Round 4

1. PHYSICS
Writer: Charles Zhang

Toss Up: Short Answer

Rank following electromagnetic radiations according to the energies of their photons, from least to greatest:

1. blue light

2. yellow light

3. x rays

4. radio waves

Bonus Answer: 4, 2, 1, 3 (accept equivalent forms)

Bonus: Multiple Choice

The work function for a certain sample is 2.3 eV. The stopping potential for electrons ejected from the sample by 7.0×10^{14}-Hz electromagnetic radiation is:

W) 0 V

X) 0.6 V

Y) 2.3 V

Z) 5.2 V

Bonus Answer: Y

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2. PHYSICS
Writer: Charles Zhang

Toss Up: Short Answer

What is the torque in N*m (read as newton meters) acting on a disk with radius of 3 meters, mass of 5kg, and rotating with an angular acceleration of 10 rad/s^2?

Bonus Answer: 225 N*m

Bonus: Short Answer

If a sphere with radius of 4 meters and a mass of 5kg is rolling at a velocity of 12m/s, find the total energy of the sphere in joules.

Bonus Answer: 648 J

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3. PHYSICS
Writer: Charles Zhang

Toss Up: Multiple Choice

Which of the following is the most accurate? The center of mass of the system consisting of Earth, the Sun, and the planet Mars is:

W) closer to the Sun than to either of the other bodies

X) closer to Earth than to either of the other bodies

Y) at the geometric center of the triangle formed by the three bodies

Z) at the center of the line joining Earth and Mars

Toss Up Answer: W

Bonus: Multiple Choice

At the same instant that a 0.50-kg ball is dropped from 25m above Earth, a second ball, with a mass of 0.25 kg, is thrown straight upward from Earth's surface with an initial speed of 15m/s. They move along nearby lines and pass each other without colliding. At the end of 2.0 s the height above Earth's surface of the center of mass of the two-ball system is:

W) 3.0m
X) 5.0m
Y) 6.5m
Z) 7.1m

Bonus Answer: Z

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4. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

In a spherical shell with radius of 2 meters a magnetic field with strength of 2 teslas passes though. What is the net magnetic flux?

Bonus Answer: 0

Bonus: Short Answer

What is the magnitude of the induced current produced as the magnetic field passing through a circle with radius of 2m and resistance of 5 ohms changes from 50 teslas to 25 teslas in 5 seconds to the nearest whole number?

Bonus Answer: 13 amperes

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5. PHYSICS

Writer: Charles Zhang

Toss Up: Short Answer

The quantity epsilon naught multiplied by the time derivative of electric flux represents what quantity in the Maxwell-Ampere equation?

Bonus Answer: Displacement current

Bonus: Short Answer

In a solenoid of length 20m with a current of 10 amperes traveling through it and undergoes 20 turns what is the magnitude of the magnetic field within it in teslas? Assume the vacuum permittivity is $9*10^{-12}$ and PI is approximately 3.

Bonus Answer: $1.8*10^{-9}$ teslas

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6. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which of these numbers are transcendental?

W) i
X) root 2
Y) e to the pi i
Z) pi

Toss Up Answer: Z

Bonus: Short Answer

What conic section does this equation create? $25x^2-150x-16y^2-128y+481=0$

Bonus Answer: Two intersecting lines/ a degenerate hyperbola

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7. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

What is the limit as x approaches 0 of x times ln x?

W) -1

X) 1

Y) 0

Z) The limit does not exist.

Toss Up Answer: Y

Bonus: Short Answer

What is the derivative of arcsec x?

Bonus Answer: 1/(x((x^2)-1)^.5)

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8. MATHEMATICS

Writer: Andrew Chen

Toss Up: Short Answer

What is the length of the longest diagonal of a unit cube?

Bonus Answer: root3

Bonus: Short Answer

What is the largest integer that cant be written as the sum of 3's and 4's?

Bonus Answer: 5

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9. MATHEMATICS

Writer: Andrew Chen

Toss Up: Short Answer

You are trying to give 5 apples to 3 friends. You can give any number of apples to each friend, including 0. How many ways are there to share the apples?

Bonus Answer: 56 (its 8C3)

Bonus: Multiple Choice

If a cubic function equals 0 at exactly two points, which of the following must be true?

W) the function passes through the origin

X) there is a double root

Y) the function is even

Z) one of the roots is imaginary

Bonus Answer: X

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10. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

Three bony shelves that project inferiorly in the nasal cavity are called

W) paranasal sinuses.

X) nasal conchae.

Y) the greater wing.

Z) the crista galli.

Toss Up Answer: X

Bonus: Multiple Choice

The olfactory foramina are found in the

W) nasal septum

X) cribriform plate

Y) hard palate

Z) lacrimal bone

Bonus Answer: X

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11. BIOLOGY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

Who is considered the father of paleontology?

W) Marquis de Condorcet

X) George Cuvier

Y) Marie Antoinette

Z) Auguste Compte

Toss Up Answer: X

Bonus: Short Answer

List the taxonomic groups from least to most specific

Bonus Answer: KINGDOM, PHYLUM, CLASS, ORDER, FAMILY, GENUS, SPECIES

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12. BIOLOGY

Writer: Shanjeed Ali

Toss Up: Short Answer

How many ATP molecules are produced by the Calvin cycle?

Bonus Answer: 0

Bonus: Short Answer

How many ATP molecules are used in the Calvin cycle to make one glucose molecule?

Bonus Answer: 18

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13. BIOLOGY

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

If the recessive allele of gene A is epistatic to gene B, what is the phenotypic ratio of the two genes?

W) 9:3:3:1

X) 12:4:3

Y) 9:4:3

Z) 9:7

Toss Up Answer: Y

Bonus: Short Answer

What genetic structure is responsible for the metabolism of lactose in E. Coli?

Bonus Answer: the lac operon

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14. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

What is the hybridization of the sulfur atom in SF4?

W) sp2

X) sp3

Y) sp3d

Z) sp3d2

Toss Up Answer: Y

Bonus: Short Answer

Which famous chemist proposed the modern kinetic molecule theory for gasses?

Bonus Answer: Bernoulli

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15. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Short Answer

Which famous chemist formulated the rule that mass is conserved through chemical reactions?

Bonus Answer: Lavosier

Bonus: Multiple Choice

Which of the following is the strongest oxidizing agent?

W) Pb2+

X) I2

Y) Ag+

Z) Pb

Bonus Answer: Y

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16. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The change in entropy is zero for:

W) reversible adiabatic processes

X) reversible isothermal processes

Y) reversible processes during which no work is done

Z) . all adiabatic processes

Toss Up Answer: W

Bonus: Multiple Choice

The Hall-Heroult process is used in the production of:

W) Mg

X) Fe

Y) Al

Z) Au

Bonus Answer: Y

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17. CHEMISTRY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Monatomic, diatomic, and polyatomic ideal gases each undergo slow adiabatic expansions from the same initial volume and the same initial pressure to the same final volume. The magnitude of the work done by the environment on the gas:

W) is greatest for the polyatomic gas

X) is greatest for the diatomic gas

Y) is greatest for the monatomic gas

Z) is the same only for the diatomic and polyatomic gases

Toss Up Answer: W

Bonus: Multiple Choice

The mean free path of a gas molecule is:

W) the shortest dimension of the containing vessel

X) the cube root of the volume of the containing vessel

Y) average distance between adjacent molecules

Z) average distance a molecule travels between intermolecular collisions

Bonus Answer: Z

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18. CHEMISTRY
Writer: Nicholas Parker Ng
Toss Up: Multiple Choice

The root-mean-square sped of molecules in a gas is:

W) the most probable speed

X) that speed such that half the molecules are moving faster than vrms and the other half are moving slower

Y) the average speed of the molecules

Z) the square root of the sum of the velocities squared

Toss Up Answer: Z

Bonus: Multiple Choice

 An ideal monatomic gas has a molar specific heat Cv at constant volume of:

W) R

X) 3R/2

Y) 5R/2

Z) 7R/2

Bonus Answer: X

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19. CHEMISTRY
Writer: Nicholas Parker Ng
Toss Up: Multiple Choice

 The number of degrees of freedom of a triatomic molecule is:

W) 1

X) 3

Y) 6

Z) 9

Toss Up Answer: Z

Bonus: Short Answer

The internal energy of an ideal gas depends on which of the following: temperature, pressure, volume.

Bonus Answer: Temperature

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20. EARTH and SPACE

Writer: William Chan

Toss Up: Multiple Choice

The surface of Venus is much hotter than would be expected, considering its distance from the Sun. Which statement best explains this fact?

W) Venus has many active volcanoes.

X) Venus as a slow rate of rotation

Y) The clouds of Venus are highly reflective

Z) The atmosphere of Venus contains a high percentage of carbon dioxide.

Toss Up Answer: Z

Bonus: Multiple Choice

The existence of Pluto and Neptune was accurately predicted through the study of the movements of

W) comets

X) other planets

Y) stars

Z) the Sun

Bonus Answer: X

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21. EARTH and SPACE

Writer: William Chan

Toss Up: Multiple Choice

A star like Earth's Sun will eventually

W) explode in a supernova

X) become a black hole

Y) change into a white dwarf

Z) become a neutron star

Toss Up Answer: Y

Bonus: Multiple Choice

Two nebulae, A and B, of equal volume are beginning to contract and form stars A and B. Nebula A has 10,000 times the mass of nebula B. Which of the following predictions is most accurate?

W) Star A will use up its fuel faster than star B.

X) Star A will probably be much redder than star B.

Y) Star B will be much hotter than star A.

Z) Stars A and B will be identical in volume.

Bonus Answer: W

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22. EARTH and SPACE

Writer: William Chan

Toss Up: Multiple Choice

Which of the following statements best describes the difference between a galaxy and a nebula?

W) A galaxy consists of stars; a nebula consists of dust and gas.

X) There are two types of nebula, but only one type of galaxy.

Y) A galaxy always emits light; a nebula never emits light.

Z) A galaxy consists of matter; a nebular consists of energy.

Toss Up Answer: W

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23. EARTH and SPACE

Writer: William Chan

Toss Up: Multiple Choice

Which instrument is used to study the composition of stars?

W) sextant

X) spectroscope

Y) seismograph

Z) chronometer

Toss Up Answer: X

Bonus: Multiple Choice

An observer viewing the sky through a telescope sees a fuzzy, glowing region in the constellation Orion. The region has an irregular shape, and some stars seem to be shining through it. The observer is most likely viewing a

W) planet

X) comet

Y) meteor

Z) nebula

Bonus Answer: Z

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24. EARTH and SPACE

Writer: William Chan

Toss Up: Multiple Choice

Which observation provides the best evidence that Earth revolves around the Sun?

W) Stars seen from Earth appear to circle Polaris

X) Earth's planetary winds are deflected by the Coriolis effect

Y) The change from high ocean tide to low ocean tide is a repeating pattern

Z) Different star constellations are seen from Earth at different times of the year.

Toss Up Answer: Z

Bonus: Short Answer

What is the name of the paradox that asks why the night sky is dark if the universe is infinite and should contain an infinite about of stars?

Bonus Answer: Olbers paradox

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25. ENERGY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The world has the least amount of which of the following fuel types?

W) oil

X) coal

Y) uranium

Z) there are about the same amount of each of these

Toss Up Answer: W

Bonus: Short Answer

What region of the world holds the majority of already discovered oil fields?

Bonus Answer: The Middle East

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