1. BIOLOGY *Multiple Choice*- Which of the following is NOT true about plankton?

W) Dinoflagellates are of the class Dinophyceae

X) Zooxanthellae, dinoflagellates with nonmotile stages, are symbionts in the tissues of invertibrates such as coral

Y) Copepods hatch as nauplius larvae

Z) Cyanobacteria do not posess chlorophyll a in plastids

BIOLOGY *Short Answer*- Ever so often, diatoms need to cast off both of their valves and replace them. What is the name of the structure of the diatom without these valves?

ANSWER: AUXOSPORES

1. MATH *Short Answer*- A pyramid composed of four equilateral triangles and a square has a base area of 16. What is the total combined area?

ANSWER: 16 + 163

MATH *Multiple Choice*- A regular hexagon has a circle circumscribed inside it and outside it. If the radius of the circle inside the hexagon is 4, then what is the difference between the two circles’ areas?

ANSWER: 16π

1. PHYSICS *Short Answer*- Marcus rolls a bowling ball towards a pin. If 500N is exerted on the pin over a course of .1 seconds, then what is the initial velocity of the bowling ball, if the mass is 10N?

ANSWER: 5 M/S

PHYSICS *Short Answer*- 60 kg Rocco is on a ramp with an incline of 30ᵒ with respect to the horizontal and a length of 12 meters. If he jumps off and lands on a spring with a coefficient of elasticity of 200, then how much is the spring compressed? Assume the acceleration due to gravity is 10 m/s.

ANSWER: 6 METERS

1. CHEMISTRY *Multiple Choice*- Which of the following four statements is false?

W) For light with a frequency less than the threshold frequency, no electrons are emitted

X) For light with a frequency less than the threshold frequency, light intensity does not have a direct relationship with the amount of electrons emitted

Y) For light with a frequency greater than the threshold frequency, the potential energy of the emitted electrons increase linearly with respect to the light’s frequency

Z) For light with a frequency greater than the threshold frequency, the number of electrons emitted increases with the intensity of the light

ANSWER: Y

CHEMISTRY *Short Answer*- List the following five elements from largest atomic radii to smallest.

Francium, Hafnium, Bohrium, Zirconium, Molybdenum

ANSWER: Francium, Bohrium, Hafnium, Zirconium, Molybdennum (1, 3, 2, 4, 5)

1. EARTH AND SPACE SCIENCE *Short Answer*- What is the type of reflector that uses an objective mirror to reflect light to a flat secondary mirror, which in turn reflects the light out of one side of the telescope?

ANSWER: NEWTONIAN

EARTH AND SPACE SCIENCE *Short Answer*- List the following four mirrors in order from least bright at the focus to most bright at the focus.

A mirror with a focal length of 900 cm and a diameter of 60 cm, a mirror with a radius of 15 inches and a focal length of 60 inches, a mirror with a focal length of 75 in and a diameter of 10 in, a mirror with a diameter of 20 cm and a focal length of 350 cm

ANSWER: 4, 1, 3, 2

1. BIOLOGY *Short Answer*- A pair of Siamese twins in the embryo have how many layers of amnions and chorions all together?

ANSWER: 2 AMNIONS, 1 CHORION

BIOLOGY *Short Answer*- During the creation of the neural tube during morphogenesis, what protein filament causes the neural plate to contract and form wedge shapes?

ANSWER: ACTIN FILAMENTS

1. MATH *Short Answer*- What is cos (arctan 8/15)?

ANSWER 15/17

MATH *Multiple Choice*- If 24 is the length of one of the legs of a right triangle and the remaining two are integers, then what is the sum of all the possible hypotenuses to this right triangle?

W) 55

X) 65

Y) 75

Z) 85

ANSWER: X

1. PHYSICS *Short Answer*- The escape speed on Earth is V. In terms of V, what is the escape speed of an object with a mass 5 times larger and a radius 3 times larger?

ANSWER:

PHYSICS *Short Answer*- Alvin needs to heat 5 kg of aluminum from 312 Kelvin to 367 Kelvin. He supplies a constant stream of 1000 J/s. Rounding to the nearest second, how many minutes and seconds does it take for the aluminum to heat up to the right temperature?

ANSWER: 4 MINUTES AND 8 SECONDS

1. CHEMISTRY *Multiple Choice*- When spheres are packed in the abc arrangement, it is called which of the following?

W) Cubic closet packed structure

X) Bilateral face-centered structure

Y) Pentagonal closet packed structure

Z) Hexagonal closet packed structure

ANSWER: W

CHEMISTRY *Short Answer*- If the radius of a germanium atom is 9 pm, then what is the exact value of the volume of a face centered cubic unit cell?

W) 11634

X) 5317

Y) 1296

Z) 2592

ANSWER: W

1. EARTH AND SPACE SCIENCE *Multiple Choice*- Astronomers imagine that Mars had a denser atmosphere about 3.5 billion years ago from which of the following?

W) Outgassing

X) Proximity with gaseous clouds

Y) Arroyos

Z) Ocean activity

ANSWER: W

EARTH AND SPACE SCIENCE *Short Answer*- Denote all of the following three statements that is true about the Murchison meteorite.

1: It contained only left-handed amino acids, showing that there was terrestrial contamination

2: The Murchison meteorite was a carbonaceous chondrite meteor

3: The meteorite suggests that there was a nonbiological origin of its organic molecules

ANSWER: 2 AND 3

1. BIOLOGY *Short Answer*- What is the name of the ring of interlocking, tooth-like structures on the upper part of a sporophyte from nonvascular plants?

ANSWER: PERISTOME

BIOLOGY *Multiple Choice*- Which of the following four statements is true?

W) Lycophytes contain the least amount of species in the bryophytes

X) Groups of sporophylls form strobili

Y) Peatlands have low temperature and a high pH

Z) Rhizoids in liverworts and hornworts are filaments of cells

ANSWER: X

1. MATH *Multiple Choice*- Jimmy eats three chocolate chip cookies every minute. Joey begins eating two minutes later and eats two cookies every minute. If they ate a total of 31 cookies, how many more cookies did Jimmy eat than Joey?

W) 5

X) 8

Y) 11

Z) 14

ANSWER: Y

MATH *Short Answer*- Billy deals out five cards face down. You know that three of the face down cards are the queen of hearts, spades, and clubs. You pick three of the cards from the face down cards and Billy shuffles them. After he deals again, you select one card from the three remaining. What is the probability that this card is a red queen?

ANSWER: 1/15

1. PHYSICS *Short Answer*- What is the law that states that the rate of flow in a tube is equal to (, where R is the radius, P1 and P2 are the pressures at the end of the tube, η is the coefficient of viscosity of the fluid, and L is the length of the tube?

ANSWER: POISEUILLE’S LAW

PHYSICS *Multiple Choice*- A cube of aluminum has a side length of 3. If the average coefficient of area expansion is 4.8 x 10-5, then what is the new volume of the cube if its temperature is increased by 40 Kelvin, to the nearest hundredth place?

W) 27.05

X) 27.08

Y) 27.15

Z) 27.21

ANSWER: X

1. CHEMISTRY *Multiple Choice*- Which of the following best explains why boron trifluoride bonds easily with NH3?

W) The boron in boron trifluoride has only 6 electrons around it and must use the extra pair from NH3.

X) The nitrogen in NH3 has only 6 electrons around it and must use the extra pair from boron trifluoride.

Y) Boron trifluoride has a double bond in it, so it prefers bonding with NH3 to remove it

Z) NH3 has a double bond in it, so it prefers bonding with boron trifluorideto remove it

CHEMISTRY *Short Answer*- Classify each of the following five molecules by the number of electrons around the central atom.

I3, PCl5, XeO3, BeCl2, ICl4-

ANSWER: 10, 10, 8, 4, 12

1. EARTH AND SPACE SCIENCE *Short Answer*- Named after the person who discovered it, what is the name of the cometary cloud that supplies the solar system’s comets?

EARTH AND SPACE SCIENCE *Short Answer*- What is the name of the star that is the eye of Taurus the Bull?

ANSWER: ALDEBARAN

1. BIOLOGY *Short Answer*- What is the name of the specialized plastids containing dense starch grains in plant cells that detect gravity?

ANSWER: STATOLITHS

BIOLOGY *Short Answer*- When a short-day plant is grafted onto a long-day plant and exposed to short days, what is the name of the unidentified molecule that causes flowering?

ANSWER: FLORIGEN

1. MATH *Short Answer*- Four circles of radius 2 are positioned so that each are externally tangent to two others. If a square has its vertexes at the center of each circle, then what is the area of the portion of the square that is not also a portion of a circle?

ANSWER: 16-4π

MATH *Multiple Choice*- Two circles of radius 8 overlap at the points P and Q. If the length of the line segment PQ is 8, then what is the area of the circles overlap?

W) 64π - 16

X) 32π/3 - 32

Y) 64π/3 - 32

Z) 32π/3 - 16

ANSWER: Y

1. PHYSICS *Short Answer*- Denote all of the following three statements that are true about leptons.

1: All leptons have a spin of ½

2: A Tau has about twice the mass of an electron

3: Scientists currently believe there are eight leptons

ANSWER: 1 ONLY

PHYSICS *Short Answer*- What experiment tried to determine the velocity of Earth relative to the hypothetical ether. No fringe shift of the magnitude required was ever observed, and it also showed that it was impossible to measure the absolute velocity of Earth with respect to the ether frame.

ANSWER: MICHELSON-MORLEY EXPERIMENT

1. CHEMISTRY *Short Answer*- Determine the number of Cl- ions in the sodium chloride unit cell, formed from 14 chlorine ions and 13 sodium ions.

W) 5

X) 8

Y) 11

Z) 14

ANSWER: X

CHEMISTRY *Short Answer*- When two sets of three spheres in adjoining layers are packed in the closest packed structures, then what type of hole is formed?

ANSWER: OCTAHEDRAL

1. EARTH AND SPACE SCIENCE *Short Answer*- Denote all of the following three statements is what M-type rocks contain on their surface?

1: Rock

2: Carbon compounds

3: Metallic substances

EARTH AND SPACE SCIENCE *Multiple Choice*- Which of the following is the black hole in the constellation Cygnus?

W) Cygnus X-1

X) Cygnus A

Y) Cygnus B-2

Z) Cygnus C-1

ANSWER: W