



## MOSFET 2025 - Round 1

### TOSS-UP

1) BIOLOGY *Short Answer* Identify all of the following 3 organelles that possess a double membrane:

- 1) Mitochondria
- 2) Lysosome
- 3) Nucleus

ANSWER: 1 AND 3 [OW]

### BONUS

1) BIOLOGY *Multiple Choice* Sickle cell anemia is caused when a glutamate residue is converted into a valine residue from a single base change. Which of the following types of mutation causes sickle cell anemia?

W) Nonsense

X) Silent

Y) Missense

Z) Deletion

ANSWER: Y) MISSENSE [SY]

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### TOSS-UP

2) MATH *Short Answer* What is the length of the longest diagonal in a regular hexagon with side length 4?

ANSWER: 8 [MW]

### BONUS

2) MATH *Short Answer* What percentage of the first 20 positive integers are prime?

ANSWER: 40% [MW]

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### TOSS-UP

3) CHEMISTRY *Short Answer* In the reaction between  $\text{PCl}_3$  and  $\text{Cl}_2$ , the rate law is given by  $k$  times the concentration of  $\text{PCl}_3$  times the concentration of  $\text{Cl}_2$ . What is the overall order of this reaction?

ANSWER: 2 [HJ]

### BONUS

3) CHEMISTRY *Short Answer* Identify all of the following four compounds that have a tetrahedral molecular geometry:

- 1)  $\text{H}_2\text{S}$
- 2)  $\text{CH}_4$
- 3)  $\text{XeO}_4$
- 4)  $\text{SF}_6$

ANSWER: 2 AND 3 [SK]

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### TOSS-UP

4) EARTH AND SPACE *Short Answer* Shreyas, on vacation, notices that almost all active Hawaiian volcanoes are on the youngest island. This is because Hawaii lies on what type of structure, where a rising mantle plume creates volcanoes within a moving plate?

ANSWER: HOTSPOT [KW]

### BONUS

4) EARTH AND SPACE *Short Answer* Kiara was outside at night walking her pet beet when she looked up and saw an aurora. Auroras result when Earth's atmosphere interacts with what constant stream of plasma released by the Sun?

ANSWER: SOLAR WIND [KW]

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### TOSS-UP

5) PHYSICS *Multiple Choice* Which of the following functions of  $x$  versus  $t$  could represent simple harmonic motion?

W)  $x = t$

X)  $x = t^2$

Y)  $x = e^t$

Z)  $x = \sin(t)$

ANSWER: Z)  $x = \sin(t)$  [YL]

### BONUS

5) PHYSICS *Short Answer* The electric field due to a point charge is proportional to what power of the distance away from the charge?

ANSWER: -2 [YL]

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### TOSS-UP

6) ENERGY *Multiple Choice* Researchers at UW-Madison are attempting to repurpose bacterial gene mapping techniques for eukaryotes. Which of the following correctly describes the nucleic acid used to store genetic information by bacteria and eukaryotes, respectively?

W) RNA, RNA

X) RNA, DNA

Y) DNA, RNA

Z) DNA, DNA

ANSWER: Z) DNA, DNA [OW]

### BONUS

6) ENERGY *Short Answer* Researchers at MIT are studying the formation of geologic features on terrestrial planets. The Tharsis Montes and Valles Marineris are features located on what planet?

ANSWER: MARS [HJ]

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### TOSS-UP

7) BIOLOGY *Short Answer* In what digestive organ is a low pH maintained in order to maintain proper function of protease enzymes?

ANSWER: STOMACH [SO]

### BONUS

7) BIOLOGY *Multiple Choice* What type of bond links the glycerol in triglycerides to the fatty acid tails?

W) Phosphate

X) Ester

Y) Glycosidic

Z) Peptide

ANSWER: X) ESTER [SY]

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### TOSS-UP

8) MATH *Short Answer* What is the greatest integer that is less than or equal to the square root of 500?

ANSWER: 22 [MW]

### BONUS

8) MATH *Short Answer* At what point do the lines  $y = 3x - 2$  and  $y = x + 2$  intersect when graphed on the coordinate plane?

ANSWER: (2, 4) [MW]

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### TOSS-UP

9) CHEMISTRY *Multiple Choice* Which of the following molecules is nonpolar?

W) CH<sub>4</sub>

X) NH<sub>3</sub>

Y) H<sub>2</sub>O

Z) HF

ANSWER: W) CH<sub>4</sub> [CZ]

### BONUS

9) CHEMISTRY *Short Answer* To two significant figures and in grams per mole, what is the molar mass of the amino acid tyrosine, with molecular formula C<sub>9</sub>H<sub>11</sub>NO<sub>3</sub>?

ANSWER: 180 [HJ]

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### TOSS-UP

10) EARTH AND SPACE *Multiple Choice* Biotite and muscovite are members of which of the following mineral groups, known for cleaving into thin sheets?

W) Feldspars

X) Carbonates

Y) Sulfides

Z) Micas

ANSWER: Z) MICAS [KW, R&M, RR]

### **BONUS**

10) EARTH AND SPACE *Short Answer* The triple alpha process, a stellar fusion process occurring in giant stars, fuses three alpha particles into what isotope?

ANSWER: CARBON-12 [SE]

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### **TOSS-UP**

11) PHYSICS *Short Answer* In atoms, the nucleus is surrounded by a cloud of what small, negatively charged particles?

ANSWER: ELECTRONS [CZ]

### **BONUS**

11) PHYSICS *Short Answer* When light of a sufficient frequency is shone upon a piece of metal, electrons are observed to be knocked out of the metal. What is the name for this effect?

ANSWER: PHOTOELECTRIC EFFECT [YL]

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### TOSS-UP

12) ENERGY *Multiple Choice* Researchers at UW-Madison are improving the efficiency of reactions through reducing their overpotentials, the potential difference required to start a reaction. Which of the following is the SI unit for electric potential?

W) Coulomb

X) Ampere

Y) Volt

Z) Ohm

ANSWER: Y) VOLT [HJ]

### BONUS

12) ENERGY *Short Answer* Researchers at the National Institute of Health are studying the central dogma in order to understand retroviruses like HIV. Order the following three cell processes from first to last according to the central dogma:

1) DNA replication

2) Translation

3) Transcription

ANSWER: 1, 3, 2 [SO]

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### TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following correctly gives an example of a pair of homologous features?

- W) Human hand and dog paw
- X) Insect wing and bat wing
- Y) Potato and sweet potato
- Z) Penguin wing and shark flipper

ANSWER: W) HUMAN HAND AND DOG PAW [OW]

### BONUS

13) BIOLOGY *Short Answer* The release of tropic hormones from the anterior pituitary gland is regulated by what region of the brain?

ANSWER: HYPOTHALAMUS [AF]

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### TOSS-UP

14) MATH *Multiple Choice* Which of the following equations is NOT a function in the x-y plane?

- W)  $x = 4/3$
- X)  $y = 4/3$
- Y)  $y = x^2$
- Z)  $y = 2x - 8$

ANSWER: W)  $x = 4/3$  [MW]

### BONUS

14) MATH *Short Answer* What is the area of an equilateral triangle with a perimeter of 24?

ANSWER:  $16\sqrt{3}$  [MW]

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### TOSS-UP

15) CHEMISTRY *Short Answer* At high temperatures and low pressures, the properties of a gas behave according to what equation, which can be derived by combining Avogadro's, Boyle's, and Charles's laws?

ANSWER: IDEAL GAS LAW (ACCEPT:  $PV = nRT$ ) [CZ]

### BONUS

15) CHEMISTRY *Short Answer* Place the following three atomic orbitals in the order in which they are filled, according to the Aufbau principle:

- 1) 3s
- 2) 3d
- 3) 4s

ANSWER: 1, 3, 2 [HJ]

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### TOSS-UP

16) EARTH AND SPACE *Short Answer* Around the Indian Subcontinent, the trade winds reverse directions with the seasons, blowing seaward in the winter but landward in the summer, hence bringing heavy summer rains. What is the name of this phenomenon?

ANSWER: MONSOONS (ACCEPT: INDIAN SUMMER MONSOON, ISM) [KW, A/O, RR]

### BONUS

16) EARTH AND SPACE *Short Answer* Order the following three geologic periods from oldest to most recent:

- 1) Cretaceous
- 2) Jurassic
- 3) Triassic

ANSWER: 3, 2, 1 [HJ, Geo, RR]

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### TOSS-UP

17) PHYSICS *Short Answer* What phenomenon occurs when two waves combine in phase, creating a resultant wave with a larger amplitude than either of the two original waves?

ANSWER: CONSTRUCTIVE INTERFERENCE [YL]

### **BONUS**

17) PHYSICS *Short Answer* Evan stabs Kian with a stick. He exerts a force of 100 newtons over an area of 2 square centimeters. In kilopascals, what is the pressure at the point of contact?

ANSWER: 500 [YL]

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### **TOSS-UP**

18) ENERGY *Multiple Choice* Researchers at the National Renewable Energy Laboratory are studying the photoelectric effect and its applications in solar panels. Photons of which of the following colors have the highest energy?

W) yellow

X) red

Y) blue

Z) green

ANSWER: Y) BLUE [SO, RR]

### **BONUS**

18) Energy *Short Answer* Researchers at NASA's Goddard Space Flight Center are observing the properties of ultra-high redshift galaxies using the James Webb Space Telescope. What effect, which describes the change in frequency of a wave emitted by a moving source, causes redshift?

ANSWER: DOPPLER EFFECT [KD]

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### **TOSS-UP**

19) BIOLOGY *Short Answer* Abscissic acid leads to the closing of what specialized plant structures, surrounded by guard cells, that regulate the entrance and exit of carbon dioxide and water?

ANSWER: STOMATA [SY]

### **BONUS**

19) BIOLOGY *Short Answer* Through what major blood vessel does blood leave the left ventricle to enter systemic circulation?

ANSWER: AORTA [SO]

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### **TOSS-UP**

20) MATH *Short Answer* Shreyas is drawing cards from a standard deck of 52 cards with replacement. What is the chance he draws a red ace for his first card?

ANSWER:  $1/26$  [SE]

### **BONUS**

20) MATH *Short Answer* What is the sum of the integers between 6 and 25, inclusive?

ANSWER: 310 [MW]

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### TOSS-UP

21) CHEMISTRY *Short Answer* What type of reaction, used to recharge secondary batteries, involves the application of an external electric current to drive a non-spontaneous redox reaction?

ANSWER: ELECTROLYSIS [HJ]

### BONUS

21) CHEMISTRY *Short Answer* If the reaction  $A + B \rightleftharpoons 2C$  has an equilibrium constant of 1.2, what is the equilibrium constant of the reaction  $2A + 2B \rightleftharpoons 4C$ ?

ANSWER: 1.44 [YL]

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### TOSS-UP

22) EARTH AND SPACE *Multiple Choice* Which of the following phases must the moon be in order for a solar eclipse to occur?

- W) New moon
- X) First quarter
- Y) Full moon
- Z) Third quarter

ANSWER: W) NEW MOON [HJ]

### **BONUS**

22) EARTH AND SPACE *Multiple Choice* Which of the following stellar classes denotes stars of the highest temperature?

W) A

X) B

Y) F

Z) O

ANSWER: Z) O [HJ]

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### **TOSS-UP**

23) PHYSICS *Short Answer* What physical quantity is represented by the area underneath a curve on a pressure versus volume diagram?

ANSWER: WORK [YL]

### **BONUS**

23) PHYSICS *Short Answer* A ball is dropped from a tall tower and takes 5 seconds to hit the bottom. A second, identical ball is launched horizontally from the same tower at a speed of 15 meters per second. In meters, what is the horizontal displacement of the second ball when it hits the ground?

ANSWER: 75 [YL]