



## MOSFET 2025 - Round 3

### TOSS-UP

1) BIOLOGY *Short Answer* Order the following three interactions from primary to tertiary in terms of protein structure:

- 1) peptide bond
- 2) disulfide bond
- 3) hydrogen bond

ANSWER: 1, 3, 2 [SY]

### BONUS

1) BIOLOGY *Multiple Choice* In the human brain, oligodendrocytes serve which of the following roles?

- W) They form the blood-brain barrier
- X) They create cerebrospinal fluid
- Y) They myelinate neurons
- Z) They are the immune cells of the brain

ANSWER: Y) THEY MYELINATE NEURONS [AF]

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### TOSS-UP

2) MATH *Short Answer* On the island of ScienceBowlia, consumers can buy goods with 4-point or 9-point coins. What is the price of the most expensive product that no consumer can buy?

ANSWER: 23 [SE]

### BONUS

2) MATH *Short Answer* What are the coordinates of the y-intercept of the line that passes through the point (8, 0) and is perpendicular to the line  $y = -2x + 25$ ?

ANSWER: (0, -4) (ACCEPT: -4) [MW]

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### TOSS-UP

3) CHEMISTRY *Short Answer* Evan is performing a reaction that is 2nd order in reactant A and 1st order in reactant B. If he doubles the concentration of both reactants, by what factor does the rate of the reaction change?

ANSWER: 8 [KD]

### **BONUS**

3) CHEMISTRY *Short Answer* Owen is burning a gas sample containing hydrogen and oxygen gas. If the reaction goes to completion and the sample initially contained 6 grams of hydrogen, then to the nearest gram, what was the initial mass of the oxygen gas in the container?

ANSWER: 48 [HJ]

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### **TOSS-UP**

4) EARTH AND SPACE *Multiple Choice* Which of the following types of volcanoes is most prone to violent felsic eruptions and includes Mount Fuji and Mount Vesuvius?

- W) Cinder cone
- X) Stratovolcano
- Y) Shield volcano
- Z) Fissure

ANSWER: X) STRATOVOLCANO [KW, Geo, RR]

### **BONUS**

4) EARTH AND SPACE *Multiple Choice* What term refers to dry, ephemeral lake beds in desert basins, which are often covered by a layer of evaporite minerals?

W) Playa

X) Alluvial fan

Y) Oxbow lake

Z) Yazoo tributary

ANSWER: W) PLAYA [KW and HJ, Geo, EDE]

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### **TOSS-UP**

5) PHYSICS *Short Answer* Cindy shines monochromatic light through a double slit and notices that an interference pattern results on the screen. What wave phenomenon does this experiment demonstrate?

ANSWER: DIFFRACTION [YL]

### **BONUS**

5) PHYSICS *Short Answer* A 5-kilogram red ball traveling at 8 meters per second to the west collides with a 20-kilogram ball moving at 4 meters per second to the east. If the balls collide perfectly inelastically, what is the final speed of the balls?

ANSWER: 1.6 [OW, RR]

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### TOSS-UP

6) ENERGY *Short Answer* Researchers at the University of Stuttgart are studying novel catalysts for conversion of alkenes to alkanes. This conversion is done through the addition of what diatomic gas to the alkenes?

ANSWER: HYDROGEN [KD]

### BONUS

6) ENERGY *Short Answer* Researchers at UW-Madison are studying the inheritance of the ROF1 and ROF2 genes. After gathering data on the genotypes of the offspring of a test cross, they hypothesize that the two genes are found on different chromosomes. What statistical test could be used on the data to evaluate their hypothesis?

ANSWER: CHI-SQUARE TEST [OW]

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### TOSS-UP

7) BIOLOGY *Short Answer* Keratin is held together by what strong covalent bonds, typically formed from two cysteines?

ANSWER: DISULFIDE BONDS [SY] cell bio

### BONUS

7) BIOLOGY *Short Answer* Dr. Kim is constructing a new organism called a Chimpkey. He crosses a Chimpkey with genotype AABbCcdd (*read: big A big A big B little B big C little c little d little d*) with a Chimpkey of genotype AABBCCDD (*read: big A big A big B big B big C big c big d big d*). What is the probability that an offspring will display a dominant phenotype for every gene?

ANSWER: 100% (ACCEPT: 1) [AF]

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### TOSS-UP

8) MATH *Short Answer* What is the units digit of 3 to the 10th power?

ANSWER: 9 [SE]

### BONUS

8) MATH *Short Answer* An isosceles right triangle with legs of length 10 is inscribed in a circle. To the nearest multiple of ten, what is the area of the circle?

ANSWER: 160 [MW]

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### TOSS-UP

9) CHEMISTRY *Short Answer* Order the following three elements by increasing electronegativity:

- 1) Oxygen
- 2) Fluorine
- 3) Chlorine

ANSWER: 3, 1, 2 [HJ]

### BONUS

9) CHEMISTRY *Multiple Choice* In which of the following situations would a chemical reaction be thermodynamically favored at all temperatures?

- W)  $\Delta H$  greater than 0 and  $\Delta S$  greater than 0
- X)  $\Delta H$  less than 0 and  $\Delta S$  greater than 0
- Y)  $\Delta H$  greater than 0 and  $\Delta S$  less than 0
- Z)  $\Delta H$  less than 0 and  $\Delta S$  less than 0

ANSWER: X)  $\Delta H$  LESS THAN 0 AND  $\Delta S$  GREATER THAN 0 [SK]

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### TOSS-UP

10) EARTH AND SPACE *Short Answer* Order the following three elements by increasing abundance in the universe:

- 1) Hydrogen
- 2) Helium
- 3) Carbon

ANSWER: 3, 2, 1 [HJ]

### BONUS

10) EARTH AND SPACE *Short Answer* Identify all of the following three solar system objects that are moons:

- 1) Ceres
- 2) Ganymede
- 3) Titan

ANSWER: 2 AND 3 [HJ]

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### TOSS-UP

11) PHYSICS *Short Answer* Two resistors with resistances of 3 and 6 ohms are connected in series to a battery with a voltage of 27 volts. In amperes, what is the current flowing through the circuit?

ANSWER: 3 [YL]



### BONUS

11) PHYSICS *Short Answer* Order the following three combinations of spring constant and compression length by increasing potential energy stored:

- 1) 6 Newtons per meter, 4 meters
- 2) 8 Newtons per meter, 3 meters
- 3) 12 Newtons per meter, 2 meters

ANSWER: 3, 2, 1 [SO]

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### TOSS-UP

12) ENERGY *Multiple Choice* Researchers in the Hoffman Lab at Yale are studying the role of mechanical stimuli in various diseases using novel tension sensors. Which of the following receptors respond to mechanical stimuli?

- W) Opsins in the eye
- X) Stretch receptors in the skin
- Y) Gustation receptors in the mouth
- Z) Sodium receptors in the kidney

ANSWER: X) STRETCH RECEPTORS IN THE SKIN [SY]

### BONUS

12) ENERGY *Short Answer* Researchers at DoE labs are studying the applications of statistics in machine learning. If one data set has a mean of 15 and a standard deviation of 2, what is the z-score of a data point with a value of 12?

ANSWER: -1.5 [SO, RR]

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**TOSS-UP**

13) BIOLOGY *Short Answer* The progression of Parkinson's disease is thought to be primarily caused by a deficiency of what neurotransmitter?

ANSWER: DOPAMINE [SK]

**BONUS**

13) BIOLOGY *Short Answer* Some researchers believe that cephalopods developed their camera eyes independently of vertebrates, and that both types of eyes separately evolved to gain a similar function over time. What type of evolution is this an example of?

ANSWER: CONVERGENT EVOLUTION [SK]

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**TOSS-UP**

14) MATH *Short Answer* What is the slope of a line perpendicular to the line with equation  $7x - 4y = -28$ ?

ANSWER:  $-4/7$  [MW]

**BONUS**

14) MATH *Short Answer* Giving your answer as a number in base-10, what is the sum of the largest 3-digit integer in base 2 and the largest 3 digit integer in base-3?

ANSWER: 33 [EZ]

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### TOSS-UP

15) CHEMISTRY *Short Answer* What is the oxidation state of the central iron atom in the complex ion  $\text{FeCl}_6^{3-}$ ?

ANSWER: +3 (ACCEPT: 3) [YL]

### BONUS

15) CHEMISTRY *Multiple Choice* Which of the following elements is NOT a metal?

- W) Lithium
- X) Strontium
- Y) Palladium
- Z) Antimony

ANSWER: Z) ANTIMONY [HJ]

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### TOSS-UP

16) EARTH AND SPACE *Short Answer* Though they form in different environments, travertine, chalk, and coquina are all composed of what chemical compound, most commonly found as the mineral calcite?

ANSWER: CALCIUM CARBONATE (ACCEPT:  $\text{CaCO}_3$ ) [HJ, R&M]

### BONUS

16) EARTH AND SPACE *Short Answer* What is the name of the process where cold, nutrient-rich deep ocean water rises to replace diverging surface waters?

ANSWER: UPWELLING [HJ]

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### TOSS-UP

17) PHYSICS *Short Answer* Time dilation and length contraction both result from what theory, which relates space and time?

ANSWER: SPECIAL RELATIVITY (ACCEPT: RELATIVITY) [CZ]

### BONUS

17) PHYSICS *Short Answer* Angelina is observing a sample of matter as it cools to near absolute zero. Interestingly, she notices that the entropy of the sample approaches a constant non-zero value. What law of thermodynamics does Angelina's experiment support?

ANSWER: THIRD LAW OF THERMODYNAMICS [OW, RR]

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### TOSS-UP

18) ENERGY *Multiple Choice* Scientists at the Renewable Energy Lab are studying photosynthesis and its biofuel applications. Which of the following colors of light do plants absorb LEAST efficiently for energy?

W) red

X) yellow

Y) green

Z) purple

ANSWER: Y) GREEN [SO, RR]

### **BONUS**

18) ENERGY *Short Answer* Researchers at Boston University are studying the magnitudes and frequencies of earthquakes in a wide range of tectonic environments. Identify all of the following three tectonic environments that are found at convergent boundaries:

- 1) Subduction zone
- 2) Mid-ocean ridge
- 3) Strike-slip fault

ANSWER: 1 ONLY [HJ]

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### **TOSS-UP**

19) BIOLOGY *Multiple Choice* In plants, what ground tissue cells conduct the majority of photosynthesis and other metabolic processes?

- W) parenchyma
- X) aerenchyma
- Y) collenchyma
- Z) sclerenchyma

ANSWER: W) PARENCHYMA [SO]

### **BONUS**

19) BIOLOGY *Short Answer* Identify all of the following three eukaryotic cellular structures that are composed of microtubules:

- 1) Flagella
- 2) Centrioles
- 3) Spindle fibers

ANSWER: ALL [SK]

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### **TOSS-UP**

20) MATH *Multiple Choice* Which of the following statements is logically equivalent to "If T is a leopard, then T has spots"?

- W) If T has spots, then T is a leopard
- X) If T is not a leopard, then T does not have spots
- Y) If T does not have spots, then T is not a leopard
- Z) If T does not have spots, then T is a leopard

ANSWER: Y) IF T DOES NOT HAVE SPOTS, THEN T IS NOT A LEOPARD [MW]

### **BONUS**

20) MATH *Multiple Choice* How many ways are there to arrange the letters in the word "syzygy", spelled S-Y-Z-Y-G-Y?

W) 120

X) 240

Y) 360

Z) 720

ANSWER: W) 120 [JW]

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### **TOSS-UP**

21) CHEMISTRY *Multiple Choice* Which of the following thermodynamic variables is NOT a state function?

W) Entropy

X) Heat

Y) Pressure

Z) Internal energy

ANSWER: X) HEAT [YL]

### **BONUS**

21) CHEMISTRY *Multiple Choice* The contrasting pieces of evidence provided by phenomena such as diffraction and the photoelectric effect most directly prove which of the following quantum mechanical principles?

- W) Heisenberg uncertainty principle
- X) Quantum tunneling
- Y) Superposition
- Z) Wave-particle duality

ANSWER: Z) WAVE-PARTICLE DUALITY [HJ]

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### **TOSS-UP**

22) EARTH AND SPACE *Short Answer* What class of stars, denoted by spectral class M, are the most common stars in the Milky Way and comprise the smallest stars on the main sequence?

ANSWER: RED DWARFS [HJ]



### BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following best explains why the apparent magnitude of a star is a misleading measurement of a star's true brightness?

- W) It only considers energy emitted in the visual region of the EM spectrum
- X) It is changed by the presence of a protoplanetary disk around the star
- Y) It depends on the distance to the star
- Z) It depends on the temperature of the star

ANSWER: Y) IT DEPENDS ON THE DISTANCE TO THE STAR [SE]

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### TOSS-UP

23) PHYSICS *Short Answer* What physical quantity is the rotational analog of mass and is multiplied by angular acceleration to give the net torque on an object?

ANSWER: MOMENT OF INERTIA (ACCEPT: ROTATIONAL INERTIA) [DL]

### BONUS

23) PHYSICS *Short Answer* How many protons and neutrons, respectively, are found inside an alpha particle?

ANSWER: 2 PROTONS, 2 NEUTRONS [YL]