

ROUND 16

TOSS-UP

1) PHYSICS *Multiple Choice* In synchrotron sources, flux and brilliance are two benchmarks of the quality of the beam. Which of the following most accurately describes flux in this case:

- W) flux is a measure of the intensity and directionality of the x-ray beam
- X) flux is the number of photons per second passing through a defined area
- Y) flux determines the smallest spot onto which the x-ray beam can be focused
- Z) flux is of little concern in beam quality if brilliance is achieved

ANSWER: X) FLUX IS THE NUMBER OF PHOTONS PER SECOND PASSING THROUGH A DEFINED AREA

BONUS

1) PHYSICS *Short Answer* This experiment, named after its two creators, was originally considered a failure, but it eventually overturned theories of the “ether” and demanded an alternative theory for why the speed of light was a constant:

ANSWER: MICHELSON-MORLEY EXPERIMENT

TOSS-UP

2) CHEMISTRY *Multiple Choice* A solution of 100 ml dimethyl ketone, 45ml amyl acetate, 15 ml butyl acetate, 15 ml ethyl acetate, and 1 ml of castor oil, can be mixed to make:

- W) enamel
- X) glue
- Y) fingernail polish
- Z) hand cleaner

ANSWER: X) GLUE

BONUS

2) CHEMISTRY *Short Answer* If a hydrogen atom is removed from an alkane, the carbon and hydrogen portion that remains is called what:

ANSWER: ALKYL GROUP

TOSS-UP

3) **BIOLOGY** *Multiple Choice* The major antibody of the human body, especially for immunity after vaccinations, is:

- W) IgG
- X) IgA
- Y) IgF
- Z) IgN

ANSWER: W) IgG

BONUS

3) **BIOLOGY** *Short Answer* Using the following single stranded DNA, give the corresponding messenger RNA sequence:

(Pronunciation: please give a brief pause at each hyphen between the reading of each three letters)

CCA - CCC - CCA - TAC - CCC - TTA - TAT

ANSWER: GGU - GGG - GGU - AUG - GGG - AAU – AUA (must be exact)

TOSS-UP

4) **ASTRONOMY** *Multiple Choice* General relativity does NOT allow for which of the following descriptions of the universe:

- W) the universe is constructed like a 4-dimensional hyperbola
- X) the universe is infinite and unbounded
- Y) the universe is both finite and unbounded
- Z) the universe is both finite and bounded

ANSWER: Z) THE UNIVERSE IS BOTH FINITE AND BOUNDED

(Solution: page 200 Timothy Ferris, coming of age in the Milky Way)

BONUS

4) **ASTRONOMY** *Short Answer* Upon passing through a fixed biconvex lens, order the following colors from the SHORTEST to the LONGEST focal lengths: red, violet, yellow, blue, and green

ANSWER: VIOLET; BLUE; GREEN; YELLOW; RED

TOSS-UP

5) MATH *Multiple Choice* Express the product of the following complex numbers in the form $a + bi$ where a and b are real: $4 + 2i$ and $2 + 5i$

- W) $6 + 10i$
- X) $-4 + 20i$
- Y) $-2 + 24i$
- Z) $2 + 24i$

ANSWER: Y) $-2 + 24i$

BONUS

5) MATH *Short Answer* Find the area of the triangle between $f(x) = 2x + 3$ and the x and y axes:

ANSWER: 2.25

(Solution: vertices at $(0, 0)$, $(0, 3)$, $(-1.5, 0)$. Area = $0.5 \times 3 \times 1.5 = 2.25$)

TOSS-UP

6) EARTH SCIENCE *Multiple Choice* Aquamarine is a gemstone that is a type of:

- W) beryl
- X) diamond
- Y) garnet
- Z) amber

ANSWER: W) BERYL

BONUS

6) EARTH SCIENCE *Multiple Choice* If the temperature at the base of an ice sheet is below the pressure-melting point, almost all motion occurs by which of the following processes:

- W) basal sliding
- X) internal ice deformation
- Y) laminar slippage
- Z) subglacial sediment deformation

ANSWER: X) INTERNAL ICE DEFORMATION

5442

TOSS-UP

7) GENERAL SCIENCE *Multiple choice* In a sodium chloride crystal, the lattice is based most closely on which of the following forms:

- W) body centered cubic
- X) cubic
- Y) hexagonal close packed
- Z) simple hexagonal

ANSWER: X) CUBIC

BONUS

7) GENERAL SCIENCE *Short Answer* What is the scientific term for the hibernation of animals in the summer to avoid the heat of a desert environment?

ANSWER: ESTIVATION

TOSS-UP

8) GENERAL SCIENCE *Multiple Choice* Which of the following best explains the D in DRAM:

- W) the memory must constantly be refreshed
- X) it speeds up access to data in files by using an inverted index
- Y) it allows the retention of the same data throughout the execution of a program
- Z) the memory is refreshed only once a session upon shutdown

ANSWER: W) THE MEMORY MUST CONSTANTLY BE REFRESHED

BONUS

8) GENERAL SCIENCE *Short Answer* A type of artificial intelligence that deals with designing computer systems that can comprehend and understand human languages is called:

ANSWER: NATURAL LANGUAGE (ACCEPT: NATURAL LANGUAGE PROCESSING)

TOSS-UP

9) PHYSICS *Multiple Choice* In the first half of the 20th century, a new law of physics called the “Bose-Einstein Distribution” was formulated. This explained which of the following:

- W) how time dilation occurs with particles at sub atomic levels
- X) how energy is shared among particles in gases
- Y) how energy and mass are related at extremely low temperatures
- Z) how solids behave at extremely low temperatures

ANSWER: X) HOW ENERGY IS SHARED AMONG PARTICLES IN GASES

BONUS

9) PHYSICS *Short Answer* If the speed of sound is 331 m/s, what is the wavelength, rounded to the first decimal place, of a soundwave that has a frequency of 100 hertz?

ANSWER: 3.3 METERS

(Solution: wavelength = speed / f = 331 / 100 = 3.31)

TOSS-UP

10) CHEMISTRY *Multiple Choice* Which positions on the benzene ring are the chlorine atoms found in the compound para-dichloro-benzene (pronounced: PARA-DIE-chloro-ben-zeen):

- W) 1 and 2
- X) 1 and 3
- Y) 1 and 4
- Z) 1 and 5

ANSWER: Y) 1 AND 4

BONUS

10) CHEMISTRY *Short Answer* Name two isotopes that have the distinction of being the only isotopes that have individual names and are the atoms of choice in the research efforts to create fusion reactors?

ANSWER: DEUTERIUM AND TRITIUM (ACCEPT: HYDROGEN-2 OR D; HYDROGEN-3 OR T)

TOSS-UP

11) BIOLOGY *Multiple Choice* T cells do much of their work by releasing:

- W) antibodies
- X) lymphocytes
- Y) cytokines
- Z) stress

ANSWER: Y) CYTOKINES

BONUS

11) BIOLOGY *Multiple Choice* Radicle is to primordial root as epicotyl is to:

- W) primordial micropyle
- X) primordial stem
- Y) primordial xylem
- Z) primordial flower

ANSWER: X) PRIMORDIAL STEM

TOSS-UP

12) ASTRONOMY *Multiple Choice* The reason magnitudes of brightness are often given in negative numbers is because:

- W) scientists originally based brightness on the negative log to the base ten
- X) astronomers got the idea from astrologers
- Y) today's astronomers extend the magnitude a lot farther in both directions than the Greeks
- Z) the Egyptians had no conceptual way of dealing with negative numbers

ANSWER: Y) TODAY'S ASTRONOMERS EXTEND THE MAGNITUDE A LOT FARTHER IN BOTH DIRECTIONS THAN THE GREEKS

BONUS

12) ASTRONOMY *Short Answer* Rounded off to the second decimal point, in seconds of arc, what is the resolving power of a 100-inch telescope?

ANSWER: 0.05 SECONDS OF ARC

(Solution: Formula is $13/\text{diameter of objective lens}$ 2.54cm/inch; $100''=254\text{cm}$; $13/254=0.05$)

TOSS-UP

13) MATH *Multiple Choice* Which decimal digits are NOT used in the octal numbering system:

- W) 7 and 8
- X) 8 and 9
- Y) 9 and 10
- Z) 7 and 9

ANSWER: X) 8 AND 9

BONUS

13) MATH *Short Answer* If $(x - 4)^2 + 4(y - 3)^2 = 16$ is graphed, the sum of the distances from any fixed point on the curve to the two foci is what?

ANSWER: 8

TOSS-UP

14) EARTH SCIENCE *Multiple Choice* Which of these would be LEAST likely to occur as a result of global warming:

- W) increased evaporation from oceans
- X) a lowering of sea levels around the globe
- Y) increased decomposition of organic matter in the soil
- Z) world-wide recession of low and middle latitude mountain glaciers

ANSWER: X) A LOWERING OF SEA LEVELS AROUND THE GLOBE

BONUS

14) EARTH SCIENCE *Short Answer* Ranging in size from less than a square kilometer to vast areas of subcontinental dimension, the land area from which water drains into a stream or river is called its:

ANSWER: WATERSHED (ACCEPT: DRAINAGE BASIN)

TOSS-UP

15) GENERAL SCIENCE *Multiple Choice* Which of the following is the BEST example of sound reasoning in science:

- W) scientific laws should not be subject to change
- X) theories can only be proven to be correct and cannot be proven false
- Y) correlation of cause and effect does not prove causation
- Z) scientific theories can only be tested by physical experimentation

ANSWER: Y) CORRELATION OF CAUSE AND EFFECT DOES NOT PROVE CAUSATION

BONUS

15) GENERAL SCIENCE *Short Answer* The first birth control pill contained an anti-ovulatory analogue of progesterone, which was based on the research involving the manufacture of steroids from this natural source:

ANSWER: YAM (ACCEPT: *DIOSCOREA*)

TOSS-UP

16) GENERAL SCIENCE *Multiple Choice* Which of the following CANNOT usually be used when connecting a printer to the computer:

- W) parallel port
- X) serial port
- Y) USB port
- Z) monitor port

ANSWER: Z) MONITOR PORT

BONUS

16) GENERAL SCIENCE *Multiple Choice* The Defense Department's experimental wide-area network called ARPANET was in use in 1969 and was based on which of the following:

- W) TCP/IP
- X) packet transmission and open architecture
- Y) mosaic
- Z) numerical integration and open streaming

ANSWER: X) PACKET TRANSMISSION AND OPEN ARCHITECTURE

(Solution: TCP/IP was developed by experimenting with ARPANET)

TOSS-UP

17) PHYSICS *Multiple Choice* Which of the following types of thermometers is the standard, chosen to delineate the intermediate temperature readings on other thermometers:

- W) constant volume gas thermometer
- X) mercury in glass thermometer
- Y) alcohol in glass thermometer
- Z) condensed helium thermometer

ANSWER: W) CONSTANT VOLUME GAS THERMOMETER

BONUS

17) PHYSICS *Short Answer* If a cyclist locks up her brakes at 15 km/hr, how much farther will she skid than if she were traveling at 5 km/hr?

ANSWER: 9 TIMES FARTHER

(Solution: $Fd = 1/2 mv^2$)

TOSS-UP

18) CHEMISTRY *Multiple choice* Which of the following has an empirical formula that is different from its molecular formula?

- W) $C_2H_6O_2$
- X) HSO_4
- Y) K_2CO_3
- Z) N_2O_3

ANSWER: W) $C_2H_6O_2$

BONUS

18) CHEMISTRY *Short answer* What is the name of the Law that says that at equilibrium, the amount of gas dissolved in a liquid at a given temperature is proportional to the partial pressure of the gas above the liquid?

ANSWER: HENRY'S LAW

TOSS-UP

19) **BIOLOGY** *Multiple Choice* Which of the following will most likely occur as T_3 and T_4 levels rise in the blood:

- W) FSH will decrease and LH will rise
- X) TSH release will fall
- Y) insulin levels will fall and oxytocin will be released
- Z) ACTH and LH will both rise

ANSWER: X) TSH RELEASE WILL FALL

BONUS

19) **BIOLOGY** *Short Answer* Of the four main blood types, which two will show no agglutination when tested against anti-B serum?

ANSWER: TYPES "A" AND "O"

TOSS-UP

20) **MATH** *Multiple Choice* $\sin(2A)$ is equal to which of the following:

- W) $\sin(A) - \cos(A)$
- X) $3 \sin(A) \div \cos(A)$
- Y) $2 \sin(A) \times \cos(A)$
- Z) $\tan(A) - 1$

ANSWER: Y) $2 \sin(A) \times \cos(A)$

BONUS

20) **MATH** *Short Answer* The pendulum of a clock swings through an angle of 1 radian, and the tip sweeps out an arc of 12 inches. How long is the pendulum?

ANSWER: 12 INCHES

TOSS-UP

21) EARTH SCIENCE *Multiple Choice* In general, a sand grain is too heavy to be picked up by the wind. However, it may be put into the air by this process:

- W) mass wasting
- X) siltation
- Y) frost heaving
- Z) saltation

ANSWER: Z) SALTATION

BONUS

21) EARTH SCIENCE *Multiple Choice* Of the following choices, which cloud formations would indicate the most severe incoming weather:

- W) cumulonimbus
- X) mammatus
- Y) pyrocumulus
- Z) stratocumulus

ANSWER: X) MAMMATUS

TOSS-UP

22) GENERAL SCIENCE *Multiple choice* Which of the following was introduced to the Americas from Africa:

- W) banana
- X) sweet potato
- Y) corn
- Z) lima bean

ANSWER: W) BANANA

BONUS

22) GENERAL SCIENCE *Short Answer* What person, from about 300 BC, and often referred to as the father of Greek Botany, wrote two treatises titled, "Inquiry" and "Causes", which carefully categorized and described the characteristics of over 550 plants:

ANSWER: THEOPHRASTUS

TOSS-UP

23) PHYSICS *Multiple Choice* By an extension of formulas derived by these two people, de Broglie showed that for any given particle there is an associated wave whose wavelength is inversely proportional to the momentum of the particle:

- W) Einstein and Bohr
- X) Bohr and Planck
- Y) Planck and Maxwell
- Z) Einstein and Planck

ANSWER: Z) EINSTEIN AND PLANCK

BONUS

23) PHYSICS *Short Answer* Rounded to the first decimal point, how long will it take a car traveling at 1 m/sec to stop, if its average breaking force is 150 newtons, the car's mass is 250 kilograms, and friction is negligible?

ANSWER: 1.7 SECONDS

(Solution: $F \times (\text{change in time}) = m \times \text{change in } v \dots 250 \times 1 / 150 = 1.7$)

TOSS-UP

24) CHEMISTRY *Multiple choice* Which of the following is NOT true of titration:

- W) if a strong acid is exactly neutralized by a strong base, a pH 7 is achieved
- X) if a strong acid is exactly neutralized by a weak base, a pH less than 7 is achieved
- Y) if a weak acid is exactly neutralized by a strong base, a pH greater than 7 is achieved
- Z) if a strong base is exactly neutralized by a strong acid, a pH greater than 7 is achieved

ANSWER: Z) IF A STRONG BASE IS EXACTLY NEUTRALIZED BY A STRONG ACID, A pH GREATER THAN 7 IS ACHIEVED

(Solution: if a strong base is exactly neutralized by a strong acid, a pH 7 is achieved)

BONUS

24) CHEMISTRY *Short answer* The science and technology of extracting metals from their natural sources and preparing them for practical use is called:

ANSWER: METALLURGY

TOSS-UP

25) BIOLOGY *Multiple Choice* Tiny openings in the insect body through which air enters are called:

- W) protopodites
- X) stomata
- Y) spinnerets
- Z) spiracles

ANSWER: Z) SPIRACLES

BONUS

25) BIOLOGY *Multiple Choice* Which of the following mechanisms is the most common method for lowering the amount of neurotransmitter in the synaptic cleft:

- W) enzymatic degradation
- X) re-uptake into the pre-synaptic terminal
- Y) re-uptake into the post-synaptic terminal
- Z) degradation by trypsin released into the synaptic cleft

ANSWER: X) RE-UPTAKE INTO THE PRE-SYNAPTIC TERMINAL