Round 11

TOSS-UP

1) MATH *Multiple Choice* A circle with radius 1 is rolling around a circle with radius 3. After the smaller circle rolls completely around the larger circle, how many revolutions has the smaller circle made?

W) 3
X) 4
Y) 5
Z) 6

ANSWER: X) 4

BONUS

1) MATH *Short Answer* What value of x yields the maximum possible value of the following expression |x-1| + 2|x-2| +…+ 19|x-19| **(the sum of all n times the absolute value of quantity x minus n for n equals 1 to 19)**

ANSWER: 14

TOSS-UP

2) ENERGY *Short Answer* Net primary production, or NPP, is defined as gross primary production minus the energy used by primary producers for their "autotrophic respiration." NPP is stated as the amount of new biomass added in a given period of time. A related value is defined as gross primary production minus the total respiration of all organisms in the system (not just primary producers). This related value is a measure of the total biomass accumulation during the given period of time. What is the name of this related value?

ANSWER: NET ECOSYSTEM PRODUCTION (ALSO ACCEPT: NEP)

BONUS

2) ENERGY *Short Answer* Bacteria can synthesize a type of polymer known as PHA, which they use to store chemical energy. What does PHA stand for?

ANSWER: POLYHYDROXYALKANOATE

TOSS-UP

3) CHEMISTRY *Short Answer* List all of the possible elements that can comprise a homonuclear diatomic molecule

Answer: (in any order): hydrogen, nitrogen, oxygen, fluorine, chlorine, bromine, and iodine (accept: H, N, O, F, C, B, and I (in any order))

BONUS

3) CHEMISTRY *Multiple Choice* Which combinations of dilute aqueous reagents will not form a precipitate?

W) $NaOH + HClO_4$
X) $AgNO_3 + HCl$
Y) $BaBr_2 + NaSO_4$
Z) $ZnI_2 + KOH$

ANSWER:W) $NaOH + HClO_4$

TOSS-UP

4) EARTH AND SPACE *Multiple Choice* Which of the following is NOT an asbestos?

W) Chrysotile
X) Rutile
Y) Tremolite
Z) Actinolite

ANSWER: X) RUTILE

BONUS

4) EARTH AND SPACE *Short Answer* You find a piece of grapelike hematite. What is its crystal habit?

ANSWER: BOTRYOIDAL

TOSS-UP

5) BIOLOGY *Short Answer* By name or number, select all of the following that are members of lophotrochozoa: 1. Cnidaria 2. Rotifera 3. Ectoprocta 4. Annelida 5. Chordata

ANSWER: 2, 3, 4

BONUS

5) BIOLOGY *Short Answer* What class of worms, which has a large, rounded proboscis at the anterior end, is named after the Greek god of fertility?

ANSWER: PRIAPULA

TOSS-UP

6) PHYSICS *Multiple Choice* In the standard model of particle physics, there are two types of Bosons. Scalar bosons encompass the Higgs bosons. What is the name of the type of boson that encompasses the other 4 bosons?

W) Force Bosons
X) Gauge Bosons
Y) Vector Bosons
Z) Normal Bosons

ANSWER: X) GAUGE BOSONS

BONUS

6) PHYSICS *Multiple Choice* Tsar Bomba, the largest nuclear bomb ever detonated, had its tamper changed from uranium to lead to decrease its yield. Which of these is NOT a reason why replacing uranium with lead would decrease the yield of the bomb?

W) Uranium reflects more neutrons than lead
X) Uranium has a higher tensile strength than lead
Y) Uranium is denser than lead
Z) Uranium can undergo a fission reaction more easily than lead

ANSWER: X) URANIUM HAS A HIGHER TENSILE STRENGTH THAN LEAD

TOSS-UP

7) MATH *Short Answer* Two planes are orthogonal to each other. How many lines exist that are a fixed distance 2 from both of these planes?

ANSWER: FOUR

BONUS

7) MATH *Multiple Choice* The seventh term of an arithmetic sequence is 5, and the twelfth term is -15. What is the first term of this sequence?

W) 29
X) 30
Y) 31
Z) 32
Answer: W) 29

TOSS-UP

8) CHEMISTRY *Multiple Choice* Which of the following compounds is insoluble in water?

W) Barium acetate
X) Beryllium acetate
Y) Lead acetate
Z) Silver acetate

ANSWER: X) BERYLLIUM ACETATE

BONUS

8) CHEMISTRY Short Answer Two gases in a chamber are separated by a wall. The volume occupied by one gas within the chamber is 1L at a pressure of 1 atm, while the volume occupied by the second gas is 5L at a pressure of 4 atm. If the wall is removed and both gases are allowed to occupy the entire chamber, what is the total pressure in the chamber in atmospheres?

ANSWER: 3.5 atm

TOSS-UP

9) EARTH AND SPACE *Multiple Choice* What is a streamlined, wind-sculpted landform that is parallel to the wind?

W) Yardang
X) Ventifact
Y) Pingo
Z) Guyot

ANSWER: W) YARDANG

BONUS

9) EARTH AND SPACE *Short Answer* Which of the following is part of an ophiolite? (1) Gabbro (2) Sheeted Dikes (3) Pendodite (4) Pillow basalt

ANSWER: ALL

TOSS-UP

10) ENERGY *Short Answer* NASA's Juno spacecraft has recently discovered sprites and ELVES within Jupiter's atmosphere. Sprites and elves, which also occur in earth's atmosphere, occur above what kind of clouds?

ANSWER: CUMULONIMBUS

BONUS

10) ENERGY *Short Answer* What is the name of the first spacecraft to enter Jupiter's atmosphere, which did so in 1995?

ANSWER: GALILEO

TOSS-UP

11) BIOLOGY *Multiple Choice* Which of the following is not true of sponges?

W) They contain special cells called choanocytes which possess many features like pumping water through the sponge
X) They contain pluripotent archaeocytes
Y) Spicules provide support to sponges and deter predators
Z) Adult sponges are asymmetrical but some are radially symmetrical

ANSWER: X) THEY CONTAIN PLURIPOTENT ARCHAEOCYTES

BONUS

11) BIOLOGY *Short Answer* What is the group of autorhythmic cells located in the wall of the right atrium called?

ANSWER: SINOATRIAL NODE (ACCEPT: SA NODE)

TOSS-UP

12) PHYSICS *Short Answer* What is the rate of change of acceleration called?

ANSWER: JERK (ACCEPT: JOLT, SURGE, LURK)

BONUS

12) PHYSICS *Short Answer* If a camera is directly facing a plane mirror 20 meters away and the camera tries to focus on an image of a chair that is directly facing the mirror and is 13 meters away from the mirror, at what distance, in meters, must the lens of a camera focus to take a picture of the chair?

ANSWER: 33

TOSS-UP

13) CHEMISTRY *Short Answer* What color flame does Sodium produce in a flame test?

ANSWER: YELLOW

BONUS

13) CHEMISTRY *Short Answer* What type of redox reaction occurs when the same element undergoes both reduction and oxidation to form two new products?

ANSWER: DISPROPORTIONATION REACTION

TOSS-UP

14) EARTH AND SPACE *Short Answer* What pressure prevents white dwarfs from collapsing?

ANSWER: ELECTRON DEGENERACY PRESSURE

BONUS

14) EARTH AND SPACE *Multiple Choice* Electron degeneracy pressure arises mostly because of which principle?

W) Pauli Exclusion Principle
X) Heisenberg Uncertainty Principle
Y) Complementarity Principle
Z) Correspondence Principle

ANSWER: W) PAULI EXCLUSION PRINCIPLE

TOSS-UP

15) BIOLOGY *Multiple Choice* What is the volume of air inhaled and exhaled each breath called?

W) Inspiration reserved volume
X) Tidal volume
Y) Residue volume
Z) Vital capacity

ANSWER: X) TIDAL VOLUME

BONUS

15) BIOLOGY *Short Answer* While there are around 20 common amino acids, some 300 additional amino acids have been found in cells. By name or number, select all of the following molecules which are amino acids. 1. 4-hydroxyproline 2. Ornithine 3. Citrulline 4. Pepsin 5. Methyllysine

ANSWER: 1, 2, 3, 5

TOSS-UP

16) PHYSICS *Short Answer* What is the electromagnetic radiation emitted when a charged particle passes through a dielectric medium at a speed greater than the phase velocity of light in that medium.

ANSWER: CHERENKOV RADIATION (VAVILOV–CHERENKOV RADIATION)

BONUS

16) PHYSICS *Short Answer* Most natural laws work backwards in time the same way they do forwards in time. What law is the most notable exception to this?

ANSWER: 2ND LAW OF THERMODYNAMICS

TOSSUP

17) MATH *Multiple Choice:* A rectangle with integer side lengths has a diagonal of length 25. Find the maximum value of the perimeter for the rectangle.
W) 31
X) 35
Y) 62
Z) 70

Answer: Z) 70

BONUS

17) MATH *Multiple Choice:* What is the value of the infinite series $1/1^2 + 1/2^2 + 1/3^2$... **(one over one squared plus one over two squared plus one over 3 squared)?**

ANSWER: $\frac{\pi^{x}}{6}$(**pi squared over six**)

TOSS-UP

18) EARTH AND SPACE *Multiple Choice* The letters WIMP delineate a subsection of astronomy. What does WIMP stand for?

W) Weak intermolecular Piezoelectricity
X) Weakly Interacting Massive Particles
Y) Water Interactions of Maximum Passivity

Z) Wander Interstellar Migrating Planets

ANSWER: X) WEAKLY INTERACTING MASSIVE PARTICLES

BONUS

18) EARTH AND SPACE *Short Answer* You are living by the ocean and have set up a well. What will most likely occur after a cone of depression forms?

ANSWER: SALTWATER INTRUSION

TOSS-UP

19) CHEMISTRY *Short Answer* What element is a brittle metal with a silvery white color when freshly produced, but with surface oxidation takes on a pink tinge. It is the most naturally diamagnetic element. It produces a multicolored stair step crystal, and is element 83.

ANSWER: BISMUTH

BONUS

19) CHEMISTRY *Multiple Choice* What rule or principle states that each orbital in a sublevel must be half-filled before being fully filled?

W) Aufbau Principle
X) Pauli Exclusion Principle
Y) Hund's Rule
Z) Heisenberg Uncertainty Principle

ANSWER: Y) HUND'S RULE

TOSS-UP

20) PHYSICS *Multiple Choice* Which one of the following is believed to prohibit time travel?

W) Causality Principle
X) Chandrasekhar Limit
Y) Loop Theory
Z) Hawking's Third Law

ANSWER: W) CAUSALITY PRINCIPLE

BONUS

20) PHYSICS *Short Answer* What theoretical particle would be able to travel backwards in time?

ANSWER: TACHYON

TOSS-UP

21) BIOLOGY *Short Answer* Synapsids, a group of tetropods from which mammals originated, notably contained what opening behind the eye socket through which powerful cheek muscles passed?

ANSWER: TEMPORAL FENESTRA

BONUS

21) BIOLOGY *Short Answer* Heterochrony, or an evolutionary change in the rate or timing of development, can result in the accelerated development of reproductive organs as opposed to other organs. What is the name of this condition, where a sexually mature organism retains features that were once juvenile structures in ancestral organisms?

ANSWER: PAEDOMORPHOSIS

TOSSUP

22) MATH *Short Answer* What are the last 2 digits in the expansion 7^2020?

ANSWER: 01 (ACCEPT: 0, 1; OR EQUIVALENT FORMS)

BONUS

22) MATH *Multiple Choice* Given that x^2 + y^2 + z^2 = 7, find the minimum value of the expression 3x + 4y + 5z.

W) -84

X) -sqrt(280) [READ: NEGATIVE SQUARE ROOT OF 280]

Y) -sqrt(350) [READ: NEGATIVE SQUARE ROOT OF 350]

Z) -36*sqrt(7) [READ: NEGATIVE 36 TIMES THE SQUARE ROOT OF 7]

ANSWER: Y) -sqrt(350)

TOSS-UP

23) ENERGY *Short Answer* Researchers at SLAC National Accelerator Lab have found a way to increase the efficiency of particle accelerators and make them smaller by utilizing terahertz radiation. What device is conventionally used to accelerate particles and can be contrasted with ferromagnets?

ANSWER: ELECTROMAGNET

BONUS

23) ENERGY *Short Answer* Researchers at SLAC National Accelerator Lab have been studying the formation and interactions of superconductors. According to BCS theory, atoms in superconductors pair up to form bosons so that they might collapse into one quantum state and overcome what principle?

ANSWER: PAULI EXCLUSION PRINCIPLE