ROUND 7

TOSS-UP

1) Physics – *Multiple Choice* Objects A and B start at the same position and have initial velocity in the same direction. Object A has constant acceleration k m/s^2 and initial velocity 2k $\frac{m}{s}$ while object B has constant acceleration 2k $\frac{m}{s^2}$ and initial velocity 0 $\frac{m}{s}$. They are at the same position at time t = 0 seconds and time t = x seconds. Which of the following is the value of x?

W) $\frac{1}{2}$
X) 1
Y) 2
Z) 4

ANSWER: Y) 2

BONUS

1) Physics – *Short Answer* A car has a constant jerk of $1\frac{m}{s^3}$, an initial velocity of 0 and an initial acceleration of 0. How many meters has the car traveled after 12 seconds?

ANSWER: 288

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TOSS-UP

2) Energy – *Short Answer* Scientists at Pacific Northwest National Laboratory are using computer models to study how a specific radionuclide interacts with soil minerals. This research will provide new data on efficient ways to clean up nuclear waste sites. What element is the specific radionuclide that they are studying, which is a major component of the spent fuel rods found at these waste sites?

ANSWER: URANIUM

BONUS

2) Energy – *Multiple Choice* The computer models determine that uranium adheres to aluminum oxide, a common soil mineral, better at a lower pH. Which of the following best explains what effect a more acidic soil at a nuclear waste site will have on the environment.

W) There will be increased rates of cancer in the animals in the area because the plants they consume will absorb more radioactive uranium.
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X) The radioactive waste will be better contained because more uranium binds to the aluminum oxide, making it less mobile.
Y) The radioactive uranium will spread easier throughout the environment because more uranium is bonded to aluminum oxide, which dissolves into nearby streams.
Z) The higher acidity means less uranium will bond to aluminum oxide, so more uranium can be dispersed in the air.

ANSWER: X) THE RADIOACTIVE WASTE WILL BE BETTER CONTAINED BECAUSE MORE URANIUM BINDS TO THE ALUMINUM OXIDE, MAKING IT LESS MOBILE

ROUND 7

TOSS-UP

3) Chemistry – *Short Answer* What is the term for a device that separates objects based on densities, and relying on the centripetal force?

ANSWER: CENTRIFUGE

BONUS

3) Chemistry – *Multiple Choice* If radioactive objects must be stored away from mankind until the radioactivity level is 0.1 % of the initial level, which of the following is closest to the amount of time Potassium - 40 must be stored till it is considered safe?

W) 1.3×10^3 years
X) 1.3×10^5 years
Y) 1.3×10^7 years
Z) 1.3×10^{10} years

ANSWER: Z) 1.3×10^{10} YEARS

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TOSS-UP

4) Biology - *Multiple Choice* Which is not a type of loose connective tissue?

W) Areolar
X) Mesenchyme
Y) Adipose
Z) Reticular

ANSWER: X) MESENCHYME

BONUS

4) Biology - *Short Answer* What is the name of the web-like middle layer of the brain?

ANSWER: ARACHNOID MATER

TOSS-UP
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ROUND 7

5) Math – *Multiple Choice* Given a standard deck of 52 cards, which of the following is the probability that the top card, the second to last card, and the last card are all red?

W) $\frac{1}{8}$
X) $\frac{2}{17}$
Y) $\frac{1}{48}$
Z) $\frac{1}{51}$

ANSWER: X) $\frac{2}{17}$

BONUS

5) Math – *Short Answer* Urn 1 has 4 red balls and 1 white ball. Urn 2 has 3 red balls and 3 white balls. An urn is selected at random and a white ball is drawn. If the ball is put back in the urn and another ball is drawn from the same urn, what is the probability it is red?

ANSWER: $\frac{41}{70}$

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TOSS-UP

6) Earth and Space - *Short Answer* By name or number, identify all of the following 5 terms that are ways wind weathers and/or erodes sand and other material: 1) Deflation, 2) Abrasion, 3) Lithification, 4) Saltation, 5) Blowout.

ANSWER: DEFLATION, ABRASION, SALTATION (ACCEPT 1, 2, 4)

BONUS

6) Earth and Space - *Multiple Choice* Which of the following is true about desert pavement?

W) desert pavement describes the pavement-like cracks in solid material that are at least 2 centimeters deep
X) desert pavement describes the pattern formed when wind deposits material into the crevices carved out by glaciers
Y) desert pavement consists of the remains of a sand dune, typically of the barchan variety
Z) desert pavement consists of a surface layer of coarse pebbles followed by a layer of finer sediments
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ANSWER: Z) DESERT PAVEMENT CONSISTS OF A SURFACE LAYER OF COARSE PEBBLES FOLLOWED BY A LAYER OF FINER SEDIMENTS

ROUND 7

TOSS-UP

7) Energy – *Short Answer* Scientists at Lawrence Berkeley National Laboratory are studying how the deposition of black carbon on snow greatly decreases what property of the snow, which is defined as the amount of incident radiation that is reflected by a surface?

ANSWER: ALBEDO

BONUS

7) Energy – *Short Answer* What is the name for the process that produces black carbon?

ANSWER: INCOMPLETE COMBUSTION

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TOSS-UP

8) Biology - *Multiple Choice* What is the genetic condition, only in males, that is characterized by low testosterone, reduced muscle mass, and enlarged breasts?

W) Jacob Syndrome
X) Turner Syndrome
Y) Klinefelter Syndrome
Z) Fragile X Syndrome

ANSWER: Y) KLINEFELTER SYNDROME

BONUS

8) Biology - *Short Answer* What is the name for the process during meiosis that can result in Klinefelter Syndrome?

ANSWER: NONDISJUNCTION
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ROUND 7

TOSS-UP

9) Physics – *Multiple Choice* Which of the following choices is the highest efficiency Carnot engine given the hot, and cold temperature respectively?

W) 500 K and 298 K
X) 274 K and 234 K
Y) 200 K and 30 K
Z) 500 K and 150 K

ANSWER: Y) 200 K AND 30 K

BONUS

9) Physics – *Short Answer* If an engine has 70% of the efficiency of an ideal engine how much useful energy in joules does it output given a heat input of 5000 J and reservoirs of 200 K and 350 K?

ANSWER: 1500 J

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TOSS-UP

10) Chemistry – *Multiple Choice* What is the name for the bond formed by the lateral overlap of two lobes of an orbital of one atom with two lobes of an orbital of another atom?

W) Sigma
X) Pi
Y) Delta
Z) Phi

ANSWER: PI

BONUS

10) Chemistry – *Short Answer* How many sigma and pi bonds are in the molecule acetic acid?

ANSWER: 7 SIGMA, 1 PI

TOSS-UP
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ROUND 7

11) Math – *Multiple Choice* Daniel can make 4 cuts into a log in 120 minutes. Assuming he works at a constant rate, which of the following is the number of minutes it takes him to cut the log into 32 pieces?

W) 900
X) 960
Y) 990
Z) 930

ANSWER: Z) 930

BONUS

11) Math – *Short Answer* If Aidan and Jeffrey work together, they can paint a house in 4 hours. If Aidan and Mateo work together, they can paint the house in 5 hours. If Jeffrey and Mateo work together, they can paint the house in 6 hours. How many hours will it take to paint the house if Aidan, Mateo, and Jeffey all work together?

ANSWER: $\frac{120}{37}$

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TOSS-UP

12) Earth and Space - *Short Answer* To the nearest integer, how many Schwarzschild radii away from the event horizon is the start of the accretion disk in a black hole?

ANSWER: 0

BONUS

12) Earth and Space - *Short Answer* What is the name for the beams of radiation emitted from large black holes traveling at speeds close to the speed of light, which are a source of cosmic rays?

ANSWER: RELATIVISTIC JETS
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ROUND 7

TOSS-UP

13) Biology - *Multiple Choice* Which of the following has the structure of a double ring nitrogen base with an amine group and is bonded to a ribose sugar?

W) Adenine
X) Adenosine
Y) Guanine
Z) Guanosine

ANSWER: X) ADENOSINE

BONUS

13) Biology - *Multiple Choice* In which type of blotting technique is formaldehyde used to denature the target fragments?

W) Northern Blot
X) Eastern Blot
Y) Southern Blot
Z) Western Blot

ANSWER: W) NORTHERN BLOT

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TOSS-UP

14) Energy – *Short Answer* Researchers at Lawrence Berkeley National Laboratory are studying how atmospheric carbon dioxide can be converted into a solid form where it remains underground. What class of minerals is carbon dioxide converted to, which includes rocks such as limestone?

ANSWER: CARBONATES

BONUS

14) Energy – *Multiple Choice* Which of the following best describes the type of rock that was studied in this research for the formation of carbonates?

W) Porous
X) Intrusive pluton
Y) Extrusive pluton
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Z) Evaporites

ANSWER: W) POROUS

ROUND 7

TOSS-UP

15) Physics – *Multiple Choice* A boy riding a carousel sits on a horse. As he revolves around the center of the carousel, his horse harmonically oscillates up and down. At the moment when the boy is at a node of oscillation on the way up, what is the direction of his acceleration?

W) Up and towards the center of the carousel
X) Down and towards the center of the carousel
Y) Down only
Z) Towards the center of the carousel only

ANSWER: Z) TOWARDS THE CENTER OF THE CAROUSEL ONLY

BONUS

15) Physics – *Multiple Choice* Which choice is closest to the critical angle for a light ray in water, passing through the boundary and into air? Assume the index of refraction of water is 1.33.

W) 40°
X) 50°
Y) 60°
Z) 70°

ANSWER: X) 50°

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TOSS-UP

16) Earth and Space - *Multiple Choice* Which of the following is an extrusive igneous rock?

W) peridotite
X) gabbro
Y) diorite
Z) komatiite

ANSWER: Z) KOMATIITE

BONUS
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16) Earth and Space - *Short Answer* Magmatic differentiation is characterized by different types of rocks forming from the same body of magma. One way this can occur is when the denser crystals that form at higher temperatures on Bowen's reaction series sink, leaving the magma with smaller concentrations of iron and other materials. The magma will now produce rocks with less of some materials and more of others. Give the term for this kind of magmatic differentiation.

ANSWER: CRYSTAL SETTLING

ROUND 7

TOSS-UP

17) Chemistry – *Multiple Choice* Which of the following is not a Lewis Acid?

W) BH_3
X) Cu^{2+}
Y) $B(CH_3)_3$
Z) C_2H_4

ANSWER: Z) C_2H_4

BONUS

17) Chemistry – *Short Answer* What are the products of the reaction of bromomethane and hydroxide?

ANSWER: METHANOL AND BROMIDE (ACCEPT C_2H_5OH AND Br^-)

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TOSS-UP

18) Math – *Short Answer* In triangle ABC, AB = 6, BC = 7, and CA = 12.8. Triangle DEF has DE = 2 * AB, EF = BC, and $m\angle ABC = m\angle DEF$ (READ the measure of angle ABC equals the measure of angle DEF). What is the ratio of the area of triangle ABC to the area of triangle DEF?

ANSWER: $\frac{1}{2}$

BONUS

18) Math – *Short Answer* Triangle JPF has JP = 3, PF = 4 and FJ = 5. Let point A be the foot of the altitude from P to FJ, and point B be the foot of the median from P to FJ. What is the absolute difference in the areas of triangles PAJ and PBJ?

ANSWER: $\frac{21}{25}$
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ROUND 7

TOSS-UP

19) Chemistry – *Short Answer* What is the hybridization of the central atom in XeF_4?

ANSWER: SP^3D^2 (ACCEPT D^2SP^3)

BONUS

19) Chemistry – *Short Answer* What is the electron pair geometry and molecular geometry, respectively, of xenon difluoride?

ANSWER: ELECTRON PAIR GEOMETRY: TRIGONAL BIPYRAMIDAL,
MOLECULAR GEOMETRY: LINEAR

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TOSS-UP

20) Physics – *Short Answer* What is the unit of measure for electrical conductance, originally called mhos because it is the reciprocal unit of resistance?

ANSWER: SIEMENS

BONUS

20) Physics – *Short Answer* Given that the derived unit Siemens is equivalent to an inverse ohm, express the units of Siemens in terms of base SI units.

ANSWER: $m^{-2}\,kg^{-1}\,s^3\,A^2$
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ROUND 7

TOSS-UP

21) Earth and Space - *Multiple Choice* Which of the following is true about the Roche limit?

W) rocks and other material outside the Roche limit usually form clusters
X) rocks and other material outside the Roche limit tend to form rings
Y) the Roche limit is inversely proportional to the square of the density of the satellite
Z) the moon is getting farther and farther away from Earth's Roche limit

ANSWER: W) ROCKS AND OTHER MATERIAL OUTSIDE THE ROCHE LIMIT USUALLY FORM CLUSTERS

BONUS

21) Earth and Space - *Multiple Choice* Consider the moon of Saturn, Titan. By what factor would the Roche limit between Saturn and Titan increase if Saturn's mass doubles while Saturn's volume stays the same?

W) 8
X) 4
Y) 3
Z) $\sqrt[3]{2}$ [Read as the cube-root of two]

ANSWER: Z) $\sqrt[3]{2}$

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TOSS-UP

22) Biology - *Multiple Choice* Which of the following is an example of a modified leaf?

W) Tendril
X) Stolon
Y) Rhizome
Z) Tuber

ANSWER: W) TENDRIL

BONUS

22) Biology - *Multiple Choice* Which of the following cells performs most of the metabolic functions of a plant, synthesizing and storing various organic products?
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W) Sclerenchyma Sclereids
X) Tracheids
Y) Parenchyma Cells
Z) Collenchyma cells

ANSWER: Y) PARENCHYMA CELLS

ROUND 7

TOSS-UP

23) Math – *Short Answer* How many ordered pairs of integers (a, b) satisfy the equation $a^3 + b^3 = 1728$?

ANSWER: 2

BONUS

23) Math – *Short Answer* What is the product of a and b given that $a^2 + b^2 = 52$ and $a + b = 10$?

ANSWER: 24