

Round 6

1. PHYSICS

Writer: William Xiang

Toss Up: Multiple Choice

Which of the following explains what happens when a negatively charged rod is held to the metal conductor of a leaf electroscope?

- W) The leaves close because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- X) The leaves close because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.
- Y) The leaves open because electrons flow from the rod to the electroscope, resulting in a net negative charge in the electroscope.
- Z) The leaves open because electrons flow from the electroscope to the rod, resulting in a net positive charge in the electroscope.

Toss Up Answer: Y

Bonus: Short Answer

A positive charge of +5.3 Coulombs is placed in an electric field of 420. Newtons per Coulomb. Find the magnitude of the force the charge experiences in this electric field, rounded to two significant figures.

Bonus Answer: 2200 N (Explanation: $F = E \cdot q$)

2. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

Which of the following units are a measure of magnetic field strength?

- 1 - Gauss
- 2 - Tesla
- 3 - Weber
- 4 - Henry

Bonus Answer: 1,2 (Gauss, Tesla)

Bonus: Multiple Choice

If the axle of a wheel is moving at a velocity of v , what is the instantaneous velocity of the top of the wheel?

- W) $-2v$
- X) 0
- Y) v
- Z) $2v$

Bonus Answer: Z

3. PHYSICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What color is a mirror?

Bonus Answer: green

Bonus: Short Answer

Using $g = 10 \text{ m/s}^2$, given the weight of an object is 2700 Newtons, what is the mass of the object on the Moon, if its gravitational force is $1/6$ as strong as that on Earth? Round your answer to the first decimal place.

Bonus Answer: 270 kg

4. PHYSICS

Writer: Shantanu Jha

Toss Up: Multiple Choice

What is true about the capacitance of two parallel plates?

- W) it is proportional to the square of the Area of the plates
- X) it is proportional to the inverse of the Area of the plates
- Y) it is proportional to the inverse of the plate separation
- Z) it is proportional to the plate separation

Toss Up Answer: Y

Bonus: Multiple Choice

A 200 farad capacitor is used in a circuit. The voltage difference between the plates of the capacitor is 10 volts. What is the magnitude of the charge on each of the capacitor's plates?

- W) 100 Coulombs
- X) 2000 Coulombs
- Y) 10 Coulombs
- Z) 200 Coulombs

Bonus Answer: X

5. PHYSICS

Writer: Shantanu Jha

Toss Up: Short Answer

Given two frequencies of 410 Hertz and 412 Hertz, what is the period of the beats produced?

Bonus Answer: .5 seconds

Bonus: Short Answer

A car is driving away at 50 meters/seconds from an observer at rest. The car is emitting a frequency at 80 Hz. What is the apparent frequency for the observer, given that the speed of sound is 350 meters/seconds? Give your answer to the nearest integer.

Bonus Answer: 70 Hertz

6. MATHEMATICS

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

What is the y-intercept in the equation $y = 4x + 3 - 2$

- W) 3
- X) 1
- Y) -2
- Z) 2

Toss Up Answer: X

Bonus: Multiple Choice

If $3x - y = 12$, what is $(8^x) / (2^y)$

- W) 2^{12}
- X) 4^4

- Y) 8^3
Z) Cannot be determined

Bonus Answer: W

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7. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the 3rd mersenne prime?

Bonus Answer: 31

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Bonus: Multiple Choice

How many terms does the 15th integral of $\sin x \, dx$ have?

- W) 1
X) 2
Y) 15
Z) 16

Bonus Answer: Z

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8. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Tim is 5 times older than his younger brother. In 3 years Tim will be 3 times older than his younger brother. Compute the difference in the ages of Tim and his younger brother.

Bonus Answer: 12

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Bonus: Short Answer

How many positive integers n have no solutions to the following equation where a and b are nonnegative integers?

$$3a + 7b = n$$

Bonus Answer: 6

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9. MATHEMATICS

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Given two attempts, what is the probability in a ratio of getting a multiple choice question correct, if there are 5 choices?

- W) 1:3
X) 1:4
Y) 2:3
Z) 2:4

Toss Up Answer: Y

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Bonus: Multiple Choice

What percentage of data falls within 2 standard deviations of the mean, assuming a normal distribution?

- W) 34.10%
X) 47.70%
Y) 68.20%

Z) 95.40%

Bonus Answer: Z

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10. BIOLOGY

Writer: William Chan

Toss Up: Multiple Choice

All of the following are examples of substances found in bacteria or archaea EXCEPT:

- W) peptidoglycan
- X) flagellin
- Y) chitin
- Z) phycobilin

Toss Up Answer: Y

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Bonus: Multiple Choice

Which of the following groups of organisms lacks motility?

- W) Cellular slime molds
- X) Ciliates
- Y) Dinoflagellates
- Z) Apicomplexans

Bonus Answer: Z

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11. BIOLOGY

Writer: William Chan

Toss Up: Multiple Choice

Genetic variation can be introduced into bacteria by all of the following methods EXCEPT:

- W) transfer of DNA between bacteria through pili
- X) mutation
- Y) transformation
- Z) DNA amplification

Toss Up Answer: Z

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Bonus: Multiple Choice

An mRNA actively being translated in the cytoplasm would have all of the following EXCEPT:

- W) a poly-A tail
- X) a 5' (read as 5 prime) cap
- Y) exons
- Z) introns

Bonus Answer: Z

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12. BIOLOGY

Writer: William Chan

Toss Up: Multiple Choice

The inheritance of skin color in humans is an example of which of the following?

- W) pleiotropy
- X) codominance

- Y) epistasis
- Z) polygenic inheritance

Toss Up Answer: Z

Bonus: Multiple Choice

A human genetic defect that is caused by nondisjunction of the sex chromosomes is

- W) sickle-cell disease
- X) hemophilia
- Y) red-green color blindness
- Z) Turner syndrome

Bonus Answer: Z

13. BIOLOGY

Writer: William Chan

Toss Up: Multiple Choice

If a cell has 46 chromosomes at the beginning of mitosis, then at anaphase there would be a total of

- W) 23 chromatids
- X) 23 chromosomes
- Y) 46 chromosomes
- Z) 92 chromosomes

Toss Up Answer: Z

Bonus: Multiple Choice

All of the following statements are true EXCEPT:

- W) spindle fibers are composed largely of microtubules.
- X) centrioles consist of nine triplets of microtubules arranged in a circle.
- Y) all eukaryotic cells have centrioles
- Z) many of the microtubules in a spindle apparatus attach to kinetochores of chromosomes

Bonus Answer: Y

14. CHEMISTRY

Writer: Raafiul Hossain

Toss Up: Short Answer

You need to prepare 500 milliliters of a 0.100 molar NaOH solution from a 0.250 molar solution. What volume, in milliliters, of the 0.250 molar solution must be diluted to 500 milliliters?

Bonus Answer: 200

Bonus: Short Answer

Can MASS SPECTROMETRY be used to calculate endpoint pH?

Bonus Answer: No

15. CHEMISTRY

Writer: Raafiul Hossain

Toss Up: Short Answer

[note: read as O two [pause] one minus] Name all of the following 4 species that contain an odd number of electrons:

O₂⁻¹; O₂⁻²; SO₂; CO

Bonus Answer: O₂⁻¹-

Bonus: Short Answer

What are the 2 alkenes (read as: al-KEENS) with the shortest carbon chains and lowest molecular weights?

Bonus Answer: ethene, propene (accept ethylene, propylene)

16. CHEMISTRY

Writer: Raafiul Hossain

Toss Up: Short Answer

A Buchner funnel is a piece of laboratory glassware to carry out what process?

Bonus Answer: Filtration

Bonus: Short Answer

Why are oxygenates used as gasoline additives?

Bonus Answer: they allow for more complete combustion

17. CHEMISTRY

Writer: Raafiul Hossain

Toss Up: Short Answer

What is the theoretical end of a titration?

Bonus Answer: equivalence point

Bonus: Short Answer

In the electrolysis of a copper chloride solution, what forms at the cathode and anode, respectively?

Bonus Answer: CATHODE = COPPER (ACCEPT: Cu); ANODE = CHLORINE (ACCEPT: CHLORINE GAS or Cl₂)

18. CHEMISTRY

Writer: Ahmad Alnasser

Toss Up: Multiple Choice

Which of the following is a nonpolar molecule with polar bonds?

W) F₂

X) CHF₃

Y) HCl

Z) CO₂

Toss Up Answer: Z

Bonus: Short Answer

M represents some unknown element. When M₂S₃ is heated in air, it is converted to MO₂. A 4.000g sample of M₂S₃ shows a decrease in mass of .277 g when it is heated in air. To the nearest whole number, what is the average atomic mass of M?

Bonus Answer: 184 g/mol

19. CHEMISTRY

Writer: Andrew Chen

Toss Up: Short Answer

Assuming no double or triple bonds in the molecule, what form of hybridization does a ketone carbon have?

Bonus Answer: sp2

Bonus: Multiple Choice

Which of the following is amphoteric?

- W) Zinc Oxide
- X) Aluminum Chloride
- Y) Acetic Acid
- Z) Magnesium Oxide

Bonus Answer: W

20. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

A pulsar is a particular type of:

- W) Neutron star
- X) Black hole
- Y) White dwarf
- Z) Black dwarf

Toss Up Answer: W

Bonus: Short Answer

What does the Schwarzschild (pronounced: Sh-worts-shield) radius of a body represent?

Bonus Answer: The radius which, if all of the mass of the body were contained within it, the body would become a black hole (or: its escape velocity would be greater than C).

21. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

Sunspots and other solar activity tend to follow a cycle lasting about how long?

- W) 1 year
- X) 11 years
- Y) 23 years
- Z) 57 years

Toss Up Answer: X

Bonus: Short Answer

Identify each of the following solar events that is correctly paired with its origin

1. Prominence; the photosphere
2. Solar filament; the chromosphere
3. Coronal mass ejection; the corona

Bonus Answer: 1, 3

22. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

Sunspots exist on which layer of the sun?

- W) Heliosphere
- X) Photosphere
- Y) Chromosphere

Z) Corona

Toss Up Answer: X

Bonus: Multiple Choice

Sunspots are characterized by

W) High magnetic field flux, and cooler temperature

X) High magnetic field flux, and hotter temperature

Y) Low magnetic field flux, and cooler temperature

Z) Low magnetic field flux, and hotter temperature

Bonus Answer: W

23. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Multiple Choice

A red dwarf is

W) A large variation of brown dwarf

X) The remnant of a main sequence star

Y) A small and cool star in the main sequence

Z) Unable to complete nuclear fusion

Toss Up Answer: Y

Bonus: Short Answer

What type of star will the Sun become once it leaves the main sequence?

Bonus Answer: Red giant

24. EARTH and SPACE

Writer: Wilson Berkow

Toss Up: Short Answer

What is the name of the plane on which the planets and Sun of the solar system move?

Bonus Answer: The ecliptic

Bonus: Short Answer

"Planet" means "wanderer", as the ancients saw that planets, unlike stars, sometimes move forward with the stars through the sky and sometimes change direction and move in the opposite direction. What are the names of these two types of motion through the sky?

Bonus Answer: Retrograde and prograde

25. ENERGY

Writer: Nicholas Parker Ng

Toss Up: Short Answer

From what country does the US import the most coal?

Bonus Answer: Columbia

Bonus: Short Answer

Rank the coal production of these states from lowest to highest: Wyoming, West Virginia, Illinois, Pennsylvania.

Bonus Answer: Pennsylvania, Illinois, West Virginia, Wyoming.
