MOSFET ROUND 6

TOSS-UP

1) Physics – *Short Answer* [6] In fluid mechanics, what principle states that a pressure change on one part of the fluid tends to be equally transmitted throughout the entire fluid?

ANSWER: PASCAL'S PRINCIPLE (ACCEPT: PASCAL'S LAW) [Mech, GW]

BONUS

1) Physics – *Multiple Choice* [6] Which of the following best describes the first postulate of special relativity?

W) All laws of physics are the same in all inertial reference frames
X) The universe is expanding
Y) Charged particles experience a force when traveling perpendicular to a magnetic field
Z) Mass and energy are equivalent

ANSWER: W) ALL LAWS OF PHYSICS ARE THE SAME IN ALL INERTIAL REFERENCE FRAMES [Modern, GW]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

2) Biology – *Short Answer* [6] What enzymes do retroviruses such as HIV use to synthesize complementary DNA directly from an RNA template?

ANSWER: REVERSE TRANSCRIPTASE [Virus, BZ]

BONUS

2) Biology – *Multiple Choice* [6] Anna conducts an analysis on a plant tissue sample and observes that it has high concentrations of lignin. Which of the following types of plant tissue is the sample most likely composed of?

W) Parenchyma
X) Collenchyma
Y) Sclerenchyma
Z) Aerenchyma

ANSWER: Y) SCLERENCHYMA [RSS, Plant tissues]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

3) Earth and Space – *Short Answer* [6] What is the major cation present in fluorite?

ANSWER: Ca^{2+} (ACCEPT: CALCIUM) [Mineralogy, BZ]

BONUS

3) Earth and Space – *Multiple Choice* [6] Which of the following is generally the strongest force driving plate motion?

W) Ridge push
X) Slab pull
Y) Slab suction
Z) Tidal forces

ANSWER: X) SLAB PULL [Other Geology, JS]

~~~~~~

TOSS-UP

4) Math – *Multiple Choice* [6] What is the last digit of 2^{2020}?

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

ANSWER: Y) 6 [Number Theory, GW]

BONUS

4) Math – *Short Answer* [6] Identify all of the following three functions that pass the horizontal line test: 1) $-2x^2 + 3x + 2$; 2) $3x^3 + 1$; 3) x.

ANSWER: 2 AND 3 (ACCEPT: $3x^3 + 1$ AND x) [Algebra, GW]
~~~~~~

TOSS-UP

5) Chemistry – *Short Answer* [6] What equation in electrochemistry is used to calculate the cell potential of an electrode in non-standard conditions?

ANSWER: NERNST EQUATION [Electrochem, ND]

BONUS

5) Chemistry – *Multiple Choice* [6] Which of the following isotopes decays radioactively?

W) Oxygen-16
X) Aluminum-27
Y) Molybdenum-96
Z) Plutonium-244

ANSWER: Z) PLUTONIUM-244 [Nuclear, Chem, DJ]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

6) Energy – *Short Answer* [6] Researchers at UW Madison are currently working with a novel catalysis method by using compounds that have an unpaired valence electron. What name is given to these classes of compounds that have unpaired valence electrons?

ANSWER: RADICAL (ACCEPT: FREE RADICAL) [Chemistry, DJ]

BONUS

6) Energy – *Short Answer* [6] Researchers at UW Madison are studying the instability of slowly pulsating B stars. They found that what pseudoforce is responsible for this instability, which deflects objects that are moving in a rotating reference frame?

ANSWER: CORIOLIS FORCE (ACCEPT: CORIOLIS EFFECT) [GW]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

7) Physics – *Multiple Choice* [6] In which of the following mediums does sound travel the fastest at standard temperature and pressure?

W) Helium
X) Argon
Y) Aluminum
Z) Water

ANSWER: Y) ALUMINUM [Misc, GW]

BONUS

7) Physics – *Multiple Choice* [6] The thermal resistance, or R-value, of an insulating material is a measure of how good of an insulator it is. It is defined as the thickness of a material divided by its thermal conductivity. Based on R-value, which of the following combinations would make for the best insulator?

W) Very thin rubber
X) Very thick rubber
Y) Very thin copper
Z) Very thick copper

ANSWER: X) VERY THICK RUBBER [Thermo, GW]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

8) Biology – *Short Answer* [6] What type of animal cell junction, analogous to plasmodesmata in plants, allows for the connection between the cytoplasms of adjacent cells?

ANSWER: GAP JUNCTION [Cell types, DJ]

BONUS

8) Biology – *Short Answer* [6] After entering the right atrium of the heart, order the following three structures which blood will pass through from first to last: 1) Pulmonary vein; 2) Right ventricle; 3) Left ventricle.

ANSWER: 2, 1, 3 (ACCEPT: RIGHT VENTRICLE, PULMONARY VEIN, LEFT VENTRICLE) [Circulatory, GW]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

9) Earth and Space – *Short Answer* [6] The Kirkwood gaps in the asteroid belt are created by orbital resonance with which planet?

ANSWER: JUPITER [Solar System, JS]

BONUS

9) Earth and Space – *Short Answer* [6] Rank the following three minerals in order of increasing crystallization temperature: 1) Olivine; 2) Quartz; 3) Amphibole.

ANSWER: 2, 3, 1 (ACCEPT: QUARTZ, AMPHIBOLE, OLIVINE) [Mineralogy, BZ]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

10) Math – *Multiple Choice* [6] Which of the following polynomials is divisible by $x + 1$?

W) $x^2 + 1$
X) $x^4 + 1$
Y) $x^6 + 1$
Z) $x^9 + 1$

ANSWER: Z) $x^9 + 1$ [Algebra, GW]

BONUS

10) Math – *Short Answer* [6] What is the product of the complex numbers $3 + i$ and $1 - 2i$?

ANSWER: $5 - 5i$ [Algebra, SS]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

11) Chemistry – *Short Answer* [6] Chemists often make the simplifying assumption that water autoionizes into H^+ and OH^-. However, water does not actually form H^+. Instead, what specific positively charged product is formed?

ANSWER: H_3O^+ (ACCEPT: HYDRONIUM; HYDRONIUM ION; HYDRONIUM CATION) [AB, DJ]

BONUS

11) Chemistry – *Multiple Choice* [6] What is the molecular geometry of the compound XeF_4?

W) Tetrahedral
X) Seesaw
Y) Trigonal bipyramidal
Z) Square planar

ANSWER: Z) SQUARE PLANAR [VSEPR, DJ]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

12) Energy – *Short Answer* [6] Researchers at UW Madison have been using liquid magneto-optic traps to constrain atoms at temperatures lower than 1 millikelvin. What state of matter is produced at extremely low temperatures for materials with integer spin when the atoms are in their lowest quantum state?

ANSWER: BOSE EINSTEIN CONDENSATION (ACCEPT: BEC) [DJ]

BONUS

12) Energy – *Short Answer* [6] Researchers at UW Madison are studying the Grotthuss mechanism in water in order to better understand the bonding properties of water. Identify all of the following three intermolecular forces that water experiences: 1) London dispersion; 2) Hydrogen bonding; 3) Ion dipole.

ANSWER: 1 AND 2 (ACCEPT: LONDON DISPERSION AND HYDROGEN BONDING) [Chemistry, DJ]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

13) Physics – *Multiple Choice* [6] In which of the following types of thermodynamic processes does a system do zero work on its surroundings?

W) Isobaric
X) Isothermal
Y) Isochoric
Z) Reversible

ANSWER: Y) ISOCHORIC [Thermo, SS]

BONUS

13) Physics – *Short Answer* [6] What experiment found that the speed of light was the same in different directions, thus disproving the existence of the luminiferous ether?

ANSWER: MICHELSON–MORLEY EXPERIMENT [Mech, GW]

~~~~~~

TOSS-UP

14) Biology – *Short Answer* [6] What fungal structures consist of a mass of branching hyphae that function for nutrient absorption, and are analogous to the roots of plants?

ANSWER: MYCELIUM [Fungus, GW]

BONUS

14) Biology – *Multiple Choice* [6] Which of the following is NOT a component of a neuron?

W) Axon
X) Acrosome
Y) Dendrite
Z) Myelin sheath

ANSWER: X) ACROSOME [Cell types, DJ]
~~~~~~

TOSS-UP

15) Earth and Space – *Short Answer* [6] What is the term for the layer in a body of water where density rapidly increases with depth?

ANSWER: PYCNOCLINE [Oceanography, BZ]

BONUS

15) Earth and Space – *Short Answer* [6] What unit of measurement is equivalent to one-sixtieth of a degree on the celestial sphere?

ANSWER: ARC MINUTE (ACCEPT: MINUTE OF ARC) [Other Astronomy, JS]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

16) Math – *Multiple Choice* [6] Which of the following vectors is parallel to the vector $i + 2j + 4k$?

W) $3i – 6j + 12k$
X) $–2i – 4j – 8k$
Y) $4i – k$
Z) $2i + 2j – 3k$

ANSWER: X) $–2i – 4j – 8k$ [Algebra, GW]

BONUS

16) Math – *Short Answer* [6] Sanjay rolls a fair six-sided die twice. What is the probability that the two rolls are different?

ANSWER: 5/6 [Combo, GW]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

17) Chemistry – *Short Answer* [6] What is the coordination number of a body centered cubic crystal lattice?

ANSWER: 8 [Crystals, ND]

BONUS

17) Chemistry – *Short Answer* [6] Identify all of the following three species that are basic when dissolved in water: 1) CH_3COOH; 2) NaCl; 3) $MgBr_2$.

ANSWER: NONE [AB, BZ]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

18) Energy – *Short Answer* [6] Scientists at the CERES center at the University of Chicago are studying neural networks in computing systems. What is the name of the field, which encompasses machine learning, that studies how computers can "mimic" human thinking and learning?

ANSWER: ARTIFICIAL INTELLIGENCE (ACCEPT: AI) [GW]

BONUS

18) Energy – *Multiple Choice* [6] Researchers at the University of Chicago are studying defects in the potassium channel protein caused by disulfide bridges. A disulfide bridge in a protein contributes to what level of protein structure?

W) Primary
X) Secondary
Y) Tertiary
Z) Quaternary

ANSWER: Y) TERTIARY [Biochemistry, DJ]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

19) Physics – *Short Answer* [6] In Faraday's law of induction, what additional law states that the induced current opposes the initial change in the magnetic flux?

ANSWER: LENZ'S LAW [E&M, SS]

BONUS

19) Physics – *Multiple Choice* [6] Light travels from air, with an index of refraction of n = 1.0, to water, with an index of refraction of n = 1.33. If the initial wavelength of the light was 600 nanometers, and assuming that the frequency of light does not change, what is the final wavelength of the light?

W) 400 nanometers
X) 450 nanometers
Y) 600 nanometers
Z) 800 nanometers

ANSWER: X) 450 NANOMETERS [Misc, GW]

~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

20) Biology – *Multiple Choice* [6] Which of the following is the specific name for the region in a prokaryotic cell containing most of the genetic material?

W) Nucleolus
X) Nucleus
Y) Nuclear lamina
Z) Nucleoid

ANSWER: Z) NUCLEOID [Bacteria, DJ]

BONUS

20) Biology – *Short Answer* [6] The posterior pituitary gland can be thought of as an extension of what structure in the brain, which is sometimes called the body's thermostat?

ANSWER: HYPOTHALAMUS [RSS, Endocrine]
~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~

TOSS-UP

21) Earth and Space – *Multiple Choice* [6] Which of the following best describes a planetary nebula?

W) Reflection nebula
X) Emission nebula
Y) Dark nebula
Z) Supernova remnant

ANSWER: X) EMISSION NEBULA [Other Astronomy, SS]

BONUS

21) Earth and Space – *Multiple Choice* [6] Which of the following statements regarding rivers is NOT true?

W) Flow velocity generally decreases with distance from the source
X) The capacity of a stream is a measure of the amount of sediment it can carry
Y) Meandering rivers tend to form on low inclines
Z) The interface between land and a stream is known as the riparian zone

ANSWER: W) FLOW VELOCITY GENERALLY DECREASES WITH DISTANCE FROM THE SOURCE [Other Geology, JS]

~~~~~~

TOSS-UP

22) Math – *Short Answer* [6] 5 friends go to a movie theater. How many ways can they be seated in a row of 5 seats?

ANSWER: 120 [Combo, SS]

BONUS

22) Math – *Short Answer* [6] A triangle has vertices at (1, 2), (5, –2), and (3, 3). What are the coordinates of the centroid of the triangle?

ANSWER: (3, 1) [Geometry, GW]
~~~~~~

TOSS-UP

23) Chemistry – *Multiple Choice* [6] Which of the following expressions is equal to the denominator for the equilibrium constant in the reaction of $N_2 + 2O_2$ in equilibrium with $2NO_2$?

W) Concentration of N_2 times the concentration of O_2 squared.
X) Concentration of NO_2 squared
Y) Concentration of NO_2
Z) Concentration of N_2 times the concentration of O_2

ANSWER: W) CONCENTRATION OF N_2 TIMES THE CONCENTRATION OF O_2 SQUARED [Equilibrium, DJ]

BONUS

23) Chemistry – *Short Answer* [6] Suppose that the pKa of formic acid is 4. When titrating a 2 molar solution of formic acid with a 2 molar solution of sodium hydroxide, what is the pH of the solution at the half-equivalence point, to the nearest integer?

ANSWER: 4 [AB, BZ]