



MOSFET 2025 - Round 7

TOSS-UP

1) BIOLOGY *Multiple Choice* Which of the following hormones is NOT secreted by the adrenal cortex?

- W) Cortisol
- X) Aldosterone
- Y) Androgens
- Z) Norepinephrine

ANSWER: Z) NOREPINEPHRINE [OW]

BONUS

1) BIOLOGY *Multiple Choice* Which of the following dispersion patterns would be found in a population of honey badgers, a species which is highly territorial?

- W) Clumped
- X) Uniform
- Y) Random
- Z) Variant

ANSWER: X) UNIFORM [OW]

TOSS-UP

2) MATH *Short Answer* Kwanga the cat is thirsty. She completely fills a hemispherical bowl with a radius of 3, then pours all of the water into a cylindrical bottle with a radius of 2. What is the height of the water in the bottle?

ANSWER: 4.5 [EZ]

BONUS

2) MATH *Short Answer* Identify all of the following three sets that have the same cardinality as the set of all natural numbers:

- 1) The set of all integers
- 2) The set of all rational numbers
- 3) The set of all real numbers

ANSWER: 1 AND 2 [EZ]

TOSS-UP

3) CHEMISTRY *Multiple Choice* Which of the following diatomic halogens has the highest bond dissociation energy?

- W) Fluorine
- X) Chlorine
- Y) Bromine
- Z) Iodine

ANSWER: X) CHLORINE [CZ]

BONUS

3) CHEMISTRY *Short Answer* What is the sum of all coefficients in the balanced reaction with lowest integer coefficients for the complete combustion of benzene?

ANSWER: 35 [YL]

TOSS-UP

4) EARTH AND SPACE *Short Answer* While typically found as an accessory mineral in igneous rocks, apatite is also formed as the inorganic component of bone tissue. What term describes minerals like these, which are formed from the activity of living organisms?

ANSWER: BIOGENIC (DO NOT ACCEPT: BIOGENOUS) [HJ]

BONUS

4) EARTH AND SPACE *Multiple Choice* Which of the following criteria does NOT generally need to be met in order for an exoplanet to be detected via the transit method?

- W) The exoplanet must be fairly large relative to its star
- X) The exoplanet must orbit fairly close to its star
- Y) The exoplanet must have a thick atmosphere
- Z) The exoplanet's orbit must appear edge-on to the Earth

ANSWER: Y) THE EXOPLANET MUST HAVE A THICK ATMOSPHERE [SE]

TOSS-UP

5) PHYSICS *Multiple Choice* The first derivative of an object's potential energy versus displacement graph is 0 at a particular point, and the second derivative is negative. Which of the following can be correctly concluded about the object at this point?

- W) It is in stable equilibrium
- X) It is in unstable equilibrium
- Y) It is in neutral equilibrium
- Z) There is not enough information to determine

ANSWER: X) IT IS IN UNSTABLE EQUILIBRIUM [YL]

BONUS

5) PHYSICS *Short Answer* Harry holds a pulley with two unequal hanging masses, one on each end. He uniformly accelerates the pulley upwards. If the left mass accelerates at 8 meters per second squared upwards and the right mass accelerates at 3 meters per second squared downwards, then in meters per second squared, what is the acceleration of Harry's hand?

ANSWER: 2.5 [YL]

TOSS-UP

6) ENERGY *Multiple Choice* Researchers at Tulane are studying novel strains of Covid-19. To amplify the amount of available DNA, the researchers are using which of the following techniques, which utilizes primers and a thermostable DNA polymerase?

- W) Gel electrophoresis
- X) PCR
- Y) Western blot
- Z) Northern blot

ANSWER: X) PCR [OW]

BONUS

6) ENERGY *Short Answer* Researchers at Boston University are using absorbance spectrophotometry to study dissolved organic carbon. Identify all of the following three properties of a solution to which absorbance values are directly proportional:

- 1) Temperature
- 2) Concentration
- 3) Path length

ANSWER: 2 AND 3 [HJ]

TOSS-UP

7) BIOLOGY *Multiple Choice* Cryptochromes are a class of plant photoreceptors that are most sensitive to which of the following colors of light?

- W) Red
- X) Green
- Y) Blue
- Z) Yellow

ANSWER: Y) BLUE [AF]

BONUS

7) BIOLOGY *Short Answer* Order the following 3 intracellular spaces by increasing pH:

- 1) Cytosol
- 2) Mitochondrial matrix
- 3) Lysosome

ANSWER: 3, 1, 2 [KD]

TOSS-UP

8) MATH *Short Answer* Probability Paul is playing a game with Cheating Charlie where they each roll one six-sided die. Paul uses a fair die, but Charlie uses a loaded die which only rolls even numbers. What is the probability that they roll the same number?

ANSWER: 1/6 [JW]

BONUS

8) MATH *Short Answer* What value of x satisfies the mean value theorem for the polynomial $x^2 + 2x + 3$ over the closed interval from 0 to 3?

ANSWER: 1.5 (ACCEPT: 3/2) [MW]

TOSS-UP

9) CHEMISTRY *Multiple Choice* Selena is electroplating with various solutions of metal ions using a current of 10 amperes for 10 seconds. Which of the following metal ions, when electroplated, would yield the highest mass of pure metal?

W) Li⁺

X) Be²⁺

Y) Na⁺

Z) Mg²⁺

ANSWER: Y) Na⁺ [KD]

BONUS

9) CHEMISTRY *Short Answer* Evan is shining a laser on a sample of iron metal and views electrons being ejected from it. If he doubles the intensity of the light from the laser, by what factor is the kinetic energy of the ejected electrons multiplied?

ANSWER: 1 [KD]

TOSS-UP

10) EARTH AND SPACE *Short Answer* Occurring after magnetic reconnection events, what solar event is caused by a magnetic bubble of mass lifting off the sun's surface?

ANSWER: CORONAL MASS EJECTION (ACCEPT: CME) [SE]

BONUS

10) EARTH AND SPACE *Multiple Choice* Which of the following is NOT true about comets?

- W) Long-period comets generally come from the Kuiper belt
- X) The gas tail of a comet always points directly away from the Sun
- Y) The coma of a comet can be a thousand times larger than the nucleus
- Z) Extinct comets are commonly mistaken for asteroids

ANSWER: W) LONG-PERIOD COMETS GENERALLY COME FROM THE KUIPER BELT [IC]

TOSS-UP

11) PHYSICS *Multiple Choice* Which of the following laws describes electromagnetic induction and states that changes in magnetic flux induce voltage?

- W) Gauss's Law for Electricity
- X) Gauss's Law for Magnetism
- Y) Ampere's Law
- Z) Faraday's Law

ANSWER: Z) FARADAY'S LAW [YL]

BONUS

11) PHYSICS *Short Answer* What term is used to describe the specific temperature at which a ferromagnetic material loses its permanent magnetic properties and becomes paramagnetic?

ANSWER: CURIE POINT [OW]

TOSS-UP

12) ENERGY *Short Answer* Scientists at the National Institute of Health are studying bacterial DNA replication. In this process, what enzyme is responsible for the separation of the two strands of DNA?

ANSWER: HELICASE [SO, RR]

BONUS

12) ENERGY *Multiple Choice* Scientists at the Food and Drug Administration support first-in, first-out as a method to reduce household food waste. This method is most similar to the behavior of what data structure in computer programming?

W) Stack

X) Linked list

Y) Array

Z) Queue

ANSWER: Z) QUEUE [SO, MDE]

TOSS-UP

13) BIOLOGY *Multiple Choice* Which of the following organs performs the most similar functions to the spleen?

W) Gallbladder

X) Bone marrow

Y) Pancreas

Z) Skin

ANSWER: X) BONE MARROW [SK]

BONUS

13) BIOLOGY *Short Answer* Located in the epithalamus, what gland is responsible for controlling sleep via the release of melatonin?

ANSWER: PINEAL GLAND [SO]

TOSS-UP

14) MATH *Short Answer* Identify all of the following three single-digit integers n which, if raised to the 2025th power, would have units digit equal to one: (*read slowly*)

1) 1

2) 6

3) 9

ANSWER: 1 ONLY [HJ]

BONUS

14) MATH *Short Answer* Kwanga the cat is hungry. She decides to eat one cupcake on Monday, two cupcakes on Tuesday, and so on, doubling the amount of cupcakes consumed each day. On which day of the week will the total amount of cupcakes she eats first exceed one billion?

ANSWER: TUESDAY [EZ]

TOSS-UP

15) CHEMISTRY *Short Answer* When a surfactant is added to water, individual molecules aggregate to form what spherical structure, with hydrophilic heads on the outside and hydrophobic tails on the inside?

ANSWER: MICELLE [CZ]

BONUS

15) CHEMISTRY *Multiple Choice* Which of the following best explains why the boiling point of HI is higher than that of HCl?

- W) HI forms hydrogen bonds, while HCl does not
- X) HI is more polarizable than HCl, yielding stronger London dispersion forces
- Y) HI is more polar than HCl, yielding stronger dipole-dipole interactions
- Z) HCl dimerizes in the gas state, creating a stabilizing effect and lowering its boiling point

ANSWER: X) HI IS MORE POLARIZABLE THAN HCl, YIELDING STRONGER LONDON DISPERSION FORCES [HJ]

TOSS-UP

16) EARTH AND SPACE *Multiple Choice* Which of the following ores is the primary source of tin?

- W) Sphalerite
- X) Hematite
- Y) Cassiterite
- Z) Galena

ANSWER: Y) CASSITERITE [KD]

BONUS

16) EARTH AND SPACE *Multiple Choice* Which of the following best explains why the subtropical horse latitudes generally have few clouds and clear skies?

- W) High atmospheric pressure
- X) Low humidity
- Y) High temperature
- Z) Low coriolis forces

ANSWER: W) HIGH ATMOSPHERIC PRESSURE [HJ]

TOSS-UP

17) PHYSICS *Short Answer* What equation, derived from Bernoulli's principle as an edge-case limit, gives the speed of water flowing out of a hole a certain distance below the surface of a container?

ANSWER: TORRICELLI'S EQUATION [YL]

BONUS

17) PHYSICS *Short Answer* A particle with charge negative 2 coulombs is initially at rest before being moved by an outside force through a potential difference of negative 50 volts. In joules, what is the magnitude of the work done on the particle by the force?

ANSWER: 100 [OW]

TOSS-UP

18) ENERGY *Short Answer* Researchers at UW-Madison are studying tumor cell growth with fluorescent labeling. These researchers are using what class of proteins, which are designed to bind to a specific epitope and are produced by the adaptive immune system?

ANSWER: ANTIBODIES [OW, RR]

BONUS

18) ENERGY *Multiple Choice* Researchers at the Joint Genome Institute are analyzing protein biochemistry. Which of the following functional groups is NOT typically found in proteins?

- W) Alcohol
- X) Ester
- Y) Amine
- Z) Carbonyl

ANSWER: X) ESTER [KD]

TOSS-UP

19) BIOLOGY *Multiple Choice* Sulfur-reducing bacteria reduce elemental sulfur to which of the following compounds?

- W) Sulfate
- X) Sulfur trioxide
- Y) Sulfur dioxide
- Z) Hydrogen sulfide

ANSWER: Z) HYDROGEN SULFIDE [KD]

BONUS

19) BIOLOGY *Short Answer* Selena's corn plants have leaves that are turning purple without chlorosis :(What nutrient are her plants likely deficient in?

ANSWER: PHOSPHORUS [SY]

TOSS-UP

20) MATH *Short Answer* What is the derivative with respect to x of the definite integral from 20 to 60 of $50x \, dx$?

ANSWER: 0 [MW]

BONUS

20) MATH *Short Answer* A circle is inscribed inside a regular hexagon. Another smaller regular hexagon is then inscribed in the circle. What is the ratio of the area of the smaller hexagon to that of the larger hexagon?

ANSWER: 3/4 [EZ]

TOSS-UP

21) CHEMISTRY *Short Answer* Connor is performing an iodometric titration to determine the concentration of hydrogen peroxide in his solution. Iodometric titrations work despite I_2 's insolubility in water because iodine instead forms what common complex in solution?

ANSWER: I_3^- (ACCEPT: TRIIODIDE) [KD]

BONUS

21) CHEMISTRY *Short Answer* Identify all of the following 3 polyatomic ions that have a lone pair on the central atom:

- 1) NO_3^-
- 2) CO_3^{2-}
- 3) SO_3^{2-}

ANSWER: 3 ONLY [KD]

TOSS-UP

22) EARTH AND SPACE *Short Answer* If a moon gets too close to its host planet, it can be torn apart by tidal forces to form rings. This process occurs when a body passes within what distance from a larger celestial object?

ANSWER: ROCHE LIMIT (DO NOT ACCEPT: ROCHE LOBE) [SE]

BONUS

22) EARTH AND SPACE *Short Answer* Order the following three layers of Earth's interior by increasing seismic wave speed:

- 1) Mantle
- 2) Outer core
- 3) Inner core

ANSWER: 2, 3, 1 [PB]

TOSS-UP

23) PHYSICS *Multiple Choice* The Standard Model describes how fundamental particles and forces interact. Which of the following forces does the Standard Model not account for?

- W) Strong
- X) Weak
- Y) Gravity
- Z) Electromagnetic

ANSWER: Y) GRAVITY [CZ]

BONUS

23) PHYSICS *Short Answer* Kian hangs a block on a spring and sets it into vertical oscillation with a frequency of F . If Kian then cuts the spring into 5 equal segments and attaches them in parallel to the block, what will the new oscillation frequency be, in terms of F ?

ANSWER: $5F$ [YL]