

ROUND ROBIN 5

TOSS-UP

1) X-Risk - *Short Answer* In thermonuclear weapons, the secondary fission core is usually composed of lithium deuteride because it can form tritium when bombarded with neutrons. The resulting tritium and deuterium can undergo fission reactions to create what nuclear isotope?

ANSWER: Helium-4

BONUS

1) X-Risk - *Multiple Choice* In which nuclear weapon design are two subcritical masses brought together in order to create a critical mass?

- W) Gun
- X) Implosion
- Y) Thermonuclear
- Z) Neutron

ANSWER: W) Gun

TOSS-UP

2) Math - *Multiple Choice* Consider the Fibonacci sequence F defined as F_n [F sub N] = $F_{n-1} + F_{n-2}$. Given that F_k ends with 0, which of the following can NOT be the units digit of F_{k+2} ?

- W) 1
- X) 5
- Y) 7
- Z) 9

ANSWER: X) 5

BONUS

2) Math - *Multiple Choice* Which of the following should be the resulting outcome of a hypothesis test if the p -value is greater than the originally determined significance level?

- W) Accept the null hypothesis
- X) Fail to accept the null hypothesis
- Y) Reject the null hypothesis
- Z) Fail to reject the null hypothesis

ANSWER: Z) Fail to reject the null hypothesis

TOSS-UP

3) Chemistry - *Multiple Choice* Neon gas is present inside a sealed chamber with a movable piston. The pressure of the neon gas is then plotted against the volume of the piston as the piston is expanded externally. Which of the following best describes what this graph would look like?

- W) Line with positive slope
- X) Line with negative slope
- Y) Curve increasing toward horizontal asymptote
- Z) Curve decreasing toward horizontal asymptote

ANSWER: Z) Curve decreasing toward horizontal asymptote

BONUS

3) Chemistry - *Short Answer* The compound trans-1-methyl-3-chlorocyclohexane [trans one methyl three chloro cyclo hexane] adopts its most stable chair conformation when the chlorine and methyl substituents are in what type of conformational positions, respectively?

ANSWER: Axial, equatorial

TOSS-UP

4) Earth and Space - *Multiple Choice* Which of the following factors would least affect the flow velocity of a stream?

- W) Stream gradient
- X) Hydraulic radius
- Y) Channel roughness
- Z) Sediment load

ANSWER: Z) Sediment load

BONUS

4) Earth and Space - *Short Answer* Identify all of the following three locations that are correctly matched to the expected tidal pattern at that location: 1) San Francisco Bay and mixed; 2) New Orleans and diurnal; 3) Chesapeake Bay and diurnal.

ANSWER: 1 and 2

TOSS-UP

5) Biology - *Short Answer* During periods of starvation, fatty acids are broken down by the liver into which molecules that are released into the blood?

ANSWER: Ketone bodies

BONUS

5) Biology - *Short Answer* Order the following three species from most to least related to C. elegans: 1) Earthworm; 2) Scorpion; 3) Sand dollar.

ANSWER: 2, 1, 3

TOSS-UP

6) Physics - *Short Answer* What term describes the loops of electric current induced within conductors by a changing magnetic field in the conductor or by the relative motion of a conductor in a magnetic field?

ANSWER: Eddy currents (ACCEPT: Foucault's currents)

BONUS

6) Physics - *Multiple Choice* A heat pump transfers heat from one reservoir at 200 kelvin to another reservoir at 300 kelvin. If 760 joules of work are done on the pump, then in joules, how much heat is expelled from the cold reservoir?

- W) 304
- X) 456
- Y) 1520
- Z) 2280

ANSWER: Y) 1520

TOSS-UP

7) X-Risk - *Multiple Choice* While global warming is occurring in most regions of Earth, the term climate change is preferred because not all of Earth is warming. Which of the following regions of Earth has undergone net cooling in the last 100 years?

- W) Central South America
- X) Central Antarctica
- Y) Northern Atlantic Ocean
- Z) Western Pacific Ocean

ANSWER: Y) Northern Atlantic Ocean

BONUS

7) X-Risk - *Short Answer* In game theory, what is the term for the decision rule that minimizes the maximum possible loss from a decision?

ANSWER: Minimax

TOSS-UP

8) Math - *Multiple Choice* If inflation is assumed to be 10 percent per year, then to the nearest hundred dollars, how much will ten thousand dollars be worth in today's money after 5 years?

- W) 8,200
- X) 7,200
- Y) 6,200
- Z) 5,200

ANSWER: Y) 6,200

BONUS

8) Math - *Short Answer* What is the surface area of a right circular cone with radius 8 and height 6?

ANSWER: 144π

TOSS-UP

9) Chemistry - *Multiple Choice* Which of the following gases would be detected at the anode when an aqueous solution of lithium fluoride is electrolyzed?

- W) Hydrogen
- X) Fluorine
- Y) Oxygen
- Z) Water

ANSWER: Y) Oxygen

BONUS

9) Chemistry - *Short Answer* The pKa [p-k-a] of hydrofluoric acid is 3 in aqueous solution. What is the pH of a 0.1 molar solution of potassium fluoride?

ANSWER: 8

TOSS-UP

10) Earth and Space - *Multiple Choice* The current expansion of the universe can be modeled locally as being proportional to what power of the redshift?

- W) 2
- X) 1
- Y) -1
- Z) -2

ANSWER: X) 1

BONUS

10) Earth and Space - *Short Answer* Identify all of the following three isotopes that are preliminary fusion isotopes in brown dwarfs: 1) Hydrogen-1; 2) Lithium-6; 3) Deuterium.

ANSWER: 2 and 3

TOSS-UP

11) Biology - *Multiple Choice* What is the coefficient of relatedness between an uncle and his niece?

- W) 50%
- X) 25%
- Y) 12.5%
- Z) 6.25%

ANSWER: Y) 25%

BONUS

11) Biology - *Short Answer* In the germination of a bean seed, order the following three regions by increasing distance from the root: 1) Cotyledon [caw-tuh-LEE-dun]; 2) Epicotyl [EP-ee-cot-ul]; 3) Hypocotyl [HY-poh-cot-ul].

ANSWER: 3, 1, 2

TOSS-UP

12) Physics - *Short Answer* Einstein added what term to his field equations to allow for a static universe, now interpreted as a vacuum energy density?

ANSWER: Cosmological constant problem (ACCEPT: Vacuum catastrophe, Lambda)

BONUS

12) Physics - *Short Answer* A thin metal sheet is initially at rest in space. A flashlight is then beamed directly at the sheet for some time to give it a constant speed. If the intensity of the flashlight is tripled and the beaming time is halved, by what factor does the velocity of the metal sheet change?

ANSWER: $\frac{3}{2}$

TOSS-UP

13) X-Risk - *Multiple Choice* Which of the following best explains why N95 masks are better at preventing the spread of airborne pathogens than normal cloth-based masks?

- W) N95 masks use strong electrostatic potentials that trap pathogens
- X) N95 masks use a strong adhesive coating that traps pathogens
- Y) N95 masks use denser material that traps pathogens
- Z) N95 masks use HEPA filtration to trap pathogens

ANSWER: W) N95 masks use strong electrostatic potentials that trap pathogens

BONUS

13) X-Risk - *Short Answer* Nuclear winter is speculated to arise from the injection of which substance, arising from the incomplete combustion of organic molecules from cities and nearby forests, into the stratosphere?

ANSWER: Black carbon (ACCEPT: Soot)

TOSS-UP

14) Math - *Short Answer* If f is an injective function, and g is a surjective function, then identify all of the following three properties that the composition g of f will necessarily possess: 1) Injectivity; 2) Surjectivity; 3) Bijectivity.

ANSWER: None

BONUS

14) Math - *Short Answer* In terms of t , what is the characteristic polynomial of the 2x2 matrix with first row 6, 8 and second row 3, 2?

ANSWER: $t^2 - 8t - 12$

TOSS-UP

15) Chemistry - *Short Answer* What point on the phase diagram of a binary mixture represents the absolute minimum temperature at which the mixture will melt?

ANSWER: Eutectic [yoo-TEC-tic]

BONUS

15) Chemistry - *Short Answer* Identify all of the following three properties that describe silver bromide: 1) Water soluble; 2) Amorphous; 3) Electrically conductive.

ANSWER: None

TOSS-UP

16) Earth and Space - *Multiple Choice* At which of the following points along a gaining river will its discharge usually be highest?

- W) Headwaters
- X) Mouth
- Y) Confluence
- Z) Bifurcation

ANSWER: X) Mouth

BONUS

16) Earth and Space - *Multiple Choice* The most precipitation would be expected in which of the following places on a 500 millibar height map?

- W) Downstream of a ridge
- X) Upstream of a ridge
- Y) Downstream of a trough
- Z) Upstream of a trough

ANSWER: Y) Downstream of a trough

TOSS-UP

17) Biology - *Short Answer* During the reaction from glucose to form glucose-6-phosphate, 1 ATP is used by the enzyme hexokinase. When the phosphate group is transferred, what metal ion cofactor remains bound to ATP?

ANSWER: Mg²⁺

BONUS

17) Biology - *Short Answer* Many people who develop heat acclimatization develop a decreased Na⁺ ion concentration in their sweat and drastically reduced temperatures. Secretion of what hormone is responsible for the decreased concentration of Na⁺?

ANSWER: Aldosterone

TOSS-UP

18) Physics - *Short Answer* Identify all of the following three types of elementary particles that are fermions: 1) Gauge bosons; 2) Leptons; 3) Quarks.

ANSWER: 2 and 3

BONUS

18) Physics - *Multiple Choice* Consider a system of units where astronomical units, solar masses, and years are the units of length, mass, and time. In these units, what is the value of the gravitational constant?

- W) $\frac{1}{2\pi}$
- X) 1
- Y) 2π
- Z) $4\pi^2$

ANSWER: Z) $4\pi^2$

TOSS-UP

19) X-Risk - *Multiple Choice* DALL-E [doll-ee] 2 generates images using what type of machine learning system, which learns by recreating an image from one with artificially added noise?

- W) Diffusion model
- X) Generative adversarial network
- Y) Autoencoder
- Z) Inverse classification model

ANSWER: Diffusion model

BONUS

19) X-Risk - *Multiple Choice* The volcanic eruptions that score highest on the volcanic explosivity index fall under what category?

- W) Pelean [PEL-ay-in]
- X) Plinian [PLY-nee-in]
- Y) Strombolian [strom-BOWL-ee-in]
- Z) Vulcanian [vul-CAYN-ee-in]

ANSWER: X) Plinian

TOSS-UP

20) Math - *Short Answer* Identify all of the following three statements about tessellation that are true: 1) The regular octagon tiles the plane; 2) There exist convex pentagons which tile the plane; 3) All triangles tile the plane.

ANSWER: 2 and 3

BONUS

20) Math - *Multiple Choice* Which of the following sets of 3 vectors can NOT be a basis for R^3 ?

- W) $(1, 1, 2), (2, 2, 1), (1, 0, 1)$
- X) $(1, -1, 2), (1, 2, -1), (2, 1, 1)$
- Y) $(1, 2, 4), (1, 3, 9), (1, 4, 16)$
- Z) $(1, 2, 1), (2, 1, 2), (2, 2, 1)$

ANSWER: X) $(1, -1, 2), (1, 2, -1), (2, 1, 1)$

TOSS-UP

21) Chemistry - *Short Answer* Upon vigorous heating, potassium nitrate releases oxygen gas to form what other compound?

ANSWER: KNO_2 (Accept: Potassium nitrite)

BONUS

21) Chemistry - *Short Answer* Identify all of the following statements that are true of SN₂ reactions: 1) The reaction occurs in one step; 2) The rate law is bimolecular; 3) Ethanol is a better solvent than THF for SN₂ reactions

ANSWER: 1 and 2

TOSS-UP

22) Earth and Space - *Multiple Choice* What process is likely responsible for the observation of blue stragglers in an otherwise reddish globular cluster?

- W) Mass stratification
- X) Extreme mass loss due to combined stellar winds
- Y) Mass transfer
- Z) Stellar collisions

ANSWER: Y) Mass transfer

BONUS

22) Earth and Space - *Short Answer* Mass transfer in white dwarf-red giant binaries can occur over long periods of time and can ultimately result in what type of bright stellar event when fusion is kickstarted on the white dwarf's surface?

ANSWER: Nova (ACCEPT: Recurrent novae; DO NOT ACCEPT: Supernova)

TOSS-UP

23) Biology - *Short Answer* The drug L-dopa is used to treat Parkinson's disease because it is converted to dopamine in the brain. What enzyme catalyzes this conversion?

ANSWER: Dopa decarboxylase

BONUS

23) Biology - *Short Answer* Inclusion cell disease is caused by a defective enzyme, which phosphorylates mannose in what cellular organelle?

ANSWER: Golgi Apparatus

TOSS-UP

24) Physics - *Short Answer* A current is flowing through an infinite wire and the magnetic field at various radial distances is measured. What is the ratio of the magnetic field measured at a radial distance R versus $2R$?

ANSWER: 2

BONUS

24) Physics - *Short Answer* What is the term given to the observation that a quark of a single color can never be observed in isolation?

ANSWER: Color confinement