type of material?

- W) Liquids
- X) Gases
- Y) Ceramics
- Z) Plasmas

ANSWER: Y) CERAMICS

TOSS-UP

5) Life Science – *Multiple Choice* What gene elements are removed from mRNA through the process of splicing?

- W) Poly-A tails
- X) Promoters
- Y) Exons
- Z) Introns

ANSWER: Z) INTRONS

BONUS

5) Life Science – *Multiple Choice* Kate is constructing a cladogram [**KLAD-oh-gram**] that includes angiosperms, conifers, ferns, and mosses. Which of the following is most likely to be an ancestral trait of this cladogram?

- W) Flowers
- X) Stems
- Y) Vasculature
- Z) Seeds

ANSWER: X) STEMS

TOSS-UP

6) Math – *Short Answer* The rate at which a factory packs boxes is proportional to the square of the number of people working. If one person packs 8 boxes an hour, how many boxes will 3 people pack in one hour?

ANSWER: 72

BONUS

6) Math – *Short Answer* What is the largest integer n such that 7 to the n th power divides 50 factorial?

ANSWER: 8

TOSS-UP

7) Physical Science – *Short Answer* What is the term used to describe compounds with the same chemical formula but different arrangements of atoms?

ANSWER: ISOMERS

BONUS

7) Physical Science – *Short Answer* The maximum amount of elemental barium allowed in drinking water by the EPA is 2 milligrams per liter. Barium has an atomic mass of 140 grams per mole. In millimoles and to two significant figures, what is the maximum amount of barium allowed in one liter of drinking water?

ANSWER: 0.014

TOSS-UP

8) Earth and Space – *Short answer* Ferro-magnetic minerals in rocks can record important details of Earth's magnetic field in the past. When these rocks are metamorphosed at high temperatures, they can lose this record. What is the name of the temperature at which this record of Earth's magnetic field is lost?

ANSWER: CURIE TEMPERATURE (ACCEPT: CURIE POINT)

BONUS

8) Earth and Space – *Short answer* Place the following three seafloor regions in order of increasing ocean water depth: 1) Abyssal [*ah-BIS-ul*] plain; 2) Oceanic ridge; 3) Oceanic trench.

ANSWER: 2, 1, 3

TOSS-UP

9) Energy – *Multiple Choice* Scientists at Oak Ridge National Lab are part of a collaboration to study quark-gluon plasma. Which of the following statements is true of gluons?

- W) They are leptons
- X) They are fermions
- Y) They are bosons
- Z) They are mesons

ANSWER: Y) THEY ARE BOSONS

BONUS

9) Energy – *Short Answer* As a part of the DUNE collaboration, Fermilab scientists are searching for neutrinos that only interact with other matter via gravity. What is the term for these neutrinos?

ANSWER: STERILE NEUTRINOS (ACCEPT: INERT NEUTRINOS)

TOSS-UP

10) Life Science – *Short Answer* What is the term for the openings on plant leaves that allow gas exchange with the atmosphere?

ANSWER: STOMATA (ACCEPT: STOMA)

BONUS

10) Life Science – *Short Answer* Place the following three neurons in chronological order of activation during a reflex arc:
1) Interneuron; 2) Motor neuron; 3) Sensory neuron.

ANSWER: 3, 1, 2

TOSS-UP

11) Math – *Short Answer* The point $(-5, 3)$ is reflected through the line $y = x$ and then reflected through the y -axis. What are the coordinates of the resulting point?

ANSWER: $(-3, -5)$ (ACCEPT: $x = -3$ AND $y = -5$)

BONUS

11) Math – *Short Answer* What is the area of a circle that circumscribes a rectangle with sides of lengths 12 and 14?

ANSWER: 85π

TOSS-UP

12) Physical Science – *Multiple Choice* The Archimedes [*ark-ih-MEE-deez*] Principle is most related to which of the following concepts?

- W) Pressure
- X) Energy
- Y) Efficiency
- Z) Buoyancy

ANSWER: Z) BUOYANCY

BONUS

12) Physical Science – *Short Answer* If a mercury barometer reads 760 mm, then, to the nearest whole meter, what value would a water barometer read at the same pressure?

ANSWER: 10

TOSS-UP

13) Earth and Space – *Short Answer* NO_x and SO_x compounds play a significant role in acid rain formation. What are the two primary acids formed by these two groups of compounds?

ANSWER: SULFURIC ACID AND NITRIC ACID (in either order)

BONUS

13) Earth and Space – *Short Answer* Identify all of the following three rock types that are foliated: 1) Marble; 2) Quartzite; 3) Anthracite.

ANSWER: NONE

TOSS-UP

14) Energy – *Short Answer* Scientists at Argonne National Lab are developing lithium-ion battery cathodes that contain manganese instead of what element found in vitamin B12?

ANSWER: COBALT

BONUS

14) Energy – *Multiple Choice* Scientists at SLAC National Accelerator Lab are studying stishovite [*STISH-oh-vyte*]. What process is thought to produce stishovite on the surface of Earth?

- W) Meteorite impact
- X) Lightning strike
- Y) Low-grade metamorphism
- Z) High-grade metamorphism

ANSWER: W) METEORITE IMPACT

TOSS-UP

15) Life Science – *Short Answer* The MAP [*map*] kinase [*KYE-nayse*] pathway is a signaling cascade pathway where successive proteins become activated. Activation of these proteins is mediated by the addition of what inorganic functional group?

ANSWER: PHOSPHATE (ACCEPT: PO_4^{3-})

BONUS

15) Life Science – *Short Answer* Identify all of the following three factors that are density-dependent limiting factors to population growth: 1) Disease; 2) Predation; 3) Competition.

ANSWER: ALL