

ROUND 7

TOSS-UP

1) PHYSICS *Short Answer* Schrödinger's equation is a fundamental part of what scientific theory?

ANSWER: QUANTUM MECHANICS (ACCEPT: QUANTUM MECHANICAL THEORY, QUANTUM THEORY, QUANTUM PHYSICS; DO NOT ACCEPT: WAVE MECHANICS)

BONUS

1) PHYSICS *Short Answer* A rocket sled can accelerate to 40 meters per second in 0.05 seconds. What force, in newtons, would a 100 kilogram test dummy on the rocket sled experience from this motion?

ANSWER: 80,000

TOSS-UP

2) ENERGY *Multiple Choice* Line losses occur when electricity is transported long distances over transmission lines. Which of the following units is an appropriate measure for line losses?

- W) Kilovolts per kilometer
- X) Megawatts per mile
- Y) Megaamperes per kilometer
- Z) Volts-ampere

ANSWER: X) MEGAWATTS PER MILE

BONUS

2) ENERGY *Multiple Choice* Rare earth magnets are often used in the production of electrical energy. What percentage of world production of the rare earth materials used to produce these magnets was mined in the United States in 2011?

- W) 0%
- X) 5%
- Y) 7%
- Z) 12%

ANSWER: W) 0%

TOSS-UP

3) CHEMISTRY *Short Answer* Dr. Ecniecs, who loves riddles, gave the following riddle about the periodic table: Element A is left-right adjacent to element B. Element A never shares what it holds. Element B is always taking from other elements. Both elements are a clear gas. Both elements are nonmetals. Combined, they have a mass less than that of gallium. What are the identities of elements A and B?

ANSWER: NEON AND FLUORINE

BONUS

3) CHEMISTRY *Short Answer* Amides are formed through a reversible reaction that causes loss of water. This reaction occurs between an amine [**uh-MEEN**] and what other type of molecule?

ANSWER: CARBOXYLIC ACID

TOSS-UP

4) BIOLOGY *Multiple Choice* Which of the following is typically derived from ectoderm [**EK-tuh-durm**]?

W) Areolar connective tissue

X) Nervous tissue

Y) Blood

Z) Simple squamous epithelium [**SKWAY-muhs ep-uh-THEE-lee-uhm**]

ANSWER: X) NERVOUS TISSUE

BONUS

4) BIOLOGY *Multiple Choice* In the human body, copper plays a role in which of the following processes?

W) Muscle contraction

X) pH balance

Y) Protein synthesis

Z) Hemoglobin synthesis [**HEE-muh-gloh-bin**]

ANSWER: Z) HEMOGLOBIN SYNTHESIS

TOSS-UP

5) MATH *Short Answer* Given that $t \neq 0$, find $f\left(\frac{1}{t}\right)$ if $f(t) = \frac{1}{t}$.

ANSWER: t

BONUS

5) MATH *Short Answer* What are the coordinates of the points of intersection of the graphs of $y = 2x^2 - x$ and $y = 2x + 35$?

ANSWER: $(-7/2, 28)$ AND $(5, 45)$ (ACCEPT: $(-3.5, 28)$ AND $(5, 45)$)

TOSS-UP

6) EARTH AND SPACE *Short Answer* What is the hottest layer of the Sun's atmosphere?

ANSWER: CORONA

BONUS

6) EARTH AND SPACE *Multiple Choice* Assuming that you start with 100% U-238 and the U-238 decays to Pb-206, how many half-lives are needed to yield 625 atoms of U-238 and 19,375 atoms of Pb-206?

- W) 4
- X) 5
- Y) 6
- Z) 8

ANSWER: X) 5

TOSS-UP

7) PHYSICS *Multiple Choice* Two spheres, each with a charge of 3 microcoulombs, are separated by 9 meters. Given that $k = 9 \times 10^9$ meters per farad, how much electric potential energy in joules is stored in this combination of charges?

- W) 9×10^{-6}
- X) 1×10^{-3}
- Y) 9×10^{-3}
- Z) 9×10^9

ANSWER: Y) 9×10^{-3}

BONUS

7) PHYSICS *Short Answer* In 1955, a soldier's parachute failed to deploy, causing him to fall 1200 feet from the plane to the ground. However, he managed to land in a snow bank, surviving the fall and suffering only minor injuries. Assuming the paratrooper weighed 100 kilograms, that he had reached terminal velocity of approximately 50 meters per second, and that the snow exerts an average force of 120,000 newtons, what minimum depth of snow, in meters to one decimal place, was necessary to stop him?

ANSWER: 1.0

TOSS-UP

8) CHEMISTRY *Multiple Choice* Which of the following is NOT true in the titration of a weak monoprotic acid with a strong base?

- W) The starting pH will be lower than 7
- X) The final pH will be higher than 7
- Y) Methyl red would be a good indicator to use
- Z) Phenolphthalein [*fee-knol-THAY-leen*] would be a good indicator to use

ANSWER: Y) METHYL RED WOULD BE A GOOD INDICATOR TO USE

BONUS

8) CHEMISTRY *Short Answer* Since internal alkynes [*AL-kyns*] have an additional pi bond, they do not form the same products as alkenes [*AL-kyns*] upon cleavage by ozone or potassium permanganate [*per-MANG-guh-nayt*]. What functional group does this cleavage produce for internal alkynes?

ANSWER: CARBOXYLIC ACID

TOSS-UP

9) BIOLOGY *Multiple Choice* After a volcanic eruption wipes out the organisms on an island, which of the following would be the first to recolonize?

- W) Large carnivore
- X) Wind-dispersed grass
- Y) Frugivorous bird [*froo-JIV-er-uhs*]
- Z) Forest tree

ANSWER: X) WIND-DISPERSED GRASS

BONUS

9) BIOLOGY *Multiple Choice* How many fused rings does the carbon skeleton of steroids have?

- W) 2
- X) 4
- Y) 6
- Z) 8

ANSWER: X) 4

TOSS-UP

10) MATH *Short Answer* Evaluate: $\int_0^4 4 dx$ [*the integral from 0 to 4 of 4 dx*].

ANSWER: 16

BONUS

10) MATH *Short Answer* A farmer has three hens of varying weights. When the hens are weighed in pairs, they weigh 11.3, 11.8, and 12.1 pounds. What is the weight in pounds of the lightest hen?

ANSWER: 5.5

TOSS-UP

11) EARTH AND SPACE *Multiple Choice* Which of the following statements is NOT true about shallow living coral reefs?

- W) They serve as centers of biodiversity
- X) They are generally found in temperate waters
- Y) They are threatened by climate change
- Z) They can be assessed using towed diver surveys

ANSWER: X) THEY ARE GENERALLY FOUND IN TEMPERATE WATERS

BONUS

11) EARTH AND SPACE *Short Answer* What effect predicted by general relativity was Gravity Probe B designed to detect?

ANSWER: FRAME DRAGGING

TOSS-UP

12) PHYSICS *Multiple Choice* A wire carries a current of 2 amperes vertically upward. What is the magnitude and direction of the magnetic field in teslas produced by the wire 4 millimeters to the North of the wire?

- W) 1×10^{-4} , West
- X) 1×10^{-4} , East
- Y) 2×10^{-4} , West
- Z) 2×10^{-4} , East

ANSWER: W) 1×10^{-4} , WEST

BONUS

12) PHYSICS *Multiple Choice* A solid sphere of uniform density rolls down an incline without slipping. At the bottom of the incline, what fraction of the kinetic energy of the sphere is rotational kinetic energy?

- W) 2/7
- X) 5/7
- Y) 1/2
- Z) 7/10

ANSWER: W) 2/7

TOSS-UP

13) ENERGY *Short Answer* What is the name for the practice of reducing or shifting electricity usage during peak periods in response to time-based rates or other forms of financial incentives?

ANSWER: DEMAND RESPONSE (ACCEPT: DYNAMIC DEMAND)

BONUS

13) ENERGY *Multiple Choice* At 100 volts, which of the following is closest to the amperage through a circuit that consists of the following in series: resistors of 10 ohms, 15 ohms, and 22 ohms followed by these resistors in parallel: 5, 10, 20, all in the same circuit.

- W) 1.5
- X) 2.0
- Y) 2.5
- Z) 5.5

ANSWER: X) 2.0

TOSS-UP

14) CHEMISTRY *Multiple Choice* Which of the following is NOT a proposed step in the Suzuki reaction catalytic cycle?

- W) Oxidative addition
- X) Transmetalation
- Y) Beta-hydride elimination
- Z) Reductive elimination

ANSWER: Y) BETA-HYDRIDE ELIMINATION

BONUS

14) CHEMISTRY *Multiple Choice* Which of the following best describes the incident and exit beams in attenuated total reflectance spectroscopy?

- W) Incident beam is photons and exit beam is electrons
- X) Incident and exit beams are ions
- Y) Incident and exit beams are photons
- Z) Incident and exit beams are electrons

ANSWER: Y) INCIDENT AND EXIT BEAMS ARE PHOTONS

TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following is NOT a tool to develop homeothermy [*hoh-mee-uh-THERM-ee*] in baby birds?

- W) Large brood size
- X) Large toes
- Y) Down
- Z) Large leg muscles

ANSWER: X) LARGE TOES

BONUS

15) BIOLOGY *Multiple Choice* Which of the following statements about the Calvin cycle is NOT true?

- W) It is an important step during photosynthesis
- X) During the Calvin cycle, the simple inorganic molecule of carbon dioxide is used to make a complex organic molecule
- Y) The compound that begins the Calvin cycle is glyceraldehydes [*glis-uh-RAL-duh-hyd*]-3-phosphate
- Z) The energy needed for the Calvin cycle is provided by the light reaction

ANSWER: Y) THE COMPOUND THAT BEGINS THE CALVIN CYCLE IS GLYCERALDEHYDE-3-PHOSPHATE

TOSS-UP

16) MATH *Short Answer* A drawer contains 30 socks: 10 brown, 9 black, 6 blue, and 5 red. What is the fewest number of socks I must pick from the drawer without looking to be absolutely certain I have 2 socks of the same color?

ANSWER: 5

BONUS

16) MATH *Short Answer* The probability that a doctor is correct when making a diagnosis is 0.8. If the doctor makes an incorrect diagnosis, the probability that a patient sues is 0.3. What is the probability that the doctor makes an incorrect diagnosis and the patient sues?

ANSWER: 0.06 (ACCEPT: 3/50 or 6%)

TOSS-UP

17) EARTH AND SPACE *Short Answer* What discovery in the second half of the 20th century led to the acceptance of the Big Bang theory and the abandonment of the steady state model?

ANSWER: COSMIC MICROWAVE BACKGROUND

BONUS

17) EARTH AND SPACE *Multiple Choice* Which of the following classes of objects is distributed around the Sun with spherical symmetry?

- W) Asteroids
- X) Trans-Neptunian objects
- Y) Kuiper belt objects **[KY-per]**
- Z) Long-period comets

ANSWER: Z) LONG-PERIOD COMETS

TOSS-UP

18) BIOLOGY *Multiple Choice* Which of the following is a major benefit of membrane-bound cells and organelles?

- W) Compartmentalization of biochemical reactions
- X) Protection from UV radiation
- Y) Thermal isolation
- Z) Membranes conduct electrical signals

ANSWER: W) COMPARTMENTALIZATION OF BIOCHEMICAL REACTIONS

BONUS

18) BIOLOGY *Multiple Choice* Which of the following is NOT a result of parasympathetic nervous system stimulation?

- W) Stimulation of glucose release by the liver
- X) Contraction of pupils
- Y) Stimulation of salivation
- Z) Contraction of bronchi **[BRONG-kee]**

ANSWER: W) STIMULATION OF GLUCOSE RELEASE BY THE LIVER

TOSS-UP

19) PHYSICS *Multiple Choice* A 500 kilogram roller coaster car rounds the top of a hill with a radius of 25 meters at a speed of 15 meters per second. Given that the acceleration due to gravity is 10 meters per second squared, what is the normal force in newtons on the car at this point?

- W) 500
- X) 4500
- Y) 5000
- Z) 5500

ANSWER: W) 500

BONUS

19) PHYSICS *Short Answer* The coefficient of kinetic friction between a car's tires and a flat road is 0.8. The car is travelling at 40 meters per second when the driver slams on the brakes, causing the tires to lock. Assuming the acceleration due to gravity is 10 meters per second squared, how far will the car travel in meters after the driver hits the brakes?

ANSWER: 100

TOSS-UP

20) ENERGY *Multiple Choice* Which of the following industries has the largest water withdrawal?

- W) Agriculture
- X) Public drinking water
- Y) Thermoelectric power
- Z) Industrial and mining

ANSWER: Y) THERMOELECTRIC POWER

BONUS

20) ENERGY *Short Answer* Your mother has a fluorescent light in her office, and you notice a hum coming from it. Which property, that governs the changing of a material's physical dimensions in response to a change in magnetization, causes this humming sound?

ANSWER: MAGNETOSTRICTION

TOSS-UP

21) CHEMISTRY *Multiple Choice* Which of the following pairs would most likely undergo a Heck reaction?

- W) Styrene and iodobenzene
- X) Ethylbenzene and phenol **[FEE-nol]**
- Y) Vinyl bromide and benzene
- Z) Cyclohexane **[sy-kluh-HEK-sayn]** and allyl bromide

ANSWER: W) STYRENE AND IODOBENZENE

BONUS

21) CHEMISTRY *Short Answer* In semicrystalline polymers, the ordered regions will break up and become disordered at the melting temperature. However, amorphous regions soften over a wider range. What is the name of this range?

ANSWER: GLASS TRANSITION

TOSS-UP

22) BIOLOGY *Multiple Choice* Restriction endonucleases **[en-duh-noo-kee-AY-sis]** are found in bacteria and are thought to provide protection from viruses by cutting viral DNA into small fragments. Molecular biologists have used these enzymes to do which of the following?

- W) Fight viral infections in eukaryotes **[yoo-KAR-ee-ohts]**
- X) Clone specific genes into plasmids for expression by bacteria
- Y) Restrict the production of telomeres in yeast
- Z) Amplify desired DNA molecules in a controlled reaction

ANSWER: X) CLONE SPECIFIC GENES INTO PLASMIDS FOR EXPRESSION BY BACTERIA

BONUS

22) BIOLOGY *Multiple Choice* What component of the nephron establishes and maintains a salt gradient used to concentrate urine?

- W) Bowman's capsule
- X) Proximal convoluted tubule
- Y) Distal convoluted tubule
- Z) Loop of Henle

ANSWER: Z) LOOP OF HENLE

TOSS-UP

23) MATH *Short Answer* Given that $f(x) = \frac{2x}{x-1}$ [**f of x equals the fraction with numerator 2x and denominator x minus 1**] is a one-to-one function, find x so that $f^{-1}(x) = 5$ [**f inverse of x equals 5**].

ANSWER: 5/2 (ACCEPT: 2.5 OR 2 1/2)

BONUS

23) MATH *Short Answer* Providing your answer in slope intercept form, what is the equation of the normal line to the function $f(x) = x^3 + 2x^2 + 5x - 2$ at the point where $x = 0$?

ANSWER: $y = (-1/5)x - 2$

TOSS-UP

24) EARTH AND SPACE *Short Answer* What is the region around a spinning black hole in which the frame dragging effect is so strong that all objects are forced to rotate around the black hole?

ANSWER: ERGOSPHERE

BONUS

24) EARTH AND SPACE *Multiple Choice* Which of the following characterizes tsunamis in the open ocean?

- W) Shallow water waves with long wavelengths and long periods
- X) Intermediate waves with long wavelengths and short periods
- Y) Deep water waves with short wavelengths and long periods
- Z) Deep water waves with long wavelengths and short periods

ANSWER: W) SHALLOW WATER WAVES WITH LONG WAVELENGTHS AND LONG PERIODS

TOSS-UP

25) PHYSICS *Multiple Choice* A 3 kilogram mass, a 4 kilogram mass, and a 5 kilogram mass are placed in a line at positions of 3 meters, 4 meters, and 5 meters, respectively, from the origin. Which of the following is nearest the location of the center of mass of this set of masses in meters from the origin?

- W) 0.24
- X) 1.00
- Y) 4.17
- Z) 12.0

ANSWER: Y) 4.17

BONUS

25) PHYSICS *Short Answer* A 10 ohm resistor, a 20 ohm resistor, and a 30 ohm resistor are connected in series to a 12 volt battery. How much energy in joules is dissipated in heat through the 30 ohm resistor in 60 seconds?

ANSWER: 72