MOSFET ROUND 9

TOSS-UP

1) Physics – *Short Answer* [9] What experiment fired alpha particles at thin sheets of metal, thus disproving the plum-pudding model of the atom?

ANSWER: RUTHERFORD GOLD FOIL EXPERIMENT (ACCEPT: GEIGER–MARSDEN EXPERIMENT; GOLD FOIL EXPERIMENT) [Modern, SS]

BONUS

1) Physics – *Short Answer* [9] If the following three objects with equal mass and radius are rolled down a ramp at the same time, order them from the first to hit the bottom to the last: 1) Uniform solid sphere; 2) Uniform disk; 3) Uniform hoop.

ANSWER: 1, 2, 3 (ACCEPT: UNIFORM SOLID SPHERE, UNIFORM DISK, UNIFORM HOOP) [Mech, SS]

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TOSS-UP

2) Biology – *Short Answer* [9] Juvenile hormone and ecdysteroids regulate what major developmental process in many insects?

ANSWER: METAMORPHOSIS [RSS, Endocrine]

BONUS

2) Biology – *Multiple Choice* [9] In which of the following processes would the T1 phage most likely participate in?

W) Transduction
X) Transformation
Y) Conjugation
Z) Binary fission

ANSWER: W) TRANSDUCTION [Bacteria, GW]
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TOSS-UP

3) Earth and Space – *Short Answer* [9] Identify all of the following three planets that have an intrinsic, global-scale magnetic field: 1) Mercury; 2) Venus; 3) Earth.

ANSWER: 1 AND 3 (ACCEPT: MERCURY AND EARTH) [Solar System, JS]

BONUS

3) Earth and Space – *Short Answer* [9] What type of metamorphism occurs when a large body of rock undergoes extensive heat and pressure due to large scale processes such as mountain building?

ANSWER: REGIONAL METAMORPHISM (ACCEPT: REGIONAL; BARROVIAN METAMORPHISM; DYNAMOTHERMAL METAMORPHISM) [Petrology, JS]

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TOSS-UP

4) Math – *Multiple Choice* [9] Which of the following statements is NOT true regarding the Fibonacci sequence?

W) It always has more odd than even terms
X) No squares besides 1 appear in the sequence
Y) The ratio of consecutive terms approaches the golden ratio
Z) It is strictly nondecreasing

ANSWER: X) NO SQUARES BESIDES 1 APPEAR IN THE SEQUENCE [Algebra, SS]

BONUS

4) Math – *Short Answer* [9] What is the decimal representation of the base-six numeral two-four-three-five?

ANSWER: 599 [Number Theory, SS]
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TOSS-UP

5) Chemistry – *Short Answer* [9] What specific type of bond forms when nitrogen's lone pair in ammonia attacks the empty p orbital of boron in boron trifluoride, and is described as a bond formed between Lewis acid-base adducts?

ANSWER: COORDINATE COVALENT BOND (ACCEPT: DATIVE BOND; DATIVE COVALENT BOND; DO NOT ACCEPT: COVALENT BOND) [AB, ND]

BONUS

5) Chemistry – *Multiple Choice* [9] Which of the following is closest to the packing efficiency of a face-centered cubic lattice?

W) 52%
X) 68%
Y) 74%
Z) 85%

ANSWER: Y) 74% [Crystals, ND]

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TOSS-UP

6) Energy – *Short Answer* [9] Researchers at UW Madison are attempting to understand the relationships between quantum dots and semiconductors for liquid crystal displays. Identify all of the following three elements that would most likely be used for an industrial semiconductor: 1) Carbon; 2) Silicon; 3) Germanium.

ANSWER: 2 AND 3 (ACCEPT: SILICON AND GERMANIUM) [Chemistry, DJ]

BONUS

6) Energy – *Short Answer* [9] The Center for Interdisciplinary Inquiry and Innovation in Sexual and Reproductive Health at the University of Chicago is a faculty-led initiative to advance sexual health. The menstrual cycle is an important part of the female reproductive system. Which two anterior pituitary hormones primarily regulate when ovulation occurs in the menstrual cycle?

ANSWER: LUTEINIZING HORMONE AND FOLLICLE STIMULATING HORMONE (ACCEPT: LH AND FSH) [GW]
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TOSS-UP

7) Physics – *Multiple Choice* [9] Which of the following quantities is equal to the ratio between the dynamic and kinematic viscosities of a fluid?

W) Bulk modulus
X) Reynolds number
Y) Density
Z) Area

ANSWER: Y) DENSITY [Mech, SS]

BONUS

7) Physics – *Short Answer* [9] An alpha particle, initially at rest, accelerates across a 4-volt potential. What is the final kinetic energy of the alpha particle in electronvolts?

ANSWER: 8 [E&M, GW]

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TOSS-UP

8) Biology – *Multiple Choice* [9] Which of the following vitamins is deficient in sufferers of beriberi?

W) Thiamine
X) Biotin
Y) Retinol
Z) Cobalamin

ANSWER: W) THIAMINE [Vitamins, DJ]

BONUS

8) Biology – *Short Answer* [9] Order the following three stages of the development of a frog from earliest to latest: 1) Gastrulation; 2) Organogenesis; 3) Cleavage.

ANSWER: 3, 1, 2 (ACCEPT: CLEAVAGE, GASTRULATION, ORGANOGENESIS) [Developmental, DJ]
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TOSS-UP

9) Earth and Space – *Multiple Choice* [9] Which of the following is the Maunder Butterfly diagram most closely associated with?

W) Moon phases
X) Sun spots
Y) Mercury's orbit
Z) Meteor showers

ANSWER: X) SUN SPOTS [Solar System, JS]

BONUS

9) Earth and Space – *Short Answer* [9] A binary system has two stars of 5 and 7 solar masses. In solar masses, what is the reduced mass of the system?

ANSWER: 35/12 [Astrophysics, SS]

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TOSS-UP

10) Math – *Short Answer* [9] A fair six-sided die is rolled 10 times. What is the probability that every roll is different?

ANSWER: 0 [Combo, GW]

BONUS

10) Math – *Short Answer* [9] A set of data has a variance of 5. Suppose each data point is multiplied by 3 and then increased by 2. What is the new variance of this set of data?

ANSWER: 45 [Statistics, SS]
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TOSS-UP

11) Chemistry – *Short Answer* [9] What is the degree of unsaturation of the compound C_6H_6?

ANSWER: 4 [Orgo, DJ]

BONUS

11) Chemistry – *Multiple Choice* [9] If the reaction of N_2 gas plus $3H_2$ gas is in equilibrium with $2NH_3$ gas, then the equilibrium constant of concentration is denoted K_c. Which of the following would be the expression for K_p?

W) K_c times the quantity RT squared
X) K_c
Y) K_c divided by the quantity RT squared
Z) K_c divided by the quantity RT cubed

ANSWER: Y) K_c DIVIDED BY THE QUANTITY RT SQUARED [Equilibrium, DJ]

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TOSS-UP

12) Energy – *Multiple Choice* [9] Researchers in the Center for Condensed Matter Sciences at UF are studying the magnetic properties of fermionic condensates. Which of the following particles is capable of forming a fermionic condensate?

W) Hydrogen-2
X) Helium-3
Y) Helium-4
Z) Gluon

ANSWER: X) HELIUM-3 [Particle, BZ]

BONUS

12) Energy – *Short Answer* [9] Researchers in the Grenning lab at UF have designed a synthesis of common terpenoid cores. Terpenoids are derived from isoprene, with a chemical formula of C_5H_8. How many pi bonds does isoprene have?

ANSWER: 2 [BZ]
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TOSS-UP

13) Physics – *Short Answer* [9] What phenomenon was first studied in pollen grains and describes the random motion of particles suspended in a fluid?

ANSWER: BROWNIAN MOTION [Misc, GW]

BONUS

13) Physics – *Multiple Choice* [9] Assuming that the speed of sound in air is 340 meters per second, then what is the fundamental frequency of a 34 centimeter long pipe with two open ends?

W) 200 hertz
X) 250 hertz
Y) 500 hertz
Z) 1000 Hertz

ANSWER: Y) 500 HERTZ [Mech, ND]

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TOSS-UP

14) Biology – *Short Answer* [9] Order the following three steps of a PCR cycle from first to last: 1) Annealing; 2) Denaturation; 3) Extension.

ANSWER: 2, 1, 3 (ACCEPT: DENATURATION, ANNEALING, EXTENSION) [Biotechnology, GW]

BONUS

14) Biology – *Multiple Choice* [9] Which of the following is always an inhibitory neurotransmitter?

W) GABA
X) Epinephrine
Y) Acetylcholine
Z) Glutamate

ANSWER: W) GABA [Nervous, DJ]
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TOSS-UP

15) Earth and Space – *Multiple Choice* [9] Which of the following terms relating to glaciers is NOT correctly matched to its definition?

W) Erratic - a large boulder carried away from its original location by a glacier
X) Kettle - a depression in an outwash plain
Y) Crevasse - a thin valley produced by glacial abrasion
Z) Arête - a thin ledge of rock that separates two glacial troughs

ANSWER: Y) CREVASSE - A THIN VALLEY PRODUCED BY GLACIAL ABRASION [Glaciology, JS]

BONUS

15) Earth and Space – *Short Answer* [9] Rank the following three hydrogen spectral line series from shortest to longest wavelengths: 1) Balmer Series; 2) Lyman Series; 3) Paschen Series

ANSWER: 2, 1, 3 (ACCEPT: LYMAN SERIES, BALMER SERIES, PASCHEN SERIES) [Stellar Astronomy, JS]

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TOSS-UP

16) Math – *Multiple Choice* [9] A quadrilateral has perpendicular diagonals with lengths of 8 and 12. What is the area of the quadrilateral?

W) 48
X) 72
Y) 96
Z) 192

ANSWER: W) 48 [Geometry, GW]

BONUS

16) Math – *Short Answer* [9] Evaluate the definite integral from 1 to 3 of the fraction with numerator 3 dx and denominator $x + 1$.

ANSWER: 3ln(2) [Calculus, GW]
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TOSS-UP

17) Chemistry – *Short Answer* [9] Identify all of the following three titrations that would result in the formation of a precipitate: 1) Hydrochloric acid and sodium hydroxide; 2) Ammonium bromide and acetate; 3) Hydrofluoric acid and barium hydroxide.

ANSWER: 3 ONLY [Lab, GW]

BONUS

17) Chemistry – *Multiple Choice* [9] Which of the following conformations of cyclohexane is the MOST stable?

W) Half-chair
X) Twist-boat
Y) Chair
Z) Envelope

ANSWER: Y) CHAIR [Orgo, ND]

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TOSS-UP

18) Energy – *Short Answer* [9] Researchers in the McDaniel lab at the University of Florida are studying the origins of separate sexes in species evolution. What term is used to describe species that have both male and female sex organs?

ANSWER: HERMAPHRODITE (ACCEPT: HERMAPHRODITISM) [BZ]

BONUS

18) Energy – *Short Answer* [9] Researchers at the UIUC are investigating the optics of 3D-printed lenses. Suppose a lens has a focal length of 0.4 meters. What is the power of the lens, in diopters?

ANSWER: 2.5 (ACCEPT: 5/2) [Optics, GW]
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TOSS-UP

19) Physics – *Short Answer* [9] What principle states that every point on a wavefront is the source of new spherical wavelets?

ANSWER: HUYGENS PRINCIPLE (ACCEPT: HUYGENS–FRESNEL PRINCIPLE) [Mech, GW]

BONUS

19) Physics – *Short Answer* [9] According to the Born interpretation, the probability density of a particle's position is proportional to what power of the wavefunction's magnitude?

ANSWER: 2 (ACCEPT: SECOND; SQUARE) [Quantum, SS]

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TOSS-UP

20) Biology – *Multiple Choice* [9] A mother with a blood type of AB and a father with a blood type of B have a child. How many different possible blood types could the child have?

W) 1
X) 2
Y) 3
Z) 4

ANSWER: Y) 3 [Genetics, GW]

BONUS

20) Biology – *Short Answer* [9] Mice with a mutation of the ob ***[o-b]*** gene were observed to develop obesity. This is because the ob gene codes for what hormone which is produced by adipose tissue, and functions in the regulation of appetite?

ANSWER: LEPTIN [RSS, Digestive]
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TOSS-UP

21) Earth and Space – *Short Answer* [9] What cycle describes the cyclical opening and closing of Earth's ocean basins due to plate tectonic processes?

ANSWER: WILSON CYCLE [Other Geology, JS]

BONUS

21) Earth and Space – *Multiple Choice* [9] Which of the following statements regarding Pluto is NOT true?

W) Ice on Pluto is primarily composed of nitrogen
X) Pluto is tidally locked to its moon Charon
Y) Pluto is smaller in volume than Earth's moon
Z) Pluto's orbit crosses that of Neptune and Uranus

ANSWER: Z) PLUTO'S ORBIT CROSSES THAT OF NEPTUNE AND URANUS [Solar System, JS]

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TOSS-UP

22) Math – *Multiple Choice* [9] A piecewise function is defined by $f(x) = x + 2$ when x is less than or equal to 1, and $f(x) = 2x - 1$ when x is greater than 1. Which of the following statements best describes the limit as x approaches 1 of $f(x)$?

W) It does not exist
X) It exists and equals 1
Y) It exists and equals 2
Z) It exists and equals 3

ANSWER: W) IT DOES NOT EXIST [Calculus, GW]

BONUS

22) Math – *Short Answer* [9] How many digits are in the base-3 representation of 9 to the 10th power?

ANSWER: 21 [Number Theory, GW]
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TOSS-UP

23) Chemistry – *Multiple Choice* [9] What are the units for the rate constant of a third order reaction?

W) Moles cubed per liters cubed per second
X) Moles squared per liters squared per second
Y) Liters cubed per moles cubed per second
Z) Liters squared per moles squared per second

ANSWER: Z) LITERS SQUARED PER MOLES SQUARED PER SECOND [Kinetics, BZ]

BONUS

23) Chemistry – *Short Answer* [9] What is the chemical formula for the anhydrous form of sulfuric acid?

ANSWER: SO_3 [Trivia, BZ]