

Round 10

1. PHYSICS

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

Monochromatic light is normally incident on a diffraction grating that is 1cm wide and has 10,000 slits. The first order line is deviated at a 30° angle. What is the wavelength, in nm, of the incident light?

W) 300

X) 500

Y) 877

Z) 1000

Toss Up Answer: X

Bonus: Multiple Choice

A spectral line of a certain star is observed to be "red shifted" from a wavelength of 500nm to a wavelength of 1500nm. Interpreting this as a Doppler effect, the speed of recession of this star is:

W) .33c

X) .5c

Y) .71c

Z) .8c

Bonus Answer: Z

2. PHYSICS

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

The equation of continuity for fluid flow can be derived from the conservation of:

W) Energy

X) Mass

Y) Angular momentum

Z) Volume

Toss Up Answer: X

Bonus: Multiple Choice

A coil has a resistance of 60Ω and an impedance of 100Ω . Its reactance, in ohms, is:

W) 40

X) 60

Y) 80

Z) 117

Bonus Answer: Y

3. PHYSICS

Writer: Nicholas Parker Ng

Toss Up: Short Answer

The Curie temperature is the temperature at which ferromagnets become paramagnets. What is the name for the point at which antiferromagnets become paramagnets?

Bonus Answer: The Neel temperature

Bonus: Multiple Choice

A hall probe measures which of the following:

- W) Capacitance
- X) Viscosity
- Y) Magnetic Field
- Z) Electric Field

Bonus Answer: Y

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4. PHYSICS

Writer: Nicholas Parker Ng

Toss Up: Short Answer

What is the name for the effect that explains the small attractive force that acts between two close parallel uncharged conducting plates in a vacuum?

Bonus Answer: The Casimir Effect

Bonus: Multiple Choice

According to Beer's law:

- W) the energy of a photon of light is inversely proportional to its wavelength
- X) the concentration of a species that absorbs light can be measured by the amount of light absorbed
- Y) the energy of characteristic X-rays increases with increasing atomic number of the emitting element
- Z) excitation of the electrons in a molecule takes place on a shorter time scale than motion of the nuclei

Bonus Answer: X

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5. PHYSICS

Writer: Andrew Chen

Toss Up: Short Answer

How many bosons are in a regular hydrogen atom?

Bonus Answer: 1 (it's the electron)

Bonus: Short Answer

Two forces have magnitudes of 15 newtons and 5 newtons. Using interval notation, what is the range of the possible magnitudes of their sum?

Bonus Answer: [10, 20], accept: between 10 and 20 Newtons inclusive

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6. MATHEMATICS

Writer: Steven Litvack-Winkler

Toss Up: Short Answer

Compute the dot product of the following vectors:

$\langle 2, 1, 3 \rangle$ and $\langle 10, -1, -5 \rangle$

Bonus Answer: 4

Bonus: Multiple Choice

$(64 + 196 + 81)(49 + 256 + 49) > (56 + 224 + 63)^2$ [Read "the quantity $64+196+81$ times the quantity $49+256+49$ strictly greater than the quantity $56+224+63$ squared] is most directly an example of what inequality?

- W) Triangle inequality
- X) Power Mean Inequality
- Y) Cauchy-Schwarz inequality [COW-SHEE sch-WARTS]
- Z) Jensen's inequality [YEN-SIN]

Bonus Answer: Y

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7. MATHEMATICS

Writer: Andrew Chen

Toss Up: Short Answer

If the log of n is 10, what is the log of 100n?

Bonus Answer: 12

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Bonus: Short Answer

How many ways are there to seat 5 people around a circular table, if rotations are ignored?

Bonus Answer: 24

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8. MATHEMATICS

Writer: Siam Muquit

Toss Up: Short Answer

If the first term in an arithmetic sequence is 2 and the third term is 6, find the 10th term.

Bonus Answer: 20

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Bonus: Short Answer

Compute the sum of the first 100 positive integers.

Bonus Answer: 5050

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9. MATHEMATICS

Writer: Siam Muquit

Toss Up: Short Answer

Find the perimeter of a right triangle with legs 11 and 60.

Bonus Answer: 132

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Bonus: Short Answer

In a 15-75-90 degrees right triangle with hypotenuse 4, what are the lengths of the shorter and longer leg, respectively? Exact answers please.

Bonus Answer: $\sqrt{6} - \sqrt{2}$, $\sqrt{6} + \sqrt{2}$

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10. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

Which mollusk does not possess a radula?

W) Squid

X) Scallop

Y) Snail

Z) Chiton

Toss Up Answer: X

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Bonus: Short Answer

What is the scientific name for the job or role an organism plays in its habitat?

Bonus Answer: Niche

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11. BIOLOGY

Writer: Amrit Hingorani

Toss Up: Multiple Choice

What branching nerve fibers receive messages?

- W) Axons
- X) Axes
- Y) Dendrons
- Z) Dendrites

Toss Up Answer: Z

Bonus: Multiple Choice

What protein was first isolated in red blood cells?

- W) Myoglobin
- X) Hemocyanin
- Y) Spectrin
- Z) Collagen

Bonus Answer: Y

12. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

Give the genus and species name of the organism that Beadle and Tatum worked with.

Bonus Answer: Neurospora crassa

Bonus: Short Answer

Archibald Garrod is credited with the discovery of which disease, characterized by blackened urine?

Bonus Answer: Alkaptonuria

13. BIOLOGY

Writer: Siam Muquit

Toss Up: Short Answer

Name the two types of cell death.

Bonus Answer: Apoptosis, Necrosis

Bonus: Short Answer

In C4 and CAM photosynthesis, which specific enzyme is used to fix CO₂ in lieu of RuBisCO?

Bonus Answer: PEP Carboxylase

14. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the most common isotope of Hydrogen?

Bonus Answer: Protium

Bonus: Short Answer

What is the hybridization of carbon atoms in alkanes?

Bonus Answer: sp³

15. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

Which noble gas is heavier than air?

Bonus Answer: Xenon (Accept: Xe)

Bonus: Short Answer

What is the mass of Sodium Chloride that is in the average human body? Answer in grams.

Bonus Answer: 250 grams

16. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

Which element is a dark red liquid at room temperature?

Bonus Answer: Bromine

Bonus: Short Answer

What is the combining capacity of Calcium?

Bonus Answer: 2

17. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the name of a mixture of metals?

Bonus Answer: Alloy

Bonus: Short Answer

What is the name given to all Group 16 elements?

Bonus Answer: Chalcogens

18. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the hybridization of the molecular bonds of Ammonia?

Bonus Answer: sp³

Bonus: Short Answer

Which element is most likely to act as an ideal gas?

Bonus Answer: Hydrogen (Accept: H)

19. CHEMISTRY

Writer: Prangon Ghose

Toss Up: Short Answer

What is the only letter that does not appear in the Periodic Table of Elements?

Bonus Answer: J

Bonus: Short Answer

Which element has the largest atomic radius?

Bonus Answer: Cesium (Accept: Cs)

20. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

In approximately 4 billion years, another galaxy is predicted to collide with the Milky Way. What is the name of this galaxy?

Bonus Answer: Andromeda

Bonus: Multiple Choice

What is the third most abundant element in the universe?

- W) Helium
- X) Lithium
- Y) Carbon
- Z) Oxygen

Bonus Answer: Z

21. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

What is the term used to describe silt and mud deposited by a stream during periods of high water?

Bonus Answer: Alluvial

Bonus: Multiple Choice

Which radioactive element is generally present in smoke detectors today?

- W) Americium
- X) Radium
- Y) Radon
- Z) Actinium

Bonus Answer: W

22. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which corner of the H-R diagram would a white dwarf most likely be found?

- W) Upper Left
- X) Lower Left
- Y) Upper Right
- Z) Lower Right

Toss Up Answer: X

Bonus: Short Answer

What element is the penultimate element formed in the core of a supergiant?

Bonus Answer: Silicon

23. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Multiple Choice

Which of the following minerals breaks in parallel sheets?

- W) Pyroxene
- X) Halite
- Y) Muscovite

Z) Calcite

Toss Up Answer: Y

Bonus: Multiple Choice

During a supernova, what percentage of the total energy released is composed of neutrinos?

- W) 10
- X) 50
- Y) 75
- Z) 99

Bonus Answer: Z

24. EARTH and SPACE

Writer: Shamaul Dilmohamed

Toss Up: Short Answer

Order the four gas giants in size from the largest to the smallest.

Bonus Answer: Jupiter, Saturn, Uranus, Neptune

Bonus: Multiple Choice

Which one of these statements about Neptune's moon, Triton, is true?

- W) It orbits in retrograde motion.
- X) Its orbit is highly eccentric.
- Y) It fractured billions of years ago and reformed.
- Z) It does not have an atmosphere.

Bonus Answer: W

25. ENERGY

Writer: Nicholas Parker Ng

Toss Up: Multiple Choice

16) Which uranium oxide is most commonly used in light water reactors?

- W) uranium(IV) oxide
- X) uranium(V) oxide
- Y) uranium(VI) oxide
- Z) Yellowcake

Toss Up Answer: W

Bonus: Multiple Choice

If a 1 kg mouse runs at 5 m/s, what is its approximate energy in electronvolts?

- W) 4.8×10^{-3}
- X) 2.9×10^{15}
- Y) 7.8×10^{19}
- Z) 4.4×10^{22}

Bonus Answer: Y
