ROUND 17

TOSS-UP

1) CHEMISTRY *Short Answer* Which two of the following 5 amino acids are classified as basic because of the structure of their side chains:
arginine; glycine; glutamic acid; phenylalanine; lysine

ANSWER: ARGININE; LYSINE

BONUS

1) CHEMISTRY *Short Answer* At 250K, the pressure of oxygen in a 1-liter container is 0.40 atmospheres. If 0.10 moles of carbon dioxide are added to the container, what will be the new pressure, in atmospheres rounded to the first decimal place?

ANSWER: 2.5 (ACCEPT: 2.4)

(Soln: P_{CO2} = (nRT/V) = [(0.10mol)(0.0821L-atm/K-mol)(250K)]/1L = 2.05 atm; P_T = 0.40 + 2.05 = 2.45atm = 2.5 atm)

TOSS-UP

2) PHYSICS *Multiple Choice* Which of the following is the MOST likely ultimate fate of the universe if mass in the universe is less than the critical density and there is no dark energy:

W) it will eventually stop expanding and maintain a constant size
X) it will stop expanding and collapse
Y) it will expand forever
Z) it will expand at an accelerating rate and then nearly collapse, then expand again and continue to oscillate this way forever

ANSWER: Y) IT WILL EXPAND FOREVER

BONUS

2) PHYSICS *Multiple Choice* Which of the following BEST explains why scientists believe the early universe up to a few hundred thousand years old was opaque:

W) deuterium at those temperatures absorbed all electromagnetic radiation
X) there was no electromagnetic radiation
Y) free electrons scattered photons and prevented them from traveling very far
Z) the temperature had cooled so far that space without stars was a dark void

ANSWER: Y) FREE ELECTRONS SCATTERED PHOTONS AND PREVENTED THEM FROM TRAVELING VERY FAR

TOSS-UP

3) BIOLOGY *Multiple Choice* The movement of cells from G-1 in the cell cycle into S-phase is mostly under the control of:

W) cyclins and cyclin-dependent kinases
X) the availability of purines and pyrimidines
Y) ubiquitin (read as: you-BIK-qui-tin) and proteosomes (read as: PRO-tee-oh-somes)
Z) G proteins and APC's

ANSWER: W) CYCLINS AND CYCLIN-DEPENDENT KINASES

BONUS

3) BIOLOGY *Multiple Choice* If you fluorescent-labeled the outsides of the trans-membrane proteins of one mammalian cell with a yellow label and another cell with a red label and fused them, which of the following would MOST likely occur over about 1 hour at 37°C:

W) the labels would remain unevenly distributed on the outside of the cells
X) the labels would quickly disappear
Y) one color would show up in the inside of the cell and the other would remain on the outside
Z) the labels would mix evenly on the outside of the cell

ANSWER: Z) THE LABELS WOULD MIX EVENLY ON THE OUTSIDE OF THE CELL

_____

TOSS-UP

4) MATH *Multiple Choice* By definition, a quadrantal angle is an angle in standard position where its terminal side:

W) lies on a coordinate axis
X) is a central angle
Y) lies only in quadrants one and three
Z) lies only in quadrants two and four

ANSWER: W) LIES ON A COORDINATE AXIS

BONUS

4) MATH *Short Answer* Find the following indefinite integral: $\int xe^x dx$ (read as: the integral of x times e to the x power, dx)

ANSWER: $xe^x - e^x + C$

TOSS-UP

5) EARTH SCIENCE *Multiple Choice* Which of the following is NOT used in determining relative geologic time:

W) principle of superposition
X) principle of original horizontality
Y) principle of cross-cutting
Z) radioisotope half-lives

ANSWER: Z) RADIOISOTOPE HALF-LIVES

BONUS

5) EARTH SCIENCE *Short Answer* Arrange the following 3 oceanic crust features from the YOUNGEST to the OLDEST: abyssal plain; continental shelf; mid-ocean ridge

ANSWER: MID-OCEAN RIDGE; ABYSSAL PLAIN; CONTINENTAL SHELF

TOSS-UP

6) GENERAL SCIENCE *Multiple Choice* Which of the following is NOT true:

W) electron tunneling is a phenomenon known since the early formulations of quantum mechanics
X) interstellar dust is now believed to constitute less than 1% of the mass in the interstellar medium
Y) antibiotic resistance in bacteria can arise from bacteria incorporating exogenous DNA into their genomes
Z) plant auxin is typically produced in bud scales and has the restricted role of cellular elongation

ANSWER: Z) PLANT AUXIN IS TYPICALLY PRODUCED IN BUD SCALES AND HAS THE RESTRICTED ROLE OF CELLULAR ELONGATION

BONUS

6) GENERAL SCIENCE *Short Answer* If the magic sum for a magic square is 15 and the top row of the magic square consists of the numbers 2, 9 and 4 and the top two numbers of the left column from the top down are 2 and 7, what are the 3 rows, from top to bottom?

          2 9 4
ANSWER: 7 5 3 (must be exact and read as 2, 9, 4   7, 5, 3   6, 1, 8)
          6 1 8

TOSS-UP

7) ASTRONOMY *Multiple Choice* Which of the following MOST directly predicts that the maximum mass possible for a white dwarf is about 1.4-times that of the Sun:

W) the Hubble constant
X) the Chandrasekhar limit (read as: chan-dra-SAY-kar)
Y) General Relativity
Z) the Fornax theorem

ANSWER: X) THE CHANDRASEKHAR LIMIT

BONUS

7) ASTRONOMY *Multiple choice* Which of the following is illustrated on Maunder's diagram:

W) sunspot activity
X) stellar luminosity
Y) cometary periods
Z) planetary orbital periods

ANSWER: W) SUNSPOT ACTIVITY

TOSS-UP

8) CHEMISTRY *Multiple Choice* Which of the following ionic compounds would have the highest melting point:

W) NaF
X) NaCl
Y) CaF_2
Z) MgO

ANSWER: Z) MgO

(Solution: NaF = 993°C; NaCl = 801; CaF_2 = 1423; MgO = 2800°C)

BONUS

8) CHEMISTRY *Short Answer* In a zinc-lead voltaic cell, what is the maximum voltage, to the third decimal place, that can be obtained if the standard reduction potential for the zinc ion is –0.763 volts and for the lead ion is –0.126 volts?

ANSWER: 0.637 (must be positive)

(Solution: +0.763 volts + (–0.126 volts) = +0.637 volts)

9) PHYSICS *Multiple Choice* Which of the following is NOT true:

W) electrons are directly affected by the strong nuclear force
X) general relativity predicts the existence of black holes
Y) a deuterium atom has two nucleons
Z) many cosmologists believe that neutrinos make up about as much mass as all the stars in the universe

ANSWER: W) ELECTRONS ARE DIRECTLY AFFECTED BY THE STRONG NUCLEAR FORCE

BONUS

9) PHYSICS *Short Answer* Ashley, who weighs 450 newtons, is with her dad at the playground, and she is sitting on a swing that is 0.60 meters above the ground. Her dad pulls her back and lets her go when the swing is 1.1 meters above the ground. How fast, in meters per second to the first decimal place, is Ashley moving when the swing passes through its lowest position?

ANSWER: 3.1 (ACCEPT: 3.2)

(Solution: $PE_g = Fd = (450N)(0.6 - 1.1m) = -225J$. $KE = -PE_g = \frac{1}{2}mv^2 \rightarrow v = \sqrt{\dfrac{2KE}{m}} = \sqrt{\dfrac{2(225J)}{450N/9.8m/s^2}} = 3.13$ m/s)

TOSS-UP

10) BIOLOGY *Short Answer* To what specific part of the tryptophan or lac operon will the repressor typically bind in order to exert its control on the operon?

ANSWER: OPERATOR

BONUS

10) BIOLOGY *Multiple Choice* Which of the following is the primary difference in regulation between the lactose and tryptophan operons:

W) tryptophan activates its repressor and lactose leads to an inactive repressor
X) when tryptophan is present, the repressor is inactive and the opposite is true for allolactose in the lac operon
Y) allolactose is considered a co-repressor whereas tryptophan is actually an inducer
Z) when tryptophan is not present, the co-repressor is able to inactivate the promoter directly

ANSWER: W) TRYPTOPHAN ACTIVATES ITS REPRESSOR AND LACTOSE LEADS TO AN INACTIVE REPRESSOR

TOSS-UP

11) MATH *Short Answer* Differentiate and simplify the following with respect to x: $y = e^{\sqrt{x}}$

ANSWER: $\dfrac{e^{\sqrt{x}}}{2\sqrt{x}}$

BONUS

11) MATH *Short Answer* For a triangle whose side $b = 6$ and $c = 8$ and the angle formed by those sides is 45º, find the area of the triangle, to the nearest whole number:

ANSWER: 17

(Solution: $K = \frac{1}{2} bc \sin A$; $= \frac{1}{2} (6)(8)(0.707) = 16.97 = 17$)

TOSS-UP

12) EARTH SCIENCE *Multiple Choice* If you were hiking on a glacier in the summertime, which of the following is the BEST way to recognize if you were walking on the zone of accumulation:

W) large amounts of rocks eroded from the nearby mountainsides have accumulated
X) you were walking mostly on exposed, bare ice
Y) last year's snow is still covering the glacial ice
Z) a bergschrund delineates the start of the accumulation zone

ANSWER: Y) LAST YEAR'S SNOW IS STILL COVERING THE GLACIAL ICE

BONUS

12) EARTH SCIENCE *Short Answer* Order the following 4 choices from the LOWEST metamorphic grade to the HIGHEST: schist; gneiss; slate; phyllite

ANSWER: SLATE; PHYLLITE; SCHIST; GNEISS

TOSS-UP

13) GENERAL SCIENCE *Multiple Choice* Which of the following is NOT typically true about lichens:

W) lichens produce a rock-dissolving acid as they grow
X) few animals other than caribou can eat lichens
Y) lichens take nutrients from the air
Z) lichens are prone to desiccation and death if water is withheld for more than a few days

ANSWER: Z) LICHENS ARE PRONE TO DESICCATION AND DEATH IF WATER IS WITHHELD FOR MORE THAN A FEW DAYS

BONUS

13) GENERAL SCIENCE *Short Answer* What general class of plant hormones and their synthetic cousins have been used as herbicides such as 2,4-D and agent orange?

ANSWER: AUXINS

TOSS-UP

14) ASTRONOMY *Multiple choice* In the first step of the proton-proton chain, when two protons come together one of the protons remains as a proton and the other:

W) is annihilated
X) turns into a neutron
Y) turns into a negatron
Z) also remains as a proton

ANSWER: X) TURNS INTO A NEUTRON

BONUS

14) ASTRONOMY *Multiple choice* In the second step of the proton-proton chain, which of the following occurs:

W) a proton combines with deuterium to produce helium-3 and a gamma ray is emitted
X) a neutron combines with deuterium to produce helium-3 and a neutrino is emitted
Y) a proton combines with deuterium to produce helium-3 and a neutrino ray is emitted
Z) a neutron combines with deuterium to produce helium-2 and a positron is emitted

ANSWER: W) A PROTON COMBINES WITH DEUTERIUM TO PRODUCE HELIUM-3 AND A GAMMA RAY IS EMITTED

TOSS-UP

15) CHEMISTRY *Multiple Choice* Consider the following reaction, $N_{2(gas)} + 3H_{2(gas)} \leftrightarrow 2NH_{3(gas)}$, whose heat of reaction, or delta H, is –91.8 kilojoules. If the temperature for the reaction is increased, which of the following will occur:

W) the concentration of N_2 increases
X) the concentration of H_2 decreases
Y) the concentration of NH_3 increases
Z) the concentration of N_2 decreases

ANSWER: W) THE CONCENTRATION OF N_2 INCREASES

BONUS

15) CHEMISTRY *Short Answer* How many kilopascals of pressure are needed to compress 400 milliliters of a gas under the conditions of 150 kilopascals of pressure and 400K, to 600 milliliters at a new temperature of 200K?

ANSWER: 50

(Solution: $\dfrac{P_1V_1}{T_1} = \dfrac{P_2V_2}{T_2}$; $\dfrac{(150kPa)(400ml)}{400K} = \dfrac{(P_2)(600ml)}{200K}$; = 50 kPa)

TOSS-UP

16) PHYSICS *Multiple Choice* Which of the following is MOST closely related to the movement of charge in non-ceramic superconductors:

W) charge confinement
X) Josephson effect
Y) Cooper pairs
Z) Hall movement

ANSWER: Y) COOPER PAIRS

BONUS

16) PHYSICS *Multiple Choice* Which of the following is NOT a standard characteristic of a laser:

W) coherent beam
X) optical gain
Y) distinctly identifiable pumping threshold
Z) distinctly identifiable pumping turn-off

ANSWER: Z) DISTINCTLY IDENTIFIABLE PUMPING TURN-OFF

TOSS-UP

17) BIOLOGY *Multiple Choice* Which of the following is the BEST description of photorespiration:

W) the process whereby primitive bacteria use light to help oxidize inorganic molecules
X) the competition of carbon dioxide and molecular oxygen for Rubisco
Y) the gaining of chemical energy in photosynthesis
Z) the loss of reduced electrons from photosystem one

ANSWER: X) THE COMPETITION OF CARBON DIOXIDE AND MOLECULAR OXYGEN FOR RUBISCO

BONUS

17) BIOLOGY *Short Answer* Name 2 of the following 4 plant types that have the LEAST amount of photorespiration if all are exposed to a bright summer Sun: agave; corn; begonia; tulip

ANSWER: AGAVE; CORN

TOSS-UP

18) MATH *Short Answer* Give the center point and the vertices of the horizontal axis and vertical axis of the ellipse for the following equation: $\dfrac{(x+1)^2}{16} + \dfrac{(y-2)^2}{9} = 1$

ANSWER: CENTER = (−1, 2); HORIZONTAL = (−5, 2) AND (3, 2);
VERTICAL = (−1, −1) AND (−1, 5)

BONUS

18) MATH *Short Answer* Differentiate and simplify the following with respect to x: $y = \dfrac{\ln x}{x}$
(read as: natural log of x divided by x)

ANSWER: $\dfrac{1 - \ln x}{x^2}$ (ALSO ACCEPT $[-(\ln x) + 1]/x^2$

TOSS-UP

19) EARTH SCIENCE *Short Answer* What is the name for the most recent Pleistocene glacial episode in North America?

ANSWER: WISCONSINIAN

BONUS

19) EARTH SCIENCE *Short Answer* A moment magnitude 7 earthquake releases how many times more energy than a moment magnitude 6 earthquake?

ANSWER: 31 (ACCEPT: 30 to 32)

(Solution: magnitude 7 wave is 10-times larger than a mag 6 and releases 31-times as much energy)

TOSS-UP

20) GENERAL SCIENCE *Multiple Choice* Which of the following is the equivalent of a googolplex:

W) 10^{100}
X) $10^{10^{10}}$
Y) $10^{10^{100}}$
Z) 10^{1000}

ANSWER: Y) $10^{10^{100}}$

BONUS

20) GENERAL SCIENCE *Multiple Choice* Most scientific evidence currently supports the belief that HIV-1 evolved from:

W) a rotovirus of monkeys
X) a retrovirus of monkeys
Y) a simian immunodeficiency virus of chimps
Z) a picorna immunodeficiency virus of monkeys

ANSWER: Y) A SIMIAN IMMUNODEFICIENCY VIRUS OF CHIMPS

TOSS-UP

21) ASTRONOMY *Short Answer* Order the following 3 stars from the one that will undergo fusion for the SHORTEST time to the LONGEST: red dwarf; our Sun; large mass o-type star

ANSWER: LARGE MASS O-TYPE STAR; OUR SUN; RED DWARF

BONUS

21) ASTRONOMY *Short Answer* If a stellar body's surface is 5,000 kelvin, what is its peak emission of electromagnetic radiation, in nanometers?

ANSWER: 580

(Solution: Wien's Law $T = 2.9 \times 10^{-3}$ m.k/λ → $0.005 \times 10^6 = 2.9 \times 10^{-3}$ m / 580×10^{-9}m = 580nm)

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TOSS-UP

22) CHEMISTRY *Short Answer* Predict the shape of a molecule of phosphorous pentafluoride, whereby each phosphorous atom has 5 valence electrons to share with 5 fluorine atoms:

ANSWER: TRIGONAL BIPYRAMIDAL

BONUS

22) CHEMISTRY *Short Answer* Give all 3 angles, in degrees, that are present in phosphorous pentafluoride:

ANSWER: 90; 120; 180

TOSS-UP

23) PHYSICS *Short Answer* As reported recently in the journal Science, researchers have succeeded in producing a high efficiency organic LED. They began with a blue emitting system and then added a single color light emitting phosphor to obtain white light. What was the single color phosphor they used?

ANSWER: YELLOW

(Solution: red and green make yellow and red green and blue make white, therefore since they needed red and green to add to blue to make white they chose a yellow phosphor)

BONUS

23) PHYSICS *Short Answer* A sphere of radius 1 meter contains uniformly distributed charge of charge density rho. Assuming ρ/ε_0 (rho over epsilon-naught) equals 30 volts per meter squared, what is the magnitude of electric field at a radius of 0.5 meters?

ANSWER: 5 V/m

_____

TOSS-UP

24) BIOLOGY *Short Answer* Which 2 of the following 4 hormones play the largest roles in regulating sperm production in humans:
luteinizing hormone; estradiol; progesterone; follicle stimulating hormone

ANSWER: LUTEINIZING HORMONE; FOLLICLE STIMULATING HORMONE
(ACCEPT: LH; FSH)

BONUS

24) BIOLOGY *Short Answer* Give the corresponding alternate DNA strand synthesized by reverse transcriptase from the following mRNA: (read slowly, pausing between each triplet)
AUA, CAG, ACU, UUC, AUU

ANSWER: TAT, GTC, TGA, AAG, TAA

TOSS-UP

25) PHYSICS *Short Answer* What is the most common term for what Einstein first proposed to operate in empty space, but later rejected as his greatest blunder following Hubble's discovery of the expansion of the universe?

ANSWER: COSMOLOGICAL CONSTANT

BONUS

25) PHYSICS *Short Answer* Name all of the following 4 particles that are leptons:
muon, photon, tau, electron

ANSWER: MUON; TAU; ELECTRON (ACCEPT: ALL BUT PHOTON)