

TOSS-UP

1) PHYSICS *Short Answer* Express the unit for optical power in terms of the SI base units.

ANSWER: 1/m or m⁻¹ (Do Not Accept “Diopter”)

BONUS

1) PHYSICS *Multiple Choice* Which of the following is true of light traveling into a denser medium?

W) The index of refraction of the denser medium is lower

X) The angle of incidence is greater than the angle of refraction

Y) The average speed of light is faster in the denser medium

Z) The light loses energy while traveling into the denser medium

ANSWER: X) The angle of incidence is greater than the angle of refraction

TOSS-UP

2) CHEMISTRY *Multiple Choice* As the concentration of solute in a solution increases, the vapor pressure of the solution will

W) Increase

X) Decrease

Y) Stay the same

Z) Increase and then decrease

ANSWER: X) Decrease

BONUS

2) CHEMISTRY *Short Answer* By name or number, order the following four solutions in order of decreasing freezing point:

- 1) .1 M KCl
- 2) .1 M Li₃N
- 3) .3 M C₆H₁₂O₆
- 4) .3 M NaPO₄

ANSWER: 1, 3, 2, 4

TOSS-UP

3) EARTH AND SPACE *Short Answer* Order the following four features of a convergent active margin from most landward to most seaward:

- I. Row of active volcanoes
- II. Deep-sea trench
- III. Narrow continental shelf
- IV. Steep continental slope

ANSWER: I III IV II

BONUS

3) EARTH AND SPACE *Short Answer* Name which of the following are true about granules on the Sun:

- I. Granules are caused by convection, with gas rising on the edges and sinking in the middle
- II. Granules are hottest in their centers and coolest on their edges
- III. Granules are primarily found in the photosphere

ANSWER: II, III

TOSS-UP

4) MATH *Short Answer* If $\sec(x) + \tan(x) = 2$, what is $\sec(x) - \tan(x)$?

ANSWER: 1/2

BONUS

4) MATH *Short Answer* If $\sec(x) + \tan(x) = 2$, what is $\csc(x) + \cot(x)$?

ANSWER: 3

TOSS-UP

5) BIOLOGY *Short Answer* In axons that are myelinated, what is the location on the axon where voltage gated sodium channels are restricted?

ANSWER: Node of Ranvier

BONUS

5) BIOLOGY *Multiple Choice* What is the type of summation that occurs when two EPSPs cross a single synapses in rapid succession

W) Subthreshold

X) Temporal

Y) Spatial

Z) Inhibitory

ANSWER: X) Temporal

TOSS-UP

6) PHYSICS *Short Answer* Tim drives a 100kg car, going 20 m/s. If the brakes apply a force of 200N, how long does it take for Tim to stop?

ANSWER: 10 seconds

BONUS

6) PHYSICS *Multiple Choice* In SI base units, the area under the curve of torque over time is equal to:

W) kg m² / s

X) kg m² / s²

Y) kg m / s²

Z) kg m³ / s²

ANSWER: W) kg m² / s

TOSS-UP

7) CHEMISTRY *Multiple Choice* Which of the following elements has the highest electronegativity?

W) Oxygen

X) Nitrogen

Y) Chlorine

Z) Hydrogen

ANSWER: W) Oxygen

BONUS

7) CHEMISTRY *Multiple Choice* Which of the following gases will exhibit the greatest deviations from ideal gas behaviour?

W) Carbon Dioxide

X) Sulfur Dioxide

Y) Methane

Z) Oxygen

ANSWER: X) Sulfur Dioxide

TOSS-UP

8) EARTH AND SPACE *Multiple Choice* The interstellar space medium primarily emits what type of electromagnetic radiation?

W) radio

X) infrared

Y) visible light

Z) UV

ANSWER: X) infrared

BONUS

8) EARTH AND SPACE *Multiple Choice* Convergence and divergence of flow aloft can often lead to the development of mid-latitude cyclones, but not always. Which of the following criteria is needed in order for the development of a mid-latitude cyclone?

W) Lows and highs aloft must be slightly west of lows and highs on the surface

X) Lows and high aloft must be completely aligned with lows and highs on the surface

Y) Air must be flowing clockwise both aloft and at the surface

Z) Air must be flowing counterclockwise both aloft and at the surface

ANSWER: W) Lows and highs aloft must be slightly west of lows and highs on the surface

TOSS-UP

9) 3) MATH *Multiple Choice* The graphs of $y = 2^x$ and $y = x^2$ intersect each other at how many points

W) 0

X) 1

Y) 2

Z) 3

ANSWER: Z) 3

BONUS

9) MATH *Short Answer* What is the area of the ellipse $16x^2 + 128x + 9y^2 - 36y = -144$.

ANSWER: 12pi

TOSS-UP

10) BIOLOGY *Short Answer* List all of the following that are biogenic amines:

- I) Norepinephrine
- II) Acetylcholine
- III) Serotonin

ANSWER: I and III

BONUS

10) BIOLOGY *Multiple Choice* Which of the following is a function of neuropeptides?

- W) Produces hallucinations
- X) Produces euphoria
- Y) affects attention
- Z) formation of long term memory

ANSWER: X) Produces euphoria

TOSS-UP

11) PHYSICS *Multiple Choice* Sound waves move fastest through:

- W) Air
- X) Ice
- Y) Water
- Z) Iron

ANSWER: Z) Iron

BONUS

11) PHYSICS *Question Type* Your bonus question goes here.

ANSWER: The correct answer

TOSS-UP

12) CHEMISTRY *Multiple Choice* A rigid container containing only neon gas and oxygen gas is at constant temperature. If a tiny hole was to be poked such that the gases could escape, how will the partial pressure of the oxygen change in relation to the initial partial pressures?

- W) The partial pressure of oxygen will decrease at a faster rate than the partial pressure of neon
- X) The partial pressure of oxygen will decrease at a slower rate than the partial pressure of neon
- Y) The partial pressures of both oxygen and neon will stay the same
- Z) The partial pressures of both oxygen and neon will increase at an equal rate

ANSWER: X) The partial pressure of oxygen will decrease at a slower rate than the partial pressure of neon

BONUS

12) CHEMISTRY *Short Answer* By name or number, indicate all of the following conditions that will be most likely to increase the rate of gas production in the chemical reaction $\text{CaCO}_3(\text{s}) + 2\text{HCl}(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + \text{H}_2\text{O}(\text{l}) + \text{CO}_2(\text{g})$:

- 1) Decreasing the particle size of CaCO_3 by crushing into a fine powder
- 2) Decreasing the concentration of the HCl solution used
- 3) Decreasing the temperature at which the reaction is performed
- 4) Adding a catalyst to the reaction

ANSWER: 1, 4

TOSS-UP

13) EARTH AND SPACE *Short Answer* What is the name of the surface current that is a strong, offshore current pulling away from the shore, which can often be escaped by swimming parallel to the shore?

ANSWER: Rip current

BONUS

13) EARTH AND SPACE *Short Answer* What is the name of a type of star that shoots beams of concentrated rays at its poles?

ANSWER: Magnetar

TOSS-UP

14) MATH *Short Answer* Expand $(a+b)^4$.

ANSWER: $a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$

BONUS

14) MATH *Short Answer* Give the type of graph of each of the following three polar equations.

i) $r = 4\cos(\theta)$

ii) $r = 1/(\cos(\theta) + \sin(\theta))$

iii) $r = 3 - 3\sin(\theta)$

ANSWER: i) circle ii) line iii) cardioid

TOSS-UP

15) BIOLOGY *Multiple Choice* Which of the following cannot be a characteristic of a cardiac muscle fiber?

W) It can be multicellular

X) It is striated

Y) The myosin and actin filaments are not organized

Z) All of the fibers are always electrically connected to one another

ANSWER: Y) The myosin and actin filaments are not organized

BONUS

15) BIOLOGY *Short Answer* Choose all of the following that are NOT correct about catecholamines.

- I. They increase heart rate and stroke volume.
- II. They dilate the bronchioles in the lungs.
- III. They shunt blood towards the skin, digestive organs, and kidneys.

ANSWER: III. THEY SHUNT BLOOD TOWARDS THE SKIN, DIGESTIVE ORGANS, AND KIDNEYS.

TOSS-UP

16) PHYSICS *Short Answer* Tim installs a pulley system to help him lift his cat. Initially, he pulls down 10m, applying 100N to lift his cat 10m. If the mechanical advantage of the pulley is the two, what is the resulting distance the cat is lifted if he uses the same amount of energy and pulls down the same distance?

ANSWER: 20m

BONUS

16) PHYSICS *Short Answer* Name all of which of the following pairs forming a particle are pions:

- I. Up quark, down quark
- II. Up quark, anti down quark
- III. Muon, anti electron

ANSWER: II only

TOSS-UP

17) CHEMISTRY *Short Answer* What neutral, period 5 element has the smallest atomic radius?

ANSWER: Radon

BONUS

17) CHEMISTRY *Multiple Choice* Which of the following elements has the lowest electron affinity?

- W) Cobalt
- X) Silver
- Y) Selenium
- Z) Barium

ANSWER: Z) Barium

TOSS-UP

18) EARTH AND SPACE *Multiple Choice* While writing science bowl questions, Tim notices a striated blue mineral showing great labradorescence on the floor. What could this mineral be?

- W) Amazonite
- X) Microcline
- Y) Labradorite
- Z) Glaucophane

ANSWER: Y) Labradorite

BONUS

18) EARTH AND SPACE *Short Answer* Name all of the following three that are true about passive margins compared to active margins:

- I. Passive margins contain a continental rise, while convergent active margins don't
- II. Passive margins have a relatively flat continental shelf, while transform active margins don't
- III. Passive margins have a broad continental shelf, while convergent active margins have narrower ones

ANSWER: I, III

TOSS-UP

19) MATH *Short Answer* Daisy wants to create a flower in math class, so she uses desmos to graph a few. Name all of the following polar equations that would give her a flower with 12 petals:

I) $r=5\cos 6\theta$

II) $r=5\sin 6\theta$

III) $r=5\sin 12\theta$

ANSWER: I and II

BONUS

19) MATH *Short Answer* The numbers x and $x+12$ are three-digit and four-digit palindromes, respectively. What is the sum of the digits of x ?

ANSWER: 26

TOSS-UP

20) BIOLOGY *Multiple Choice* Amino acids must contain what two functional groups?

W) Amine and Thiol

X) Amine and Carbonyl

Y) Amine and Hydroxyl

Z) Amine and Carboxyl

ANSWER: Z) Amine and Carboxyl

BONUS

20) BIOLOGY *Multiple Choice* At what age does the prefrontal cortex fully develop?

W) 10 years

X) 14 years

Y) 18 years

Z) 25 years

ANSWER: Z) 25 years

TOSS-UP

21) PHYSICS *Multiple Choice* What quantity is equal to $U - TS$?

W) Gibbs Free Energy

X) Enthalpy

Y) Helmholtz Free Energy

Z) Work

ANSWER: Y) Helmholtz Free Energy

BONUS

21) PHYSICS *Question Type* Calculate the change in entropy when a mol of gas is isothermally expanded from 100L to 271L.

ANSWER: $nR\ln(271/100) = 8.314 \text{ J/K}$

TOSS-UP

22) CHEMISTRY *Short Answer* The equation of a reaction is $\text{Mg} + 2\text{OH} = \text{Mg(OH)}_2$. What is the order of the reaction, given that the graph of time versus $1/[\text{Mg}]$ is linear?

ANSWER: Second Order

BONUS

22) CHEMISTRY *Multiple Choice* What is the molarity of the amount of hydrochloric acid that is present in one liter of water if the pH is 4

ANSWER: 1.0×10^{-4}

TOSS-UP

23) EARTH AND SPACE *Short Answer* What is a name for the center of mass in a star system?

ANSWER: Barycenter

BONUS

23) EARTH AND SPACE *Multiple Choice* Alfred Wegener discovered evidence of glacial activity on the southern ends of India, Australia, South America, and Africa. One hypothesis for this activity is that Earth was undergoing a global ice age 300 million years ago. Which of the following is evidence of why that hypothesis is wrong?

W) Currently, the southern ends of those landmasses are close enough to the poles to form glaciers

X) O₁₈ to O₁₆ ratios 300 million years ago in sediment cores are too high

Y) Tree rings formed 300 million years ago are too thick

Z) Scientists have discovered coal deposits dating back to 300 million years ago

ANSWER: Z) Scientists have discovered coal deposits dating back to 300 million years ago

TOSS-UP

24) MATH *Short Answer* In how many ways can you split 8 cookies among 3 people?

ANSWER: 21

BONUS

24) MATH *Short Answer* A square of area 20 is inscribed in a semicircle. What is the area of the semicircle?

ANSWER: 25/2 pi

TOSS-UP

25) BIOLOGY *Multiple Choice* The stage of a viruses life cycle when it assembles and buds from its host cell, causing the cell to burst, is known as what?

W) Lysogenic cycle

X) Lytic cycle

Y) Wilson cycle

Z) Krebs cycle

ANSWER: X) Lytic cycle

BONUS

25) BIOLOGY *Multiple Choice* Name all of which of the following are differences between retroviruses and togaviruses:

- I. Retroviruses contain RNA, while togaviruses contain DNA
- II. Retroviruses replicate inside the nucleus, while togaviruses replicate outside
- III. Retroviruses require reverse transcriptase to replicate, while togaviruses don't

ANSWER: II, III