

Middle School
Set 6

TOSS-UP

1) Energy – *Short Answer* Scientists at Fermi National Accelerator Lab are studying what substance that is thought to be the reason that the expansion of the universe is accelerating?

ANSWER: DARK ENERGY (do not accept: DARK MATTER)

BONUS

1) Energy – *Multiple Choice* Scientists supported by the Department of Energy are studying matter whose properties can be described using the Dirac [*dih-RAHK*] equation. In that sense, this matter is similar to which of the following elementary particles?

- W) Photon
- X) Up quark
- Y) Gluon
- Z) W boson

ANSWER: X) UP QUARK

TOSS-UP

2) Life Science – *Multiple Choice* Root nodules are commonly found in legumes. Which of the following types of plants is an example of a legume?

- W) Pineapple
- X) Tomato
- Y) Maple
- Z) Soybean


ANSWER: Z) SOYBEAN

BONUS

2) Life Science – *Multiple Choice* Base substitutions that occur in coding regions that result in the change from one amino acid to another in the resulting protein are referred to as what type of mutation?

- W) Silent
- X) Nonsense
- Y) Missense
- Z) Insertion

ANSWER: Y) MISSENSE



TOSS-UP

3) Math – *Short Answer* What is the second-smallest positive multiple of 13 with at least three digits?

ANSWER: 117

BONUS

3) Math – *Short Answer* Find the y -coordinates of all points of intersection of the parabola $y = x^2 - 2x - 15$ and the line $y = 2x - 3$.

ANSWER: -7 AND 9

TOSS-UP

4) Physical Science – *Multiple Choice* Jan tosses a football to Nick by exerting a force on the ball with her arm. According to Newton's Third Law, what is the reaction force that opposes Jan's exertion?

- W) Jan's arm exerts a force on her body
- X) The football exerts a force on Jan's arm
- Y) The football exerts a force on Nick's arm when he catches it
- Z) Nick's arm exerts a force on his body when he catches it

ANSWER: X) THE FOOTBALL EXERTS A FORCE ON JAN'S ARM

BONUS

4) Physical Science – *Short Answer* Rank the following three objects in terms of increasing de Broglie [*da-BROY*] wavelength:

- 1) one-kilogram block moving at one meter per second;
- 2) 10-kilogram block moving at one meter per second;
- 3) one-kilogram block traveling at 5 meters per second

ANSWER: 2, 3, 1

TOSS-UP

5) Earth and Space – *Multiple Choice* Which of the following layers of the Sun has the lowest density?

- W) Chromosphere
- X) Corona
- Y) Photosphere
- Z) Radiation zone

ANSWER: X) CORONA

BONUS

5) Earth and Space – *Short Answer* What type of star is thought to be the progenitor star of Type IA *[one-ay]* supernovae?

ANSWER: WHITE DWARF

TOSS-UP

6) Energy – *Multiple Choice* Lawrence Berkeley National Lab scientists are studying the ability of a pill, originally designed to treat radiation poisoning, to remove MRI contrast dyes from the body. Which of the following lanthanide [*LAN-tha-nide*] elements used in these dyes are they hoping to remove?

- W) Lead
- X) Gadolinium [*GAD-oh-LIN-ee-um*]
- Y) Plutonium
- Z) Uranium

ANSWER: X) GADOLINIUM

BONUS

6) Energy – *Short Answer* Scientists at Argonne National Lab are developing lithium-ion batteries that do not contain cobalt. Identify all of the following three features that are advantages of these batteries:
1) Higher energy density; 2) Cheaper raw materials; 3) They are primary cells.

ANSWER: 2

TOSS-UP

7) Life Science – *Short Answer* What peripheral nervous system structures contain neuronal cell bodies and satellite glia, and are often considered nerve relays?

ANSWER: GANGLIA (ACCEPT: GANGLION)

BONUS

7) Life Science – *Short Answer* Mycorrhizae [*MY-koh-RYE-zee*] is an example of a mutualistic relationship between organisms from what two kingdoms?

ANSWER: PLANTAE AND FUNGI (ACCEPT: PLANTS AND FUNGUSES, in either order)

TOSS-UP

8) Math – *Short Answer* For the function f of $x = -6x + 5$, what is f inverse of -43 ?

ANSWER: 8

BONUS

8) Math – *Short Answer* How many positive integers less than 1,000 can be formed using some or all of the digits 1, 2, 3, 4, and 5, at most once each?

ANSWER: 85

TOSS-UP

9) Physical Science – *Short Answer* Organic compounds known as amines are so-named because they possess what element aside from carbon and hydrogen?

ANSWER: NITROGEN

BONUS

9) Physical Science – *Short Answer* When making coffee, Rishi heats up 500 grams of water from 25 degrees Celsius to 90 degrees Celsius. In kilocalories, how much energy does this take?

ANSWER: 32.5 (ACCEPT: 65/2, 32 1/2)

TOSS-UP

10) Earth and Space – *Short Answer* The North American Plate and the Eurasia Plate meet at what specific seafloor feature that passes through Iceland?

ANSWER: MID-ATLANTIC RIDGE

BONUS

10) Earth and Space – *Multiple Choice* Just before a lightning strike, how is charge distributed in a rain cloud?

- W) Negative at the base and top, positive in the center
- X) Positive at the base and top, negative in the center
- Y) Negative at the base, positive at the top
- Z) Positive at the base, negative at the top

ANSWER: Y) NEGATIVE AT THE BASE, POSITIVE AT THE TOP

TOSS-UP

11) Energy – *Short Answer* Scientists at SLAC National Accelerator Lab are studying the oxygen-evolving complex. What molecule does this complex break down to form oxygen?

ANSWER: WATER (ACCEPT: H₂O)

BONUS

11) Energy – *Multiple Choice* Scientists at Argonne National Lab are refining the SIR model. This model is meant to predict what?

- W) Annual rainfall
- X) Disease spread
- Y) Local wind speed
- Z) Stellar evolution rate

ANSWER: X) DISEASE SPREAD

TOSS-UP

12) Life Science – *Multiple Choice* When basophils react to a foreign substance, they secrete a signaling molecule that causes blood vessels to dilate and leak fluid at the site of inflammation. What is this signaling molecule?

- W) Antigen
- X) Histamine
- Y) Lumen
- Z) Pepsin

ANSWER: X) HISTAMINE

BONUS

12) Life Science – *Multiple Choice* Which of the following proteins is the most highly conserved across all living organisms?

- W) Insulin
- X) RNA polymerase [*pah-LIM-er-ace*]
- Y) P53
- Z) Hemoglobin

ANSWER: X) RNA POLYMERASE

TOSS-UP

13) Math – *Short Answer* Two triangles have identical corresponding angle measures. The larger triangle has sides of lengths 9, 11, and 16. The smaller triangle has smallest side of length 5. What is the perimeter of the smaller triangle?

ANSWER: 20

BONUS

13) Math – *Short Answer* What is the polynomial in the variable x with least degree, integer coefficients, and leading coefficient one that has $-3 + \sqrt{7}$ as a zero?

ANSWER: $x^2 + 6x + 2$

TOSS-UP

14) Physical Science – *Short Answer* An example of a fission reaction is the addition of a neutron to uranium-235, producing krypton-92, three neutrons, and an isotope of barium. What is the mass number of the barium isotope?

ANSWER: 141

BONUS

14) Physical Science – *Short Answer* Identify all of the following three waves that are transverse waves: 1) Light; 2) P waves generated by earthquakes; 3) Sound.

ANSWER: 1



TOSS-UP

15) Earth and Space – *Multiple Choice* What type of ocean wave has a typical period of approximately one hundredth of a second?

- W) Tsunami
- X) Tide
- Y) Capillary wave
- Z) Seiche [*saysh*]

ANSWER: Y) CAPILLARY WAVE

BONUS

15) Earth and Space – *Short answer* Swelling soils increase in volume when they are wet due to the presence of what group of minerals?

ANSWER: CLAYS