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Lightning

1. CHEMISTRY: *Multiple Choice:* The van't Hoff factor, represented by I, is a measure of the effect of a solute upon colligative properties of a solution. Which of the following explanations best explains why carboxylic acids such as acetic acid have a van't Hoff factor less than one when dissolved in benzene?  
  
W) carboxylic acids readily disassociate in benzene

X) carboxylic acids form dimers through hydrogen bonding when placed in benzene

Y) carboxylic acids do not disassociate nor associate in benzene due to weak intermolecular forces between the solute and solvent

Z) carboxylic acids have a negative free energy of solvation in benzene

ANSWER: X) carboxylic acids form dimers through hydrogen bonding when placed in benzene

2. PHYSICS: *Short Answer:* Bob the bricklayer pulls a 10 kg stack of bricks straight up a 1 m high wall. He then decides to build a ramp that is elevated at 30 degrees above the vertical and push the bag of bricks up the ramp to the top of the wall. If the ramp is 1 meter high and Bob pushed the bag for 2 meters, neglecting the force of friction, what is the difference in work done on the bag between pushing the bricks up the ramp and lifting them straight up to the nearest Joule?  
  
ANSWER: 0 JOULES  
  
3. BIOLOGY: *Short Answer:* By name or number, identify all of the following four vitamins that are NOT fat-soluble  
  
1. Vitamin C

2. Vitamin A

3. Vitamin K

4. Vitamin D  
  
ANSWER: 1 ONLY  
  
4. EARTH AND SPACE SCIENCE: *Multiple Choice:* Based on the Hubble sequence, the Milky Way galaxy is classified as   
  
W)E3  
X) S0

Y) SBc  
Z) Sa

ANSWER: Y) SBc  
  
5. MATHEMATICS: *Short Answer:* What is the sum of the infinite geometric series whose first 3 terms are 2, -1, 0.5

ANSWER: 1.5  
  
6. CHEMISTRY: *Short Answer:* A reaction occurs at room temperature in an open beaker. It is found that delta H is equal to 100 kJ. Calculate the resulting change in entropy of the surroundings, to the nearest whole number.

ANSWER: 333 J/K

7. PHYSICS: *Short Answer:* By name or number, identify all of the following four quark flavors that are stable  
  
1. top

2. up

3. down

4. strange  
  
ANSWER: 2, 3

8. BIOLOGY: *Multiple Choice:* Female mammals, including humans, inherit two X chromosomes. To prevent the overproduction of proteins coded by genes on the X chromosome, one X chromosome in each female cell becomes inactivated during embryonic development, condensing into a compact object called a   
  
W) Mendel body

X) Barr body

Y) Morgan body

Z) nondisjunction bodies

9. EARTH AND SPACE SCIENCE: *Short Answer:* By name or number, identify all of the following five rocks that would be classified as nonfoliated:  
  
1. marble

2. anthracite

3. gniess

4. slate

5. phyllite  
  
ANSWER: 1, 2

10. MATHEMATICS: *Short Answer:* What is the limit of (x2 + 2x - 8) / (x - 2) as x approaches 2?   
  
ANSWER: 6  
  
11. CHEMISTRY: *Short Answer:* Dichlorobenzene occurs in three arene substitution patterns: ortho, meta, and para  
  
A. Identify all of the three forms that are polar  
B. Identify the form that has the highest dipole moment  
  
ANSWER: A. ortho, meta B. ortho

12. PHYSICS: *Short Answer:* An incompressible fluid flowing through a circular pipe with radius r encounters a join in the pipe where the radius halves. By what factor does the velocity of the fluid flowing through the tube increase?  
  
ANSWER: 4

13. BIOLOGY: *Multiple Choice:* All of the following animal viruses of the single-stranded RNA family have a viral envelope except for  
  
W) picornaviruses  
X) coronaviruses

Y) flaviviruses  
Z) togaviruses

ANSWER: W) picornaviruses

14. EARTH AND SPACE SCIENCE: *Multiple Choice:* Rich clusters of galaxies, such as the Virgo cluster, contain a thousand or more galaxies condensed in a volume 3 megaparsecs in diameter. The dominant galaxy type in rich clusters is   
  
W) spiral

X) barred spiral  
Y) irregular  
Z) elliptical

ANSWER: Z) elliptical

15. MATHEMATICS: *Short Answer:* Use differentials to approximate the square root of 101 to the hundredth's place  
  
ANSWER: 10.05

16. CHEMISTRY: *Multiple Choice:* Mist and fog are examples colloids that consist of a liquid dispersed in a gas. These types of colloids are known as a

W) sol  
X) aerosol  
Y) emulsion  
Z) foam  
  
ANSWER: X) aerosol  
  
17. PHYSICS: *Short Answer:* An ideal transformer consists of 100 coils of wire in the primary winding and 50 coils of wire in the secondary. If the voltage in the primary coil is 220V and a load is connected to the secondary coil, what is the voltage in the secondary coil?  
  
ANSWER: 110 V  
  
18. BIOLOGY: *Short Answer:* What biological term refers to the phenotype of a species as it occurs in nature, such as red eyes in Drosophila?  
  
ANSWER: WILD TYPE  
  
19. EARTH AND SPACE SCIENCE: *Multiple Choice:* Which of the following events would NOT point to the existence of a planet orbiting a star  
W) slight movements of the star due to the planet's gravitational field  
X) changes in the brightness of the star due to the passage of the planet in front of it

Y) magnification of the star's brightness through gravitational lensing by the planet

Z) detection of spectral lines other than those hydrogen and helium in the star's spectrum

ANSWER: Z) detection of spectral lines other than hydrogen and helium in the star's spectrum

20. MATHEMATICS: *Short Answer:* Find all critical values of the function f(x) = (x2 + 2x +1)/x  
  
ANSWER: -1, 0, 1  
  
21. CHEMISTRY: *Multiple Choice:* A chemist has a solution of an unknown ionic compound.

The chemist could determine that there is strontium in the solution by adding

W) NaNO3

X) K2SO4  
Y) MgOH  
Z) LiCl  
  
ANSWER: X) K2SO4

22. PHYSICS: *Short Answer:* A released from rest and rolls down a ramp inclined at 30 degrees above the horizontal. If the acceleration of the ball in free fall is g and friction is neglected, express the acceleration of the ball as it rolls down the ramp in terms of g  
  
ANSWER: 0.5g  
  
23. BIOLOGY: *Multiple Choice:* Mycorrhizae is a term given to the mutualistic symbiosis of fungi and plants. In one type of mycorrhizae, the mycelium of the fungi forms a dense sheath over the surface of the root, extending from the mantle into the soil. This relationship is called  
  
W) endomycorrhizae  
X) exomycorrhizae

Y) arbuscular mycorrhizae

Z) ectomicorrhizae

ANSWER: Z) ectomicorrhizae

24. EARTH AND SPACE SCIENCE: *Multiple Choice:* Based on Bwoen's reaction series, which of the following minerals would you expect to be most stable at surface conditions?  
  
W) muscovite mica  
X) biotite mica  
Y) calcium rich plagioclase feldspar  
Z) olivine  
  
ANSWER: W) muscovite mica

25. MATHEMATICS: *Short Answer:* Two numbers are found to have a sum of 22 and a product of 72. What is the difference between the numbers?

ANSWER: 14 (OR -14)