

ROUND 14

TOSS-UP

1) MATH *Short Answer* If the determinant of a 2 by 2 matrix, denoted A, is equal to -2, what is the determinant of 2 times A?

ANSWER: - 8

BONUS

1) MATH *Multiple Choice* Which of the following matrices does not have the same determinant as the 2 by 2 matrix with row 1: 0, -1; and row 2: 1, 0?

- W) the 2 by 2 matrix row 1: 0, -1; row 2: -1, 0
- X) the 2 by 2 matrix row 1: 1, 0; row 2: 0, 1
- Y) the 2 by 2 matrix row 1: 1, -1; row 2: 0, 1
- Z) the 2 by 2 matrix row 1: 0, 1; row 2: -1, 0

ANSWER: W) THE 2 BY 2 MATRIX ROW 1: 0, -1; ROW 2: -1, 0

TOSS-UP

2) PHYSICS *Short Answer* If two sine waves are played with frequencies of 400 and 410 Hertz, at what frequency in Hertz will you perceive that their volumes are “pulsing”?

ANSWER: 10

BONUS

2) PHYSICS *Multiple Choice* If the fundamental frequency of a pipe open at both ends is 70 Hertz, what will its next two harmonics be in Hertz?

- W) 105 and 140
- X) 140 and 210
- Y) 210 and 350
- Z) 210 and 420

ANSWER: X) 140 AND 210

TOSS-UP

3) EARTH AND SPACE *Multiple Choice* If you measure the solar altitude at noon and find it to be 90°, at which of the following locations could you be?

- W) Congo, in sub-Saharan Africa
- X) France, in Western Europe

- Y) Buenos Aires, Argentina, in southeastern South America
- Z) Tokyo, Japan, off the coast of eastern Asia

ANSWER: W) CONGO, IN SUB-SAHARAN AFRICA

BONUS

3) EARTH AND SPACE *Short Answer* If where you live, the sun rises at 75° northeast on the horizon, in May, and the solar altitude is less than 90° at the equinox, in which hemisphere do you live?

ANSWER: NORTHERN HEMISPHERE

TOSS-UP

4) BIOLOGY *Short Answer* Many mammal species produce colostrum during the late stages of pregnancy or shortly after giving birth. This "first milk" transfers antibodies from the mother to the infant. What is the isotype of these antibodies that can be transferred from the infant gut to the infant bloodstream?

ANSWER: IgA

BONUS

4) BIOLOGY *Multiple Choice* In humans, in addition to transferring antibodies, colostrum also stimulates the development of the neonatal gut through the transference of:

- W) Pheromones (read as: FEHR-oh-mōens)
- X) Non-heritable mutations
- Y) Beta-galactose
- Z) Growth factors

ANSWER: Z) GROWTH FACTORS

TOSS-UP

5) CHEMISTRY *Multiple Choice* Which of the following is a polar, aprotic solvent?

- W) Water
- X) Methanol
- Y) Dimethyl sulfoxide
- Z) Chloroform

ANSWER: Y) DIMETHYL SULFOXIDE

BONUS

5) CHEMISTRY *Multiple Choice* What kind of isomers are mannose and glucose?

- W) Enantiomers (read as: i-nahn-TEE-ōe-mehrs)
- X) Conformational isomers
- Y) Mesoisomers
- Z) Diastereoisomers (read as: dy-ah-STEHR-ee-ōE-mehrs)

ANSWER: Z) DIASTEREOISOMERS

TOSS-UP

6) PHYSICS *Multiple Choice* In determining the escape velocity of an object on Earth, which of the following values is generally least important?

- W) The mass of the object
- X) The volume of the object
- Y) The radius of Earth
- Z) The mass of Earth

ANSWER: X) THE VOLUME OF THE OBJECT

BONUS

6) PHYSICS *Short Answer* A spherical Gaussian surface encloses two point charges, q_1 and q_2 , while a third point charge, q_3 , is placed outside the Gaussian surface. The electrical field on the Gaussian surface is due to which of the charges?

ANSWER: $q_1, q_2,$ AND q_3 (ACCEPT: 1, 2, 3, OR ALL)

TOSS-UP

7) CHEMISTRY *Multiple Choice* Transition metal elements have atoms or ions with which of the following orbitals partially filled?

- W) d
- X) f
- Y) p
- Z) s

ANSWER: W) d

BONUS

7) CHEMISTRY *Multiple Choice* Which choice represents the electron configuration for the magnesium 2+ ion?

- W) $1s^2 2s^2 2p^6 3s^2$
- X) $1s^2 2s^2 2p^6 3s^2 3p^2$
- Y) $1s^2 2s^2 2p^6 3s^1$
- Z) $1s^2 2s^2 2p^6$

ANSWER: Z) $1s^2 2s^2 2p^6$

TOSS-UP

8) MATH *Short Answer* How far apart, in degrees, are the asymptotes of the graph of $2\tan(3x/2)$ (read as: 2 times the tangent of 3x over 2)?

ANSWER: 120°

BONUS

8) MATH *Multiple Choice* If the sine of an angle is 0.3, which of the following is a possible cosine of that angle?

- W) .09
- X) .7
- Y) $\sqrt{.7}$
- Z) $\sqrt{.91}$

ANSWER: Z) $\sqrt{.91}$

TOSS-UP

9) ENERGY *Multiple Choice* A strong oxidizing agent would show which of the following characteristics?

- W) A large, positive reduction potential
- X) A large, positive oxidation potential
- Y) A small, positive reduction potential
- Z) A small, positive oxidation potential

ANSWER: W) A LARGE, POSITIVE REDUCTION POTENTIAL

BONUS

9) ENERGY *Multiple Choice* Which of the following is the strongest reducing agent yielding the most ATP per molecule during oxidative phosphorylation?

- W) FADH₂
- X) FAD⁺
- Y) NADH
- Z) NAD⁺

ANSWER: Y) NADH

TOSS-UP

10) EARTH AND SPACE *Multiple Choice* A putative observation of methane on Mars was reported in 2009. Which of the following is NOT considered a possible source of this methane?

- W) Methanogenesis
- X) Clathrate (read as: CLAH-thrayt) dissociation
- Y) Volcanic outgassing
- Z) Serpentinization

ANSWER: Y) VOLCANIC OUTGASSING

BONUS

10) EARTH AND SPACE *Short Answer* If the moon is in a new moon phase on April 1, approximately when will the next spring tide occur?

ANSWER: ANY DATE FROM APRIL 13 to APRIL 16

TOSS-UP

11) PHYSICS *Short Answer* Assuming that the light bulbs, wires, and batteries are all the same in two different circuits, how would the brightness of two light bulbs in series compare to the brightness of just one light bulb?

ANSWER: DIMMER (ACCEPT: LESS BRIGHT, LESS)

BONUS

11) PHYSICS *Short Answer* What will the power loss be in watts in a 100,000 volt transmission line carrying 10 amperes of current if the resistance of the line is 20 ohms?

ANSWER: 2000

TOSS-UP

12) ENERGY *Multiple Choice* One component of a solar energy system is the charge controller. Its function is to:

- W) Provide electrical protection to the system
- X) Regulate the amount of power that goes into energy storage for later use
- Y) Dissipate excess energy
- Z) Store the energy for later use

ANSWER: X) REGULATE THE AMOUNT OF POWER THAT GOES INTO THE ENERGY STORAGE FOR LATER USE

BONUS

12) ENERGY *Short Answer* How much heat in kilocalories does it take to heat 10 kilograms of bathwater from 10° Celsius to 20° Celsius?

ANSWER: 100

TOSS-UP

13) MATH *Short Answer* What is the derivative of $\sin(w)$ at $w = 0$?

ANSWER: 1

BONUS

13) MATH *Short Answer* What is the derivative of $\cos\left(\frac{\pi}{2} + w\right)$ (read as: cosine of open parenthesis pi over 2 plus w close parenthesis) with respect to w , in terms of $\cos(w)$?

ANSWER: $-\cos(w)$ (DO NOT ACCEPT: OTHER ANSWERS)

TOSS-UP

14) EARTH AND SPACE *Multiple Choice* What will likely happen to the amount of dissolved oxygen in a river downstream of a tributary that brings sewage effluent?

- W) The amount of oxygen will be depleted
- X) The amount of oxygen will stay the same
- Y) Oxygen will be generated
- Z) More oxygen will diffuse into the water

ANSWER: W) THE AMOUNT OF OXYGEN WILL BE DEPLETED

BONUS

14) EARTH AND SPACE *Multiple Choice* Does a heavy wet snowfall in Buffalo, New York necessarily mean that Boston, Massachusetts will experience the same weather?

- W) Yes, because they are geographically close and the Westerlies drive storm systems across the U.S. towards the East
- X) Yes, because airmasses hitting New England are always impacted by their proximity to the ocean and, therefore, pick up moisture that will be dumped as snow
- Y) No, because Buffalo, New York, is subject to lake-effect snows; the airmass may be “dried out” by the time it gets to Boston
- Z) No, because weather in the U.S. is driven by the Westerlies which push storm systems from east to west across the continent

ANSWER: Y) NO, BECAUSE BUFFALO, NEW YORK, IS SUBJECT TO LAKE-EFFECT SNOWS; THE AIRMASS MAY BE “DRIED OUT” BY THE TIME IT GETS TO BOSTON

TOSS-UP

15) ENERGY *Multiple Choice* Which of the following principles is at work in hybrid cars?

- W) Recapture some of car's kinetic energy and use it to go faster
- X) Recapture some of the car's kinetic energy and use it for better fuel economy
- Y) Recapture some of the car's kinetic energy to synthesize gasoline
- Z) Recapture engine heat and convert it to more kinetic energy for the car

ANSWER: X) RECAPTURE SOME OF THE CAR'S KINETIC ENERGY AND USE IT FOR BETTER FUEL ECONOMY

BONUS

15) ENERGY *Short Answer* If a force of 10 newtons raises a mass 1.0 meters in 1.0 seconds, then what is the power in watts?

ANSWER: 10

TOSS-UP

16) BIOLOGY *Multiple Choice* Humans have a gene, called LCT, which encodes lactase. In most of the world, LCT is active in young children but is turned off in adults. However, northern Europeans and three different tribes of African pastoralists carry a mutation that permits it to be expressed in adults. The mutation is different in each of the four cases, indicating the mutation is an example of:

- W) Paralogous genes
- X) Convergent evolution
- Y) Homologous genes
- Z) Divergent evolution

ANSWER: X) CONVERGENT EVOLUTION

BONUS

16) BIOLOGY *Short Answer* The human foot and the monkey foot are very different, despite common primate ancestry. The evolution of these differing traits allowed organisms to adapt to different environmental conditions. This type of evolution is known as:

ANSWER: DIVERGENT EVOLUTION

TOSS-UP

17) MATH *Multiple Choice* In a parallelogram ABCD, the sides AB and DC can be represented by:

- W) Opposite vectors
- X) Two different vectors with the same direction
- Y) Two different vectors with the same magnitude
- Z) The same vector

ANSWER: Z) THE SAME VECTOR

BONUS

17) MATH *Short Answer* The number 360 has how many positive integer factors?

ANSWER: 24

TOSS-UP

18) EARTH AND SPACE *Multiple Choice* What kind of plate tectonic boundary formed the East African rift?

- W) Divergent
- X) Convergent
- Y) Thrust
- Z) Transform

ANSWER: W) DIVERGENT

BONUS

18) EARTH AND SPACE *Short Answer* What oceanic plate sits west of the South American plate, forming a convergent boundary?

ANSWER: NAZCA PLATE

TOSS-UP

19) MATH *Short Answer* If N represents the number of sides for a regular polygon that tessellates the plane, how many different values of N are there?

ANSWER: 3

BONUS

19) MATH *Short Answer* Find the limit as x approaches -2 of $(x^3 + 8)/(2x + 4)$ (read as: the quantity x cubed plus 8 divided by the quantity $2x$ plus 4).

ANSWER: 6

TOSS-UP

20) CHEMISTRY *Multiple Choice* Which of the following ions are NOT isoelectronic with an argon atom?

- W) K^+
- X) Ti^{2+}
- Y) S^{2-}
- Z) Ca^{2+}

ANSWER: X) Ti^{2+}

BONUS

20) CHEMISTRY *Multiple Choice* In a breath analyzer, what color change occurs in a potassium dichromate solution in the presence of alcohol?

- W) Orange-yellow to green
- X) Red to blue
- Y) Clear to pink
- Z) Orange-yellow to red

ANSWER: W) ORANGE-YELLOW TO GREEN

TOSS-UP

21) PHYSICS *Short Answer* When the path difference between two slits is an odd multiple of the light's wavelength divided by 2, the waves arrive 180 degrees out of phase. What kind of interference does this represent?

ANSWER: DESTRUCTIVE

BONUS

21) PHYSICS *Multiple Choice* A beam of white light is incident on a triangular glass prism with an index of refraction of 1.5 for visible light, producing a spectrum. Initially, the prism is in a glass aquarium filled with air. If the aquarium is filled with water with an index of refraction of 1.3, which of the following is true?

W) The spectrum produced has the deviation of the beam opposite to that in air

X) The positions of red and violet are reversed in the spectrum

Y) The spectrum produced has greater separation between red and violet than that produced in air

Z) The spectrum produced has lesser separation between red and violet than that produced in air

ANSWER: Z) THE SPECTRUM PRODUCED HAS LESSER SEPARATION BETWEEN RED AND VIOLET THAN THAT PRODUCED IN AIR

TOSS-UP

22) CHEMISTRY *Short Answer* What is the pH for a solution with 0.01 mole of nitric acid in 1.0 liter of water?

ANSWER: 2

BONUS

22) CHEMISTRY *Short Answer* What are the nonsuperimposable mirror images of a chiral compound called?

ANSWER: ENANTIOMERS

TOSS-UP

23) BIOLOGY *Multiple Choice* The incorporation of beta carotene genes from daffodil flowers into rice represents a type of:

- W) Traditional plant breeding
- X) Natural selection
- Y) Genetic engineering
- Z) Bioprospecting

ANSWER: Y) GENETIC ENGINEERING

BONUS

23) BIOLOGY *Short Answer* What is the method by which scientists determine the precise chromosomal location for a gene that encodes a particular biological trait?

ANSWER: GENE MAPPING

TOSS-UP

24) EARTH AND SPACE *Multiple Choice* Which of the following is NOT an accurate description of the dominant airmass effecting America's Pacific Northwest?

- W) Cool
- X) Maritime
- Y) Humid
- Z) Dry

ANSWER: Z) DRY

BONUS

24) EARTH AND SPACE *Multiple Choice* The Chinook winds that come from the west and move air down the eastern face of the Rocky Mountains are known as "snow eaters", because:

- W) The winds bring moist warm air from California, causing the snows to melt and "disappear" from the Front Range region of Colorado
- X) The airmass brings cold, dry winds from the peaks of the Rockies, causing the snow to freeze into black ice, making it look like the snow "disappeared"
- Y) The winds blow the snow off the Front Range and onto the Plains, making the snow "disappear" from the eastern face of the mountains
- Z) The airmass warms as it descends, increasing its water vapor capacity and causing the snow to sublime and "disappear"

ANSWER: Z) THE AIRMASS WARMS AS IT DESCENDS, INCREASING ITS WATER VAPOR CAPACITY AND CAUSING THE SNOW TO SUBLIME AND "DISAPPEAR"

TOSS-UP

25) BIOLOGY *Short Answer* Which one or ones of the following are aquatic insect nymphs that have external gills on either the thorax or the abdomen: 1) stoneflies, 2) damselflies, 3) dragonflies, or 4) mayflies?

ANSWER: STONEFLIES, DAMSELFLIES, AND MAYFLIES (ACCEPT: 1, 2, 4)

BONUS

25) BIOLOGY *Short Answer* In insects, prothoracicotropic (read as: prōe-thoh-rah-si-koh-TROH-pik) hormone stimulates the prothoracic gland to produce what hormone important in insect development?

ANSWER: ECDYSONE