ROUND 11

TOSS-UP

1) Physics – *Multiple Choice* A wooden block with a coefficient of static friction greater than the coefficient of kinetic friction is placed on a rough surface. When the surface is at an angle of 25° to the horizontal, the block does not move, and when the angle to the horizontal is 35° the block slides down the surface. Which of the following could be the coefficient of static friction?

W) 0.4
X) 0.6
Y) 0.8
Z) 1.0

ANSWER: X) 0.6

BONUS

1) Physics – *Short Answer* Another wooden block with a mass of 6 kg and coefficient of static friction greater than the coefficient of kinetic friction is placed on a ramp at an inclination of 45°. The coefficient of kinetic friction between the block and the ramp is found to be 0.5. A block of unknown mass is connected to the block on the ramp with a massless frictionless pulley, hanging over the edge of the ramp. Assuming g = 10, what is the mass of the block that hangs over the ramp in simplest radical form?

ANSWER: $1.5\sqrt{2}$(ACCEPT: $3\sqrt{2}/2$)

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TOSS-UP

2) Energy – *Multiple Choice* Researchers at the Lawrence Berkeley National Laboratory are exploring the use of ionic liquids as a biomass pretreatment. These researchers sought to decrease the cost of ionic liquids by synthesizing them directly from hydrophobic monomers that can be found within the cell wall. Which of the following is this monomer that assists in the transport of water in plants by strengthening the vascular tissue, allowing it to withstand pressure changes?

W) Cholesterol
X) Cellulose
Y) Galactose
Z) Lignin

ANSWER: Z) LIGNIN
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BONUS

2) Energy – *Multiple Choice* These researchers hope to use this research to improve the economic viability of biofuels. A common biofuel, ethanol, is used in gasoline, usually in the form E10, where the gasoline contains 10% ethanol. E10 reduces the emissions of fuel by up to around what percent?

W) 0.1%
X) 10%
Y) 30%
Z) 70%

ANSWER: Y) 30%

ROUND 11

TOSS-UP

3) Chemistry – *Short Answer* Avogadro's Law states that the number of moles of a gas is directly proportional to what quantity of the gas?

ANSWER: VOLUME

BONUS

3) Chemistry – *Short Answer* An adsorption isotherm apparatus consists of a dosing chamber with a volume of 40 milliliters as well as a sample chamber. The two airtight chambers are initially separated by a valve and at a pressure of 0 torr. Helium gas is let into the dosing chamber until the pressure reaches 750 torr. The valve is then opened, and the helium expands into the sample chamber. Once the pressure has equilibrated between both chambers, it is measured to be 300 torr. In milliliters, determine the volume of the sample chamber.

ANSWER: 60

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TOSS-UP

4) Biology - *Short Answer* What is the name for the process in cells that helps distribute molecules within a cell by using motor proteins to cause a circular flow in the cytoplasm?

ANSWER: CYTOPLASMIC STREAMING

BONUS

4) Biology - *Short Answer* By name or number, identify all of the following 5 organelles that have a double membrane: 1) Nucleus, 2) Mitochondria, 3) Chloroplast, 4) Lysosome, 5) Peroxisome.

ANSWER: 1, 2, 3
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ROUND 11

TOSS-UP

5) Math – *Short Answer* What type of planar curve is defined by the graph of $r^2 = 4 \sin(2\theta)$?

ANSWER: LEMNISCATE

BONUS

5) Math – *Short Answer* What is the distance between the point (2, 4, 3) and the plane 5x - 2y + 3z = -12 in simplest radical form?

ANSWER: $23\sqrt{38}/38$

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TOSS-UP

6) Earth and Space - *Multiple Choice* Which of the following is caused by the Coriolis Effect and occurs when fast-moving water near the surface drags subsequent layers of water at slower speeds to create a spiraling effect in the shape of a funnel?

W) ekman spiral
X) whirlpool
Y) coriolis spiral
Z) gyre

ANSWER: W) EKMAN SPIRAL

BONUS

6) Earth and Space - *Short Answer* What specific type of current forms when Eckman transport creates a mound of water where the force of gravity is equal to the force exerted by the Coriolis Effect?

ANSWER: GEOSTROPHIC CURRENT
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ROUND 11

TOSS-UP

7) Energy – *Multiple Choice* Researchers at Oak Ridge National Laboratory have been developing a method of identifying gene expression patterns in drought-resistant plants. Which of the following is an adaptation of desert plants, which have evolved to be able to cope with the harsh and dry conditions?

W) Buttress roots
X) Leaf Waxing
Y)Aerenchyma Tissue
Z) Drip tips

ANSWER: X) LEAF WAXING

BONUS

7) Energy – *Short Answer* During normal photosynthesis, plants open their stomata throughout the day to take in the carbon dioxide needed to produce carbohydrates.However, a small percentage of plants perform this during the night. What is this form of photosynthesis called?

ANSWER: CAM (ACCEPT: CRASSULACEAN ACID METABOLISM)

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TOSS-UP

8) Biology - *Multiple Choice* Which of the following is NOT true about mallards?

W) Both sexes have a blue patch on their wings
X) They dive in the water to catch their prey
Y) They can live in almost every wetland habitat
Z) Males give a rasping voice instead of quacking

ANSWER: X) THEY DIVE IN THE WATER TO CATCH THEIR PREY

BONUS

8) Biology - *Short Answer* What type of bird feet are deeply cleft, with long, strong, sharply curved nails?

ANSWER: RAPTORIAL
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ROUND 11

TOSS-UP

9) Physics – *Short Answer* The percent uncertainty in mass of an object is 1%. If the percent uncertainty in velocity of that object is 3%, to the nearest percent what is the uncertainty in the kinetic energy.

ANSWER: 7%

BONUS

9) Physics – *Multiple Choice* A standing wave is formed in a tube open at one end and closed at the other. If there is only 1 node, and the tube is 10 m long, what is the wavelength of the wave inside the tube in meters?

W) 5
X) 10
Y) 20
Z) 40

ANSWER: Z) 40

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TOSS-UP

10) Chemistry – *Multiple Choice* Which of the following is a polar, aprotic solvent?

W) Water
X) Acetic acid
Y) Acetone
Z) Toluene

ANSWER: Y) ACETONE

BONUS

10) Chemistry – *Short Answer* Which of the following is the most nucleophilic in acetic acid?

W) F^- (READ F minus)
X) Cl^-
Y) Br^-
Z) I^-
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ANSWER: Z) I^-

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TOSS-UP

11) Math – *Multiple Choice* For which of the following dimensions of matrices is their product undefined?

W) 2x3 times 3x6 (READ 2 by 3 times 3 by 6)
X) 4x5 times 5x4
Y) 2x2 times 3x2
Z) 2x4 times 4x1

ANSWER: Y) 2x2 TIMES 3x2

BONUS

11) Math – *Short Answer* A student has an average of 77 over 5 tests. To have an average grade of 80 after the next test, what must the student score on the next test?

ANSWER: 95

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TOSS-UP

12) Earth and Space - *Short Answer* Which spectral class of stars has the strongest emission lines of ionized hydrogen?

ANSWER: O

BONUS

12) Earth and Space - *Short Answer* By name or number, list the following 4 spectral classes of stars in order of lowest to highest surface temperature: 1) B9, 2) O4, 3) O2, 4) A0.

ANSWER: A0, B9, O4, O2 (ACCEPT: 4, 1, 2, 3)

ROUND 11

TOSS-UP

13) Biology - *Short Answer* Damage to which part of the hypothalamus would most likely lead to excessive overeating?

ANSWER: VENTROMEDIAL HYPOTHALAMUS

BONUS

13) Biology - *Multiple Choice* Which of the following cranial nerves is responsible for relaying somatosensory information from the face and head?

W) Trigeminal Nerve
X) Facial Nerve
Y) Glossopharyngeal Nerve
Z) Vagus Nerve

ANSWER: W) TRIGEMINAL NERVE

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TOSS-UP

14) Energy – *Multiple Choice* Scientists at Lawrence Livermore National Laboratory are studying the formation of short-lived cumulus clouds during fair weather. Which of the following best explains why these clouds have a significant effect at cooling the surface?

W) The large amounts of precipitation from cumulus clouds cools the surface.
X) The strong updrafts created by cumulus clouds bring cool air over the surface.
Y) The cumulus clouds have a high albedo, so there is less incoming solar radiation hitting the surface.
Z) The cumulus clouds have a low albedo, so there is less incoming solar radiation hitting the surface.

ANSWER: Y) THE CUMULUS CLOUDS HAVE A HIGH ALBEDO, SO THERE IS LESS INCOMING SOLAR RADIATION HITTING THE SURFACE

BONUS

14) Energy – *Multiple Choice* The scientists are studying the causes of the formation of these shallow cumulus clouds. Which of the following is not a factor that affects the formation of cumulus clouds?
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W) Increase in the humidity 1-2 km above the surface.
X) Increase in the humidity 10-20 km above the surface.
Y) The thermodynamic variability of the atmosphere.
Z) Heat transport from the surface to the atmosphere.

ANSWER: X) INCREASE IN HUMIDITY 10-20KM ABOVE THE SURFACE

ROUND 11

TOSS-UP

15) Physics – *Short Answer* In a liquid, the speed of sound is equal to the square root of what quantity divided by the density?

ANSWER: BULK MODULUS

BONUS

15) Physics – *Short Answer* List the following materials from least to greatest resistivity at standard temperature and pressure: 1) Aluminum, 2) Copper, 3) Glass.

ANSWER: 2, 1, 3

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TOSS-UP

16) Earth and Space - *Short Answer* While looking at a transform plate boundary, you notice that the tectonic plate closest to you is moving to your right. What specific type of fault is found at this transform plate boundary?

ANSWER: SINISTRAL (DO NOT ACCEPT: STRIKE-SLIP)

BONUS

16) Earth and Space - *Multiple Choice* Which of the following discontinuities appears below continents and is characterized by the abrupt stop of S-waves?

W) Conrad
X) Gutenberg
Y) MOHO
Z) Lehmann

ANSWER: X) GUTENBERG
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ROUND 11

TOSS-UP

17) Chemistry – *Multiple Choice* What is the product when an alcohol is dehydrated?

W) Alkane
X) Alkene
Y) Alkyne
Z) Ketone

ANSWER: X) ALKENE

BONUS

17) Chemistry – *Short Answer* What is the anhydride of iodic acid?

ANSWER: I_2O_5 (ACCEPT DIIODINE PENTOXIDE, IODINE PENTOXIDE)

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TOSS-UP

18) Math – *Multiple Choice* 3 humans and 6 aliens sit in a row of 9 seats. Assuming the aliens are indistinguishable but the humans are not, how many distinct ways can the humans and aliens sit in this row of 9 seats?

W) 72
X) 432
Y) 504
Z) 1296

ANSWER: Y) 504

BONUS

18) Math – *Short Answer* Find the sum of squares of the roots of $f(x) = x^3 + 7x^2 - 10x - 16$.

ANSWER: 69
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ROUND 11

TOSS-UP

19) Chemistry – *Multiple Choice* Which of the following is not very soluble in water but would be soluble in hydrochloric acid?

W) Potassium chlorate
X) Copper (II) nitrate
Y) Aluminum hydroxide
Z) Strontium hydroxide

ANSWER: Y) ALUMINUM HYDROXIDE

BONUS

19) Chemistry – *Short Answer* What is the pH of a 0.25 M solution of $C_6H_6NH_2$ given the K_b is 4×10^{-10}?

ANSWER: 9

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TOSS-UP

20) Physics – *Short Answer* Interaction with what particles are responsible for spontaneous electroweak symmetry breaking?

ANSWER: HIGGS BOSON

BONUS

20) Physics – *Short Answer* A point charge charge +2 C moves with velocity 2 m/s to the right in the presence of a constant magnetic field of strength 6 T directed downwards and an electric field of strength 5 N/C directed upwards. What is the magnitude of the instantaneous force on the charge?

ANSWER: 26 N
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ROUND 11

TOSS-UP

21) Earth and Space - *Short Answer* What term is used to describe the process in which an air mass becomes narrower, taller, and heavier as it moves towards the center of a cyclone?

ANSWER: HORIZONTAL CONVERGENCE

BONUS

21) Earth and Space - *Short Answer* What is the cooling degree day for a 24 hour period in Gainesville, Florida with a high of 83°F and a low of 69°F?

ANSWER: 11
(Solution: [83+69]/2 - 65 = 11)

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TOSS-UP

22) Biology - *Short Answer* When mature, which of the basic plant cell types has a thick secondary cell wall and contains large amounts of lignin?

ANSWER: SCLERENCHYMA

BONUS

22) Biology - *Short Answer* What is the name for the thin layer rich in pectin that forms between the primary cell walls of adjacent plant cells?

ANSWER: MIDDLE LAMELLA
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ROUND 11

TOSS-UP

23) Math – *Short Answer* 4 fair six-sided dice are rolled. What is the probability that the product of the numbers shown on the top faces of the dice is even?

ANSWER: $\frac{15}{16}$

BONUS

23) Math – *Short Answer* Jimmy draws three cards off the top of a standard 52-card deck without replacement. What is the probability that at least 2 of the cards have the same suit?

ANSWER: $\frac{256}{425}$