

TOSS-UP

1) EARTH AND SPACE SCIENCE *Short Answer* First described by William Buckland in 1829, originally called “fossil fir cones” and “bezoar stones”, and ranging in size from a few millimeters to over 60 centimeters, what are the fossil dung and stomach contents that are useful to paleontologists because they provide direct evidence of the predation and diet of extinct organisms?

ANSWER: COPROLITES

BONUS

1) EARTH AND SPACE SCIENCE *Short Answer* Arrange the following 4 components of the interstellar medium from least dense to most dense:
HI clouds; intercloud medium; coronal gas; molecular clouds

ANSWER: 3, 2, 1, 4

TOSS-UP

2) PHYSICS *Short Answer* You connect a capacitor $C_1 = 5.0 \text{ F}$ to a power supply, charge it to a potential difference of $V_0 = 120 \text{ V}$, and disconnect the power supply. If the charge Q on the capacitor C_1 is 600 C , what is the energy stored in C_1 , in joules?

ANSWER: 36,000 JOULES

BONUS

2) PHYSICS *Multiple Choice* Which of the following particles does not obey Bose-Einstein statistics?

- W) graviton
- X) Z boson
- Y) muon
- Z) gluon

ANSWER: Y) MUON

TOSS-UP

3) BIOLOGY *Multiple Choice* Which of the following major animal phyla are characterized by pseudocoelomate, unsegmented bilaterally symmetrical worms, with a tubular digestive tract passing from the mouth to the anus, living in great numbers in soil and aquatic environments, some of which are important animal parasites, including pinworms and hookworms?

- W) platyhelminthes
- X) nematoda
- Y) annelida
- Z) hemichordata

ANSWER: X) NEMATODA

BONUS

3) BIOLOGY *Multiple Choice* Which of the following cell types functions to mediate the maturation of other T cells in the thymus, but is not involved in the immediate response to infection?

- W) Helper T cell
- X) Inducer T cell
- Y) Cytotoxic T cell
- Z) Suppressor T cell

ANSWER: X) INDUCER T CELL

TOSS-UP

4) CHEMISTRY *Short Answer* By name or number, indicate all of the following 3 molecules that have an electron-pair geometry of trigonal planar:

BCl_3 , NCl_3 , CO_3^{2-}

ANSWER: 1 AND 3

BONUS

4) CHEMISTRY *Short Answer* Nitrogen and oxygen gases react to form ammonia gas in the reaction $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \rightarrow 2 \text{NH}_3(\text{g})$. If 500 mL of N_2 at 1 atm and 25 °C were available for reaction, what volume of H_2 , at the same temperature and pressure, would be required in the reaction? Give your answer in liters.

ANSWER: 1.50 L

TOSS-UP

5) ENERGY *Short Answer* Which two hydrocarbons, which have octane numbers of 0 and 100, respectively, are used for comparison to hydrocarbons that are burned in one-cylinder test engines in order to find their unknown octane numbers?

ANSWER: HEPTANE AND 2, 2, 4-TRIMETHYLPENTANE (ACCEPT: ISOOCTANE FOR 2, 2, 4-TRIMETHYLPENTANE)

BONUS

5) ENERGY *Short Answer* What specific type of light water nuclear reactor, developed by the Idaho National Laboratory and General Electric in the mid-1950s, is used for the generation of electrical power and has a reactor core which heats water which turns to steam and turns the steam turbine?

ANSWER: BOILING WATER REACTOR (BWR)

TOSS-UP

6) MATHEMATICS *Short Answer* Indicate, by name or number, all of the following four

functions that have the given end behavior: $\lim_{x \rightarrow +\infty} f(x) = +\infty$

- 1: the cosine function
- 2: the greatest integer function
- 3: the natural logarithmic function
- 4: the logistic function

ANSWER: 2 AND 3

BONUS

6) MATHEMATICS *Short Answer* Find $\sin(\theta)$ and $\tan(\theta)$ if $\cos(\theta) = 5/6$ and $\cot(\theta) > 0$.

ANSWER: $\sin(\theta) = \sqrt{11}/6$, $\tan(\theta) = \sqrt{11}/5$

TOSS-UP

7) EARTH AND SPACE SCIENCE *Short Answer* In what specific region of the H-R diagram are giants fusing helium in their cores and then in shells primarily through the triple alpha process after they have left the main sequence?

ANSWER: HORIZONTAL BRANCH

BONUS

7) EARTH AND SPACE SCIENCE *Short Answer* Indicate all of the following three statements that is/are true of the variation of density with depth in oceans:

- 1: the water column in low latitudes is isopycnal
- 2: the density of ocean waters is inversely proportional to the temperature
- 3: vertical mixing between the layers above and below the pycnocline vitally supports nutrient transport

ANSWER: 2 AND 3

TOSS-UP

8) PHYSICS *Short Answer* By name or number, indicate all of the following 3 choices that can be expected to have a filled valence band and an empty conduction band at absolute zero:

- 1: pure germanium
- 2: sodium metal
- 3: porcelain insulator

ANSWER: 1 AND 3

BONUS

8) PHYSICS *Multiple Choice* A large tank consists of water that is 25.0 m deep, and it is open to the atmosphere. Assuming that the pressure at the surface of the tank is 1.01×10^5 Pa and the acceleration due to gravity is 10 ms^{-2} , which of the following values can be estimated to be the

pressure at the bottom of the tank, in pascals?

- W) 3.5×10^3
- X) 3.5×10^4
- Y) 3.5×10^5
- Z) 3.5×10^6

ANSWER: Y) 3.5×10^5

TOSS-UP

9) BIOLOGY *Short Answer* What virus, first reported in 1911 by American medical researcher Peyton Rous, was found to infect and initiate cancer in the chicken fibroblast cells growing in culture from which more viruses could be isolated, and is classified as a retrovirus because it makes a DNA copy of its RNA genome and inserts that copy into the host cell's DNA?

ANSWER: ROUS AVIAN SARCOMA VIRUS (ACCEPT: ROUS SARCOMA VIRUS)

BONUS

9) BIOLOGY *Multiple Choice* Which of the following growth factors of mammalian cells has a narrow range of specificity, and works to trigger the division of activated T lymphocytes during the immune response?

- W) Interleukin-2
- X) Erythropoietin
- Y) Transforming growth factor β
- Z) Platelet-derived growth factor

ANSWER: W) INTERLEUKIN-2

TOSS-UP

10) CHEMISTRY *Short Answer* How many radial and angular nodes, respectively, exist for the orbital with the following set of quantum numbers? $\{3, 1, 0, \frac{1}{2}\}$

ANSWER: 1 RADIAL, 1 ANGULAR

BONUS

10) CHEMISTRY *Multiple Choice* Which of the following Bravais lattices is not correctly paired with the number of atoms it contains?

- W) face-centered cubic, 4
- X) body-centered cubic, 2
- Y) primitive orthorhombic, 2
- Z) body-centered orthorhombic, 2

ANSWER: Y) PRIMITIVE ORTHORHOMBIC

TOSS-UP

11) ENERGY *Multiple Choice* Which of the following natural gas formations, which is formed by the compaction of silt and clay-sized mineral particles, is projected by the Annual Energy Outlook to make up 45% of the U.S. natural gas supply by 2035?

- W) shale gas
- X) methane hydrates
- Y) biomass
- Z) liquefied natural gas

ANSWER: W) SHALE GAS

BONUS

11) ENERGY *Short Answer* Indicate all of the following 3 statements that is/are TRUE about propane and its usage for energy:

- 1: it is a very clean burning fossil fuel
- 2: it is supplied to local propane dealers at distribution terminals
- 3: it is used to heat asphalt for highway construction and repairs

ANSWER: 1 AND 3

TOSS-UP

12) MATHEMATICS *Short Answer* What is the equation of the line with a slope of $-3/4$, containing the point (8, -2)?

ANSWER: $y = (-3/4)x + 4$

BONUS

12) MATHEMATICS *Short Answer* Consider the following equation: $2x^2 + 3x = 2$. Indicate, by name or number, all of the following 4 values of x that are solutions of the equation:

- 1: $x = 2$
- 2: $x = -2$
- 3: $x = 1/2$
- 4: $x = -1/2$

ANSWER: 1 AND 3