



## MOSFET 2025 - Round 2

### TOSS-UP

1) BIOLOGY *Multiple Choice* Which of the following statements is true about cardiovascular disease?

- W) Taking clotting inhibitors like aspirin can reduce the risk of cardiovascular disease
- X) Atherosclerosis is caused by the buildup of proteins in the endothelium
- Y) Hypertension occurs when blood pressure is abnormally low
- Z) Ventricular fibrillation decreases the risk of heart failure

ANSWER: W) TAKING CLOTTING INHIBITORS LIKE ASPIRIN CAN REDUCE THE RISK OF CARDIOVASCULAR DISEASE [SY]

### BONUS

1) BIOLOGY *Multiple Choice* If a sequence of 3 nucleotides on the coding strand reads 5 prime TAG 3 prime, then the sequence of the mRNA made from this portion of DNA would read:

W) 5 prime AUC 3 prime

X) 5 prime UAG 3 prime

Y) 5 prime ATC 3 prime

Z) 5 prime UUC 3 prime

ANSWER: X) 5 PRIME UAG 3 PRIME [AF]

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### TOSS-UP

2) MATH *Short Answer* What is the base-ten equivalent of the base-seven number six five?

ANSWER: 47 [MW]

### BONUS

2) MATH *Short Answer* The point (4, 5) is reflected across the graph of  $y = 1$  and the resulting point is then reflected across the graph of  $y = x$ . What are the coordinates of the final point?

ANSWER: (-3, 4) [MW]

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### TOSS-UP

3) CHEMISTRY *Short Answer* Sodium borohydride and lithium aluminum hydride are both reagents used in what general type of reaction, which involves the gain of electrons?

ANSWER: REDUCTION [CZ]

### BONUS

3) CHEMISTRY *Short Answer* In the VSEPR model, identify all of the following three electron-pair geometries that could yield a bent molecular geometry:

- 1) Trigonal planar
- 2) Tetrahedral
- 3) Trigonal bipyramidal

ANSWER: 1 AND 2 [HJ]

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### TOSS-UP

4) EARTH AND SPACE *Short Answer* What is the name of the tallest mountain in the solar system?

ANSWER: OLYMPUS MONS [VM]

### BONUS

4) EARTH AND SPACE *Short Answer* The presence of an E horizon between topsoil and subsoil layers is indicative of what process, where soil nutrients are washed out of the soil by infiltrating water?

ANSWER: LEACHING (ACCEPT: ELUVIATION) [HJ]

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### TOSS-UP

5) PHYSICS *Multiple Choice* Which of the following circuit components stores energy in the form of an electric field?

W) Capacitor

X) Inductor

Y) Battery

Z) Diode

ANSWER: W) CAPACITOR [YL]

### BONUS

5) PHYSICS *Short Answer* What is the ratio of the charge of the positron to the charge of its antiparticle, the electron?

ANSWER: -1 (ACCEPT: 1: -1) [YL]

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### TOSS-UP

6) ENERGY *Multiple Choice* Material scientists are studying rayon, a soft fabric. Rayon is a reconstituted form of what structural carbohydrate, most commonly found in the cell walls of plants?

W) Cellulose

X) Amylose

Y) Chitin

Z) Pectin

ANSWER: W) CELLULOSE [SO]

### BONUS

6) ENERGY *Short Answer* Scientists at NASA are studying the accelerating expansion of the universe. One theory, known as the lambda-CDM model, proposes that this expansion is primarily driven by what hidden, low-density substance?

ANSWER: DARK ENERGY [SO]

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### TOSS-UP

7) BIOLOGY *Multiple Choice* Which of the following hormones binds to receptors in the interior of a target cell?

- W) Epinephrine
- X) Testosterone
- Y) Insulin
- Z) Growth hormone

ANSWER: X) TESTOSTERONE [OW]

### BONUS

7) BIOLOGY *Multiple Choice* A plant with the floral pattern *sepal petal petal sepal* is likely missing which of the following MADS-box genes?

- W) A
- X) B
- Y) C
- Z) D

ANSWER: Y) C [SY]

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### TOSS-UP

8) MATH *Short Answer* Frances rolls two standard 6-sided dice. What is the probability that she rolls at least one odd number?

ANSWER:  $\frac{3}{4}$  (ACCEPT: 0.75) [MW]

### BONUS

8) MATH *Multiple Choice* If 4 chords are drawn inside a circle, what is the maximum number of regions the circle can be divided into?

W) 8

X) 9

Y) 10

Z) 11

ANSWER: Z) 11 [JW]

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### TOSS-UP

9) CHEMISTRY *Multiple Choice* Which of the following elements has the lowest ionization energy?

W) Lithium

X) Sodium

Y) Fluorine

Z) Chlorine

ANSWER: X) SODIUM [YL]

### **BONUS**

9) CHEMISTRY *Short Answer* In order for a liquid to rise up a small tube via capillary action, the adhesive forces between the liquid and the tube walls must exceed what other force, which represents the attraction of liquid molecules to other liquid molecules?

ANSWER: COHESION [HJ]

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### **TOSS-UP**

10) EARTH AND SPACE *Short Answer* The phrase “dark side of the moon” refers to the fact that one face of the Moon always faces away from observers on the Earth. This phenomenon is due to what effect, where orbiting celestial bodies rotate synchronously due to gravitational forces?

ANSWER: TIDAL LOCKING [HJ]

### **BONUS**

10) EARTH AND SPACE *Short Answer* Identify all of the following three types of plate boundaries where earthquakes commonly occur:

- 1) Divergent
- 2) Convergent
- 3) Transform

ANSWER: ALL [HJ]

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### TOSS-UP

11) PHYSICS *Short Answer* A ball is dropped from rest at the Earth's surface. In meters per second, what is the speed of the ball 2 seconds after it is dropped?

ANSWER: 19.6 [YL]

### BONUS

11) PHYSICS *Short Answer* Identify all of the following three quantities that are vectors:

- 1) Force
- 2) Power
- 3) Momentum

ANSWER: 1 AND 3 [OW]

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### TOSS-UP

12) ENERGY *Multiple Choice* Which of the following energy sources is the MOST dependent on the time of day?

- W) wind
- X) geothermal
- Y) nuclear
- Z) coal

ANSWER: W) WIND [SO]

### BONUS

12) ENERGY *Multiple Choice* Scientists at the Princeton Plasma Physics Lab are studying high-energy physics. Which of the following correctly describes a difference between electrons and muons?

- W) electrons are positively charged, while muons are negatively charged
- X) muons are more massive than electrons
- Y) electrons are much less stable than muons
- Z) electrons do not interact with gravity, while muons do

ANSWER: X) MUONS ARE MORE MASSIVE THAN ELECTRONS [SO]

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### TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following nucleic acids is NOT directly involved in prokaryotic protein synthesis?

- W) rRNA
- X) tRNA
- Y) miRNA
- Z) mRNA

ANSWER: Y) miRNA [SK]

### BONUS

13) BIOLOGY *Short Answer* What model proposes that both substrates and enzymes undergo conformational changes to achieve an ideal arrangement for a chemical reaction?

ANSWER: INDUCED FIT MODEL (ACCEPT: INDUCED FIT) [OW]

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### TOSS-UP

14) MATH *Multiple Choice* In triangle ABC,  $AB = 5$ ,  $BC = 6$ , and  $AC = 7$ . Which of the following pairs of adjectives best describes ABC?

- W) Isosceles and obtuse
- X) Isosceles and acute
- Y) Scalene and obtuse
- Z) Scalene and acute

ANSWER: Z) SCALENE AND ACUTE [EZ]

### BONUS

14) MATH *Short Answer* Find the value of the product  $xyz$  in the following system of 3 equations:  $x + y = 7$ ,  $x + z = 8$ ,  $y + z = 9$

ANSWER: 60 [MW]

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### TOSS-UP

15) CHEMISTRY *Multiple Choice* Which of the following compounds does NOT readily dissolve in water?

- W) Hydrogen chloride
- X) Ethanol
- Y) Hexane
- Z) Ammonium sulfate

ANSWER: Y) HEXANE [HJ]

### BONUS

15) CHEMISTRY *Short Answer* For a given reaction at 250 kelvin, the enthalpy change is +12 kilojoules per mole, and the entropy change is +30 joules per mole kelvin. In kilojoules per mole and to two significant figures, what is the Gibbs free energy change of this reaction?

ANSWER: +4.5 [HJ]

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### TOSS-UP

16) EARTH AND SPACE *Multiple Choice* The majority of Earth's upper mantle is composed of what green, ultramafic rock?

- W) Peridotite
- X) Diorite
- Y) Basalt
- Z) Granite

ANSWER: W) PERIDOTITE [KW, Geo or R/M, RR]

### BONUS

16) EARTH AND SPACE *Short Answer* Identify all of the following three atmospheric gases that are considered greenhouse gases:

- 1) Argon
- 2) Nitrous oxide
- 3) Water vapor

ANSWER: 2 AND 3 [HJ, A/O, RR]

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### TOSS-UP

17) PHYSICS *Short Answer* In a typical Hookean spring, the potential energy of the spring is proportional to what power of the spring's displacement from its relaxed length?

ANSWER: 2 [YL]

### BONUS

17) PHYSICS *Short Answer* A photon is moving through a vacuum with a frequency of  $1.5 \times 10^6$  hertz. To one significant figure, what is the photon's wavelength, in meters?

ANSWER: 200 [OW]

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### TOSS-UP

18) ENERGY *Multiple Choice* Scientists at the National Institute of Health are researching the pathology of Tay-Sachs disease. Tay-Sachs disease is caused by a buildup of lipids due to a failure in what organelle?

W) Nucleus

X) Rough ER

Y) Lysosome

Z) Plasma membrane

ANSWER: Y) LYSOSOME [SO, RR]

### BONUS

18) ENERGY *Short Answer* Researchers at Boston University are investigating how ongoing climate change affects the ability for forest ecosystems to store carbon. Order the following three carbon pools by increasing total storage capacity:

- 1) Soil
- 2) Oceans
- 3) Terrestrial vegetation

ANSWER: 3, 1, 2 [HJ, RR/EDE]

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### TOSS-UP

19) BIOLOGY *Multiple Choice* Which of the following conditions is NOT necessary for a population to be in Hardy-Weinberg equilibrium?

- W) Random mating
- X) Large populations
- Y) Nonzero immigration
- Z) No natural selection

ANSWER: Y) NONZERO IMMIGRATION [OW]

### BONUS

19) BIOLOGY *Short Answer* What chemicals produced by mast cells are primarily responsible for allergic reaction responses?

ANSWER: HISTAMINES [SK]

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**TOSS-UP**

20) MATH *Short Answer* Find the product of the roots of the polynomial  $2x^2 + 5x + 8$ .

ANSWER: 4 [SE]

**BONUS**

20) MATH *Short Answer* If the sum of the square roots of two numbers is 3, what is the smallest possible sum of the two numbers?

ANSWER: 4.5 (ACCEPT: 9/2) [JW]

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**TOSS-UP**

21) CHEMISTRY *Multiple Choice* Which of the following acids is the strongest?

W) Hydrofluoric acid

X) Perchloric acid

Y) Formic acid

Z) Oxalic acid

ANSWER: X) PERCHLORIC ACID [HJ]

### BONUS

21) CHEMISTRY *Short Answer* Identify all of the following three species which would be present in the net ionic equation after mixing aqueous solutions of  $\text{K}_2\text{SO}_4$  and  $\text{BaCl}_2$ :

- 1)  $\text{K}^+$
- 2)  $\text{Ba}^{2+}$
- 3)  $\text{BaSO}_4$

ANSWER: 2 AND 3 [HJ]

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### TOSS-UP

22) EARTH AND SPACE *Short Answer* What two stellar properties are plotted along the axes of the Hertzsprung-Russell diagram?

ANSWER: TEMPERATURE AND LUMINOSITY [HJ]

### BONUS

22) EARTH AND SPACE *Multiple Choice* Which of the following objects is NOT a dwarf planet?

- W) Pluto
- X) Charon
- Y) Eris
- Z) Makemake

ANSWER: X) CHARON [SE]

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### TOSS-UP

23) PHYSICS *Short Answer* Identify all of the following 3 metals that are ferromagnetic:

- 1) Aluminum
- 2) Iron
- 3) Nickel

ANSWER: 2 AND 3 [OW]

### BONUS

23) PHYSICS *Multiple Choice* Which of the following changes to a circuit would decrease the equivalent resistance of a circuit with a 9-volt battery and a 2-ohm resistor?

- W) Changing the battery for a 7-volt battery
- X) Adding an additional 2-ohm resistor in parallel
- Y) Adding an additional 2-ohm resistor in series
- Z) Increasing the length of the wires in the circuit

ANSWER: X) ADDING AN ADDITIONAL 2-OHM RESISTOR IN PARALLEL [OW]