



## MOSFET Invitational Double Elimination 3

### TOSS-UP

- 1) BIOLOGY *Multiple Choice* Which of the following options best describes the spatial separation of the light-dependent reactions and the Calvin cycle in photosynthesis?
- W) The light-dependent reactions take place in the stroma and the Calvin cycle takes place in thylakoids
- X) The light-dependent reactions take place across the inner chloroplast membrane and the Calvin cycle takes place in the stroma
- Y) The light-dependent reactions take place across the thylakoid membrane and the Calvin cycle takes place in the stroma
- Z) The light-dependent reactions take place across the outer chloroplast membrane and the Calvin cycle takes place in the intermembrane space

ANSWER: Y) THE LIGHT-DEPENDENT REACTIONS TAKE PLACE ACROSS THE THYLAKOID MEMBRANE AND THE CALVIN CYCLE TAKES PLACE IN THE STROMA [W: OW, E: EB; MDE Bio-CB]

### BONUS

- 1) BIOLOGY *Multiple Choice* Which of the following statements is true regarding RNA splicing?
- W) Splicing is the process of removing exons from the primary transcript
- X) RNA splicing occurs in both eukaryotes and prokaryotes
- Y) RNA splicing can lead to multiple different polypeptide chains from a single gene
- Z) RNA splicing takes place in the cytosol

ANSWER: Y) RNA SPLICING GENERATES MULTIPLE DIFFERENT POLYPEPTIDE CHAINS FROM A SINGLE GENE [W: OW, E: EB; MDE Bio-CB]

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**TOSS-UP**

2) CHEMISTRY *Multiple Choice* Which of the following could be valid units for the rate constant  $k$ ?

- W) Moles per second
- X) Liters per second
- Y) Moles per liter
- Z) Moles per liter per second

ANSWER: Z) MOLES PER LITER PER SECOND [W: HJ, E: AS, MDE Chem-EK]

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**BONUS**

2) CHEMISTRY *Short Answer* An organic compound containing only carbon, hydrogen, and oxygen is 58.8% carbon, 9.9% hydrogen and 31.3% oxygen by mass. What is its empirical formula?

ANSWER:  $C_5H_{10}O_2$  [W: HJ, E: AS; MDE Chem-Other]

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**TOSS-UP**

3) EARTH AND SPACE *Multiple Choice* Which of the following rocks exhibits the lowest grade metamorphism?

- W) Migmatite
- X) Phyllite
- Y) Slate
- Z) Schist

ANSWER: Y) SLATE [W: HJ, E: EB; MDE ESS-RM]

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**BONUS**

3) EARTH AND SPACE *Short Answer* What theory was created to explain the apparent homogeneity of the Cosmic Microwave Background, and postulates that the universe experienced a period of extremely rapid expansion soon after the Big Bang?

ANSWER: INFLATION [W: JW, E: SC; MDE ESS-OA]

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**TOSS-UP**

4) MATH *Short Answer* What is the greatest common divisor of the numbers 108 and 144?

ANSWER: 36 [W: KR, E: EB; MDE Math-NT]

**BONUS**

4) MATH *Short Answer* Three numbers a, b, and c, have a product of 27. What is the minimum value for their sum?

ANSWER: 9 [W: SC, E: EB; MDE Math-A]

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**TOSS-UP**

5) PHYSICS *Short Answer* What property of a liquid has both dynamic and kinematic types, and is the fluid analog of friction?

ANSWER: VISCOSITY [W: JW, E: SC; MDE Phys-ME]

**BONUS**

5) PHYSICS *Short Answer* A block of mass 5 kg and specific heat capacity 20 J/kg\*K is brought from an initial temperature of 50K to a final temperature of 150K. How much heat was supplied to the block during this process?

ANSWER: 10,000 J [W: RF, E: SC MDE Phys-ET]

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### **TOSS-UP**

6) ENERGY *Short Answer* Researchers at UW Madison are studying Alu elements and other “junk” DNA in the human genome. Alu elements are an example of what class of genes that have the ability to move from one location in the genome to another?

ANSWER: TRANSPOSONS [W: OW, E: EB; MDE]

### **BONUS**

6) ENERGY *Multiple Choice* Researchers at UNR’s Nevada Seismological Lab are studying earthquake magnitudes. The highest magnitude earthquakes are found at thrust faults, a subtype of which of the following types of faults?

- W) Strike-slip
- X) Reverse
- Y) Normal
- Z) Oblique-slip

ANSWER: X) REVERSE [W: HJ, E: EB; MDE]

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### **TOSS-UP**

7) BIOLOGY *Multiple Choice* In a certain forest ecosystem, the primary producers hold about 1,000,000 joules of energy. How many joules of energy would be held at the secondary consumer level?

- W) 100,000
- X) 10,000
- Y) 1,000
- Z) 100

ANSWER: X) 10,000 [W: OW, E: EB; MDE Bio-EEB]

### **BONUS**

7) BIOLOGY *Short Answer* Order the following 3 plant cell wall structures from farthest to closest to the protoplast of the cell:

- 1) Primary cell wall
- 2) Secondary cell wall
- 3) Middle lamella

ANSWER: 3, 1, 2 [W: OW, E: EB; MDE Bio-P]

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**TOSS-UP**

8) CHEMISTRY *Multiple Choice* Which of the following is NOT the most common isotope of its respective element?

- W) Boron-10
- X) Carbon-12
- Y) Nitrogen-14
- Z) Oxygen-16

ANSWER: W) BORON-10 [W: HJ, E: AS; MDE Chem-AM]

**BONUS**

8) CHEMISTRY *Short Answer* Identify all of the following three structures that an alkane could have:

- 1) Double bonds
- 2) Triple bonds
- 3) Rings

ANSWER: 3 ONLY [W: AS, E: HJ; MDE Chem-Other]

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### **TOSS-UP**

9) EARTH AND SPACE *Short Answer* Identify all of the following three geologic features that can be found at active continental margins:

- 1) Continental shelf
- 2) Trench
- 3) Volcanic arc

ANSWER: ALL [W: HJ, E: EB; MDE ESS-G]

### **BONUS**

9) EARTH AND SPACE *Multiple Choice* What is the current origin theorized for Phobos, the innermost moon of Mars?

- W) It is the core of a destroyed planetesimal  
X) It is a captured asteroid  
Y) It was formed from the debris from a catastrophic impact event  
Z) It formed in orbit as Mars condensed from the circumstellar disk

ANSWER: X) IT IS A CAPTURED ASTEROID [W: SC, E: EB; MDE ESS-SS]

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### **TOSS-UP**

10) MATH *Short Answer* A square is inscribed in a circle. What fraction of the circle's area is inside of the square?

ANSWER:  $2/\pi$  [W: SC, E: EB; MDE Math-G]

### **BONUS**

10) MATH *Short Answer* Determine the number of palindromes that can be formed from a subset of the letters of the word "Grass" spelled "G, R, A, S, S"?

ANSWER: 8 [W: KR, E: SC; MDE Math-C]

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**TOSS-UP**

11) PHYSICS *Multiple Choice* Which type of thermodynamic process occurs with no transfer of heat?

- W) Isothermal
- X) Isobaric
- Y) Isochoric
- Z) Adiabatic

ANSWER: Z) ADIABATIC [W: KR, E: EB; MDE Phys-ET]

**BONUS**

11) PHYSICS *Short Answer* A certain metal has a work function of 800 eV. If researchers want to produce an electron with energy 400eV through the photoelectric effect, what is the minimum photon energy they must use?

ANSWER: 1200 eV [W: JW, E: EB; MDE Phys-MO]

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**TOSS-UP**

12) ENERGY *Short Answer* Researchers at the UW Madison Ice Cube Neutrino Observatory are studying the different types of neutrinos. What phenomenon occurs when an electron neutrino undergoes a transformation and becomes a muon neutrino?

ANSWER: FLAVOR OSCILLATION (ACCEPT: NEUTRINO OSCILLATION) [W: JW, E: OW; MDE]

**BONUS**

12) ENERGY *Short Answer* Researchers at UW-Madison are studying X-chromosome inactivation in embryonic cells during development, and the effect it has on the adult phenotype of cats. What highly methylated, condensed chromosome is the product of X-chromosome inactivation?

ANSWER: BARR BODY [W: OW, E: EB; MDE]

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### **TOSS-UP**

- 13) BIOLOGY *Multiple Choice* Which of the following genes in humans code for proteins that stimulate cell growth and development, and often lead to cancer when mutated?
- W) Tumor-suppressor genes  
X) Proto-oncogenes  
Y) Caspase genes  
Z) Protein kinases

ANSWER: X) PROTO-ONCOGENES [W: OW, E: EB; MDE Bio-G]

### **BONUS**

- 13) BIOLOGY *Short Answer* What type of cell helps regulate blood calcium levels by breaking down existing bone tissue?

ANSWER: OSTEOCLASTS (DO NOT ACCEPT: OSTEOBLASTS) [W: SG, E: EB; MDE Bio-AP]

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### **TOSS-UP**

- 14) CHEMISTRY *Multiple Choice* In which of the following titrations would the equivalence point always be at a pH of 7?
- W) Strong acid-strong base  
X) Strong acid-weak base  
Y) Weak acid-strong base  
Z) Weak acid-weak base

ANSWER: W) STRONG ACID-STRONG BASE [W: HJ, E: EB; MDE Chem-R]

### **BONUS**

- 14) CHEMISTRY *Short Answer* Place the following three compounds in order of increasing bond strength:

- 1) F<sub>2</sub>
- 2) N<sub>2</sub>
- 3) HF

ANSWER: 1, 3, 2 [W: HJ, E: AS; MDE Chem-AM]

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**TOSS-UP**

15) EARTH AND SPACE *Short Answer* In the mid-20th century, astronomers discovered a new type of extremely strong point-like radio source. What are these objects, thought to be powered by supermassive black holes at the centers of galaxies, called?

ANSWER: QUASARS [W: JW, E: EB; MDE ESS-OA]

**BONUS**

15) EARTH AND SPACE *Short Answer* Order the following three water masses by increasing density:

- 1) Low temperature and high salinity
- 2) High temperature and low salinity
- 3) High temperature and high salinity

ANSWER: 2, 3, 1 [W: HJ, E: SC; MDE ESS-AO]

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**TOSS-UP**

16) MATH *Short Answer* Alice is playing a game. On her turn, she rolls a fair six-sided die. If it lands on a prime number she gets to roll again, if it does not land on a prime number she loses and stops rolling. What is the probability Alice rolls the die exactly three times?

ANSWER: 1/8 [W: OW, E: EB; MDE Math-C]

**BONUS**

16) MATH *Short Answer* Triangle DEF has sides of length 3, 9, and 10. What is the area of this triangle?

ANSWER: 4  $\sqrt{11}$  [W: HJ, E: EB; MDE Math-G]

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**TOSS-UP**

17) PHYSICS *Short Answer* What effect in quantum mechanics allows particles to pass through classically forbidden energy barriers, and contributes to energy leakage in batteries?

ANSWER: QUANTUM TUNNELLING [W: RF, E: SC; Phys-MO]

**BONUS**

17) PHYSICS *Short Answer* A thin convex lens has a focal length of 4 cm. An apple is placed 12 cm away from the lens. How far away from the lens, in centimeters, will the image of the apple be through the lens?

ANSWER: 6 [W: SC, E: EB; MDE Phys-ME]

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**TOSS-UP**

18) ENERGY *Multiple Choice* Scientists at Lawrence Berkeley National Labs are investigating the interactions between biogeochemical cycles and soil nutrients. Which of the following soil horizons contains the highest levels of humus?

- W) A
- X) E
- Y) O
- Z) R

ANSWER: Y) O [W: EB, E: HJ; MDE]

**BONUS**

18) ENERGY *Multiple Choice* Researchers at Marquette University are studying formal logic and the foundations of mathematics. Which of the following logical propositions is always true if the statement “P implies Q” is true?

- W) P and Q
- X) Q implies P
- Y) Not P implies Not Q
- Z) Not Q implies Not P

ANSWER: Z) NOT Q IMPLIES NOT P [W: JW, E: SC; MDE]

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**TOSS-UP**

19) BIOLOGY *Short Answer* What respiratory pigment is found in muscle cells and is capable of binding to only one oxygen molecule?

ANSWER: MYOGLOBIN [W: OW, E: EB; EDE Bio-AP]

**BONUS**

19) BIOLOGY *Short Answer* Identify all of the following 3 functional groups that have a negative charge:

- 1) Amine
- 2) Carboxyl
- 3) Phosphate

ANSWER: 2 AND 3 [W: OW, E: EB; DE Bio-Other]

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**TOSS-UP**

20) CHEMISTRY *Short Answer* In acid-base titrations, indicators, such as phenolphthalein, change color when the reaction has reached what point?

ANSWER: ENDPOINT (DO NOT ACCEPT: EQUIVALENCE POINT) [W: AS, E: HJ; MDE Chem-Other]

**BONUS**

20) CHEMISTRY *Multiple Choice* Which of the following is not a valid set of units for specific heat capacity?

- W) Meters squared per kelvin per second square
- X) Calories per degree Fahrenheit per pound
- Y) BTUs per degree Celsius per kilogram
- Z) Joules per kelvin per mole

ANSWER: Z) JOULES PER KELVIN PER MOLE [W: AS, E: EB; MDE Chem-T]

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**TOSS-UP**

21) EARTH AND SPACE *Multiple Choice* As a star progresses along the asymptotic giant branch, in which direction on the HR diagram does it tend to move?

- W) Up and to the right
- X) Up and to the left
- Y) Down and to the right
- Z) Down and to the left

ANSWER: W) UP AND TO THE RIGHT [W: SC, E: EB; MDE ESS-SA]

**BONUS**

21) EARTH AND SPACE *Short Answer* Identify all of the following three statements that are true regarding unconformities:

- 1) Unconformities represent a gap in the geologic record
- 2) Unconformities can form during a time period of no deposition
- 3) Unconformities violate the stratigraphic principle of superposition

ANSWER: 1 AND 2 [W: HJ, E: EB; MDE ESS-G]

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**TOSS-UP**

22) MATH *Short Answer* Find the sum of the roots of the quadratic equation  $2x^2 - 15x + 36$ .

ANSWER: 7.5 (ACCEPT: 15/2) [W: KR, E: SC; MDE Math-A]

**BONUS**

22) MATH *Short Answer* What is the smallest positive integer n such that  $2^n$  leaves a remainder of 1 when divided by 17?

ANSWER: 8 [W: SC, E: EB; MDE Math-NT]

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### **TOSS-UP**

23) PHYSICS *Multiple Choice* A proton is moving in the positive x direction in a uniform magnetic field pointing in the negative z direction. In which direction would the force on the particle point?

- W) Negative y direction
- X) Positive y direction
- Y) Negative z direction
- Z) Positive z direction

ANSWER: X) POSITIVE Y DIRECTION [W: RF, E: EB; MDE Phys-ET]

### **BONUS**

23) PHYSICS *Multiple Choice* A string with mass  $M$  and length  $L$  under tension  $T$  supports transverse waves with speed  $v$ . If the tension on the string is quadrupled, and the mass and length are both doubled, in terms of  $v$ , what is the new speed of waves on the string?

- W)  $V/2$
- X)  $V/\sqrt{2}$
- Y)  $\sqrt{2}V$
- Z)  $2V$

ANSWER: Z)  $2V$  [W: RF, E: SC; MDE Phys-ME]