# Round 9

**TOSSUP**

1) ENERGY *Short Answer* The Alpha Magnetic Spectrometer, or AMS, is an experiment aboard the ISS conducted by CERN that detects antimatter found in cosmic rays. The amount of matter significantly outnumbers the number of antiparticles in our current universe because of an asymmetry in the production of matter and antimatter during the big bang. If, however, equal amounts of matter and antimatter were produced during the big bang, the universe would be filled exclusively with what particle?

ANSWER: PHOTONS

**BONUS**

1) ENERGY *Multiple Choice* Which of the following is the reason dark matter is given its name?

W) It is the matter that composes a perfect black body.
X) It is radiation that is released after a supernova which creates a black dwarf
Y) It doesn't interact with normal matter and especially light.
Z) It is a hypothetical particle just like the Higgs boson but its function is not known yet.

ANSWER: Y) IT DOESN'T INTERACT WITH NORMAL MATTER AND ESPECIALLY LIGHT

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**TOSSUP**

2) BIOLOGY *Multiple Choice* Which of the following statements about R-selected species is not true?

W) R-selected species generally have type III survivorship curves
X) The population of R-selected species generally remains stable and close to the carrying capacity
Y) R-selected species are found in environments with little competition
Z) Density dependent inhibition is not a significant threat to populations of R-selected species

ANSWER: X) THE POPULATION OF R-SELECTED SPECIES GENERALLY REMAINS STABLE AND CLOSE TO THE CARRYING CAPACITY

**BONUS**

2) BIOLOGY *Multiple Choice* Which of the following is correct about a country with a crude birth rate of 20 and a crude death rate of 14?

W) It has a 6 percent population growth rate.
X) It has a 0.6 percent population growth rate.
Y) The population growth rate doesn't depend on crude birth and death rates, and therefore couldn't be determined.
Z) The population growth rate depends on net immigration along with birth and death rates, so it can't be determined with the given data.

ANSWER: Z) THE POPULATION GROWTH RATE DEPENDS ON NET IMMIGRATION AS WELL, SO IT CAN'T BE DETERMINED WITH THE GIVEN DATA.

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**TOSSUP**

3) CHEMISTRY *Multiple Choice* An organic compound has a molecular formula of $C_3H_4$. Which compound below belongs to the same class of hydrocarbons?

W) $C_2H_6$
X) $C_3H_6$
Y) $C_4H_{10}$
Z) $C_2H_2$

ANSWER: Z) $C_2H_2$

**BONUS**

3) CHEMISTRY *Short Answer* The general formula for an alkyne is the same as the one for the cyclo-form of these compounds. Name these compounds.

ANSWER: ALKENE(S)

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**TOSSUP**

4) EARTH AND SPACE *Short Answer* Harlow Shapley calculated the size of the Milky Way galaxies using the period-luminosity relationship of what kinds of stars?

ANSWER: CEPHEID VARIABLES (ACCEPT: VARIABLE)

**BONUS**

4) EARTH AND SPACE *Multiple Choice* Which of the following is not true of population 1 and population 2 stars?

W) Population 1 stars are younger than population 2 stars
X) Population 1 stars have a greater metal content than population 2 stars
Y) Population 1 stars are further away from the galactic plane than population 2 stars
Z) Population 1 stars have nearly circular orbits, while population 2 stars have orbits ranging from nearly circular to highly eccentric.

ANSWER: Y) POPULATION 1 STARS ARE FURTHER AWAY FROM THE GALACTIC PLANE THAN POPULATION 2 STARS

**TOSSUP**

5) BIOLOGY *Short Answer* In the light dependent reactions, electrons often take an alternative pathway that utilizes only photosystem II. What is the name of this pathway?

ANSWER: Cyclic Electron Flow

**BONUS**

5) BIOLOGY *Multiple Choice* The presence of which of the following enzymes or enzyme classes allows for the transfer of 2 electrons and 1 proton from glucose to NAD+ in cellular respiration?

W) Mutase
X) Enolase
Y) Hydro-lyase
Z) Dehydrogenase

ANSWER: Z) DEHYDROGENASE

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**TOSSUP**

6) MATH *Short Answer* What is the sum of the first 10 natural numbers?

ANSWER: 55

**BONUS**

6) MATH *Multiple Choice* What is the sum of the first 30 even numbers?

W) 900
X) 910
Y) 920
Z) 930

ANSWER: Z) 930

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**TOSSUP**

7) PHYSICS *Multiple Choice* Which of the following is most correct about the normal force?

W) It is always equal to the weight
X) It always has the same magnitude as weight but always has a different direction
Y) It forms an action-reaction force pair with weight as stated by Newton's third law
Z) It has the same magnitude as weight only when the surface is level with the ground

ANSWER: Z) IT HAS THE SAME MAGNITUDE AS WEIGHT ONLY WHEN THE SURFACE IS LEVEL WITH THE GROUND

**BONUS**

7) PHYSICS *Multiple Choice* A bow weighing 35 N rests on a surface. If an identical box is placed on top of the first one, what will happen to the normal force on the first box?

W) remains the same
X) decreases to 17.5 N
Y) increases to 70 N
Z) increases to 140 N

ANSWER: Y) INCREASES TO 70 N

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**TOSSUP**

8) ENERGY *Multiple Choice* Scientists at Sandia National Lab have helped to test the purity and effectiveness of hand sanitizer made in a distillery to help with the sanitizer shortage by using gas chromatography. Which pod the following Garas is the most commonly used mobile phase in gas chromatography?

W) Oxygen
X) Helium
Y) Carbon dioxide
Z) Sulfur Hexafluoride

ANSWER: X) HELIUM

**BONUS**

8) ENERGY *Multiple Choice* Researchers at the SLAC National Accelerator Lab are studying how to employ antibodies to prevent the SARS-CoV-2 virus's outer layer called the receptor-binding domain from binding to ACE2. Which of the following does ACE2 regulate?

W) Body temperature
X) Blood oxygen levels
Y) Insulin production
Z) Blood Pressure

ANSWER: Z) BLOOD PRESSURE

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**TOSSUP**

9) EARTH AND SPACE *Multiple Choice* Which of the following is considered the third brightest natural object in the sky?

W) Moon
X) Venus
Y) Mars
Z) Mercury

ANSWER: X) VENUS

**BONUS**

9) EARTH AND SPACE *Short Answer* What is the apparent path that the sun takes across the sky over the year most commonly called?

ANSWER: ECLIPTIC (ACCEPT WORD FORMS)

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**TOSSUP**

10) CHEMISTRY *Multiple Choice* What principle best describes why the 4s subshell is filled before the 3d subshell?

W) Aufbau's Principle
X) Hund's Rule
Y) Pauli Exclusion Principle
Z) Schrodinger's Equation

ANSWER: W) AUFBAU'S PRINCIPLE

**BONUS**

10) CHEMISTRY *Multiple Choice* Although the 6s subshell usually fills before the 5d, which of these elements has a full 5d subshell but not a full 6s subshell?

W) Osmium
X) Iridium
Y) Platinum
Z) Gold

ANSWER: Z) GOLD

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**TOSSUP**

11) BIOLOGY *Multiple Choice* Adipose cells make up what kind of tissue?

W) Epithelial Tissue
X) Connective Tissue

Y) Storage Tissue
Z) Structural Tissue

ANSWER: X) CONNECTIVE TISSUE

**BONUS**

11) BIOLOGY *Multiple Choice* Brown fat, also known as brown adipose tissue, is found within some mammals and contains an exceptionally large amount of mitochondria specialized for heat production. These specialized mitochondria contain thermogenin, an uncoupling agent that allows them to produce more heat than normal mitochondria undergoing cellular respiration. In order for this to occur, thermogenin must affect which of the following parts of cellular respiration?

W) Glycolysis
X) Pyruvate Oxidation
Y) Krebs Cycle
Z) Oxidative Phosphorylation

ANSWER: OXIDATIVE PHOSPHORYLATION

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**TOSSUP**

12) MATH *Multiple Choice* Which of the following is not a reason why an m by n matrix, where m and n may or may not be equal, cannot be invertible?

W) It is not a square matrix
X) Its determinant is zero
Y) Its determinant is negative
Z) It contains fewer than n pivot columns

ANSWER: Y) ITS DETERMINANT IS NEGATIVE

**BONUS**

12) MATH *Short Answer* What is the determinant of the matrix with row 1: 1 2 3, row 2: 0 4 5, row 3: 0 0 6

ANSWER: 24

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**TOSSUP**

13) PHYSICS *Multiple Choice* Which of the following definitions best describes the impulse?

W) Force times displacement
X) Force times velocity

Y) Mass times velocity
Z) Force times time

ANSWER: Z) FORCE TIMES TIME

**BONUS**

13) PHYSICS *Short Answer* Given that the equation of impulse is $2t^3 + t$, where t is time in seconds and impulse is in kg meters per second, find force in, newtons, at 5 seconds.

ANSWER: 151 NEWTONS

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**TOSSUP**

14) ENERGY *Short Answer* Researchers at Idaho National Lab have created the Multi-Mission Radioisotope Thermoelectric Generator, or MMRTG, to power the Perseverance rover. What radioactive isotope will be used in this generator, and has also been used in the Voyager spacecraft.

ANSWER: Plutonium (Pu) - 238

**BONUS**

14) ENERGY *Short Answer* Before constructing the IceCube lab, scientists took ice core samples from Antarctic glaciers. By name or number, each of the following three pieces of information that can be found about the past from these ice cores.

1) Temperature
2) Atmospheric Composition
3) Volcanic Eruptions

ANSWER: ALL

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**TOSSUP**

15) EARTH AND SPACE *Multiple Choice* The ore of which of the following metals is a sulfide mineral called sphalerite?

W) Iron
X) Copper
Y) Zinc
Z) Mercury

ANSWER: Y) ZINC

**BONUS**

15) EARTH AND SPACE *Short Answer* Give, by name or number, each of the following which is a common ore of iron: 1) hematite; 2) ilmenite; 3) goethite; 4) limonite 5) rutile

ANSWER: HEMATITE, GOETHITE, LIMONITE (ACCEPT: 1, 3, 4)

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**TOSSUP**

16) CHEMISTRY *Multiple Choice* What is the ideal final product of the Haber-Bosch process?

W) Nitric acid
X) Hydrogen gas
Y) Ammonium
Z) Ammonia

ANSWER: Z) AMMONIA

**BONUS**

16) CHEMISTRY *Short Answer* In the Ostwald process, ammonia is used to make what corrosive compound?

ANSWER: NITRIC ACID (ACCEPT: $HNO_3$)

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**TOSSUP**

17) BIOLOGY *Multiple Choice* The movement of neurotransmitters across a synapse is an example of which of the following kinds of chemical signaling?

W) Autocrine
X) Endocrine
Y) Paracrine
Z) Mesocrine

ANSWER: Y) PARACRINE

**BONUS**

17) BIOLOGY *Multiple Choice* The bottlenose dolphin, has superficial arteries that are surrounded by veins. What primary advantage does this arrangement provide to the dolphin?

W) It helps reduce the concentration of carbon dioxide in the dolphin's cells.
X) It allows dolphins to release excess heat to their surroundings.

Y) It contributes to the efficiency of the dolphin's excretory system.
Z) It helps reduce heat loss to the surrounding water.

ANSWER: Z) IT HELPS REDUCE HEAT LOSS TO THE SURROUNDING WATER

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**TOSSUP**

18) MATH *Short Answer* Evaluate the integral from -1 to 1 of the function sin(2x).

ANSWER: 0

**BONUS**

18) MATH *Short Answer* Find the slope of tangent line at x = 2.5 of the function $f(x) = 3x^2 + \ln(x) + 9$

ANSWER: 15.4

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**TOSSUP**

19) PHYSICS *Multiple Choice* What quantity is measured in henries and is the property that causes an electromotive force to be generated due to a change in the current flowing?

W) Capacitance
X) Resistance
Y) Inductance
Z) Hysteresis

ANSWER: Y) INDUCTANCE

**BONUS**

19) PHYSICS *Short Answer* Given that the inductance across an inductor is 2 henries and the instantaneous rate of current change is 3 amperes/second, find the instantaneous voltage.

ANSWER: 6 VOLTS

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**TOSSUP**

20) CHEMISTRY *Multiple Choice* Which of the following types of hydrocarbons are saturated?

W) Alkynes

X) Alkenes
Y) Alkanes
Z) Alcohols

ANSWER: Y) ALKANES

**BONUS**

20) CHEMISTRY *Multiple Choice* Which of the following compounds has no chain isomers?

W) Hexane
X) Propane
Y) Butane
Z) Octane

ANSWER: X) PROPANE

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**TOSSUP**

21) MATH *Short Answer* By name or number, identify which of the following 4 options is a negative number. 1) $\log_{0.2}(3)$, 2) $\log_{1/3}(1/5)$, 3) $\log_4(3)$, 4) $\log_2(\log_2(9))$

ANSWER: 1, 3 ($\log_{0.2}(3)$, $\log_4(3)$)

**BONUS**

21) MATH *Short Answer* Given that $ln(\frac{a+b}{2}) = (ln(a) + ln(b))/2$, find the value of b in terms of a.

ANSWER: a

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**TOSSUP**

22) EARTH AND SPACE *Short Answer* What term describes fragments of one rock unit within an igneous rock that have not been derived from the original magma that formed the rock?

ANSWER: XENOLITHS (ACCEPT INCLUSIONS?)

**BONUS**

22) EARTH AND SPACE *Short Answer* The age of invertebrates within the Paleozoic period encompasses what two geologic periods?

ANSWER: ORDIVICIAN, CAMBRIAN

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**TOSSUP**

23) PHYSICS *Short Answer* The fifth harmonic of a standing wave contains how many nodes and antinodes respectively?

ANSWER: 6, 5

**BONUS**

23) PHYSICS *Short Answer* If the fifth harmonic of a standing wave has a frequency of 630 Hz and has a length of 25 meters, what is the speed of a wave with the same frequency and wavelength as the second harmonic of that same standing wave?

ANSWER: 252 m/s