The 63rd Annual
Merck State Science Day Competition
May 23, 2013

INTEGRATED SCIENCE

Directions: To register as a student:
You will need to ask your teacher for the school phone number used for your school.
Fill out the form using your normal email address but please use a password that is NOT associated with any other secure accounts (Your MSSD password).
You must also select the test you will be taking at this time.

On the day of the MSSD competition:

You will be asked to login using your email address and your MSSD Password.
You are encouraged to register early and to log into your test page. Try the Demo Test if you have not already done so.In this demo test, answers are not saved. In a regular test, each answer is stored when **Submit** is used.
When finished, select **FINISHED TEST** in lower left.

Using the Answer Panel

The Demo Test "answer panel" at the bottom of the window is pre-set to show 3 answer boxes per page. (A normal test may show 10 or more answers per page.)
1. The current question has a black border.
2. Questions that have been answered will be tinted **Green**
3. Click **Submit** to record your answer and scroll to the next test question (even if it is on the next page).
4. Any answer can be edited. Delete your original choice, enter your new letter choice, then **Submit** the correction.
5. **>** moves to the next set of questions (**<** moves back)
6. Click on any number to answer that question.

Hint: The size of the lettering in the bottom answer panel can be adjusted using CTRL + to magnify the browser view. The TEST view can be adjusted using the size control in the PDF viewer (eg Adobe Reader).

INFORMATION THAT MAY BE USEFUL IN SOLVING SOME PROBLEMS

1 calorie = 4.184 joules
$1/f = 1/d_o + 1/d_i$
$C = 2f$
$h_i/h_o = d_i/d_o$
$E = hf$
speed of light in vacuum = 3.0×10^8 m/sec
Planck's constant, h = 6.63×10^{-34} joule-sec
$v = c\sqrt{1 - v^2/c^2}$
Avogadro's Number = 6.02×10^{23}
$Q = mc\Delta T$
$KE_{ave} = 1/2mv^2$
$PE_{grav} = mgh$
$W = F \times S$
$W = Vq$
$v_{avg} = s/t$
$s = v_o t + 1/2at^2$
$v_f^2 = v_i^2 + 2as$
$v_f = v_i + at$
$c = f\lambda$
$P_1V_1/T_1 = P_2V_2/T_2$
$I = V/R$
1 C = 6.25×10^{18} e^-
$D = M/V$
$v = f\lambda$
$P = W/t$
K_f water = 1.86 °C/*m*
K_b water = 0.51°C/*m*

Merck Institute for Science Education

Universal gas constant: R = 8.31 kPa-liter/(mole-K) = 0.0821 atm-liter/(mole-K)

The Periodic Table of the Elements

1 **H** Hydrogen 1.00794																	2 **He** Helium 4.003
3 **Li** Lithium 6.941	4 **Be** Beryllium 9.012182											5 **B** Boron 10.811	6 **C** Carbon 12.0107	7 **N** Nitrogen 14.00674	8 **O** Oxygen 15.9994	9 **F** Fluorine 18.9984032	10 **Ne** Neon 20.1797
11 **Na** Sodium 22.989770	12 **Mg** Magnesium 24.3050											13 **Al** Aluminum 26.981538	14 **Si** Silicon 28.0855	15 **P** Phosphorus 30.973761	16 **S** Sulfur 32.066	17 **Cl** Chlorine 35.4527	18 **Ar** Argon 39.948
19 **K** Potassium 39.0983	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.955910	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.9415	24 **Cr** Chromium 51.9961	25 **Mn** Manganese 54.938049	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933200	28 **Ni** Nickel 58.6934	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.61	33 **As** Arsenic 74.92160	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Krypton 83.80
37 **Rb** Rubidium 85.4678	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.90585	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.90638	42 **Mo** Molybdenum 95.94	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.90550	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.8682	48 **Cd** Cadmium 112.411	49 **In** Indium 114.818	50 **Sn** Tin 118.710	51 **Sb** Antimony 121.760	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90447	54 **Xe** Xenon 131.29
55 **Cs** Cesium 132.90545	56 **Ba** Barium 137.327	57 **La** Lanthanum 138.9055	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.9479	74 **W** Tungsten 183.84	75 **Re** Rhenium 186.207	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.217	78 **Pt** Platinum 195.078	79 **Au** Gold 196.96655	80 **Hg** Mercury 200.59	81 **Tl** Thallium 204.3833	82 **Pb** Lead 207.2	83 **Bi** Bismuth 208.98038	84 **Po** Polonium (209)	85 **At** Astatine (210)	86 **Rn** Radon (222)
87 **Fr** Francium (223)	88 **Ra** Radium (226)	89 **Ac** Actinium (227)	104 **Rf** Rutherfordium (261)	105 **Db** Dubnium (262)	106 **Sg** Seaborgium (263)	107 **Bh** Bohrium (262)	108 **Hs** Hassium (265)	109 **Mt** Meitnerium (266)	110 (269)	111 (272)	112 (277)	113	114				

58 **Ce** Cerium 140.116	59 **Pr** Praseodymium 140.90765	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.964	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.92534	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93032	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93421	70 **Yb** Ytterbium 173.04	71 **Lu** Lutetium 174.967
90 **Th** Thorium 232.0381	91 **Pa** Protactinium 231.03588	92 **U** Uranium 238.0289	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** Nobelium (259)	103 **Lr** Lawrencium (262)

1995 IUPAC masses and Approved Names from http://www.chem.qmw.ac.uk/iupac/AtWt/
masses for 107-111 from C&EN, March 13, 1995, p. 35
112 from http://www.gsi.de/z112e.html

Multiple Choice

Identify the choice that best completes the statement or answers the question and enter it in the answer window on the computer screen, then ***SUBMIT*****.**

1. Starch easily dissolves in water while cellulose does not. Both substances consist of chains of glucose molecules. What accounts for the difference in properties?
   - **A)** Starch contains sucrose which allows it to dissolve
   - **B)** Cellulose contains maltose which prevents it from dissolving
   - **C)** Starch consists of long twisted chains of glucose molecules
   - **D)** Cellulose consists of long straight chains of glucose molecules
   - **E)** Both C and D are correct

2. Which of the following terms are properly matched?
   - **A)** Maltose and Lipid
   - **B)** Polysaccharide and Polypeptide
   - **C)** Enzyme and Protein
   - **D)** Substrate and Lipid
   - **E)** Steroid and Nucleic Acid

3. How are the functions of prokaryotic cells controlled without the presence of a nucleus?
   - **A)** The ribosomes make proteins which ultimately controls the function of the cell
   - **B)** The mitochondria produces ATP which ultimately controls the functions of the cell
   - **C)** The genetic material found in prokaryotic cells ultimately controls the function of the cell
   - **D)** Both B and C are correct
   - **E)** Both A and B are correct

4. What would happen to a plant with a genetic defect that produced no central vacuoles?
   - **A)** The plant would adapt to use the vacuoles that store pigment
   - **B)** The plant would function inefficiently and die
   - **C)** The plant would use molecules more efficiently
   - **D)** The plant would adapt by fusing other vacuoles together to form a central vacuole
   - **E)** The plant would absorb sunlight more efficiently

5. If a cell were exposed to poison that blocked the cell's ability to manufacture ATP, what effect would that have on the cell membrane's transport process?
   - **A)** All active transport processes would stop
   - **B)** The cell would immediately die since no energy was being created
   - **C)** All passive transport processes would continue until the concentration gradient disappeared
   - **D)** The cell would adapt and begin to manufacture other energy molecules
   - **E)** Both A and C are correct

6. Which of the following statement (s) are true about the sodium-potassium pump?
   - **A)** Two sodium ions are brought into the cell while three potassium ions are released from the cell
   - **B)** This carrier protein requires a concentration gradient
   - **C)** The sodium-potassium pump helps to alleviate a build-up of sodium in muscle cells during intense exercise
   - **D)** The difference in charge from the outside to the inside of the cell is important for the conduction of electrical impulses along nerve cells
   - **E)** The sodium-potassium pump can transport thousands of ions per second

7. How would global temperature increases affect plants?
   - **A)** There would be no effect on plants
   - **B)** Initially the plant growth may increase because of an excess of carbon dioxide levels
   - **C)** Initially the plant growth may increase because of more precipitation worldwide
   - **D)** Increased temperatures would eventually kill unadapted plants
   - **E)** Both B and D are correct

8. Which of the following statement(s) are true about glycolysis?
- **A)** Glycolysis occurs in the mitochondria of a cell
- **B)** NADP+ is the electron acceptor in the redox reactions
- **C)** The net yield of ATP molecules produced during glycolysis is four
- **D)** *Glyceraldehyde 3-phosphate* is produced in both glycolysis and the light independent reaction of photosynthesis
- **E)** The only step in glycolysis that requires ATP is the breakdown of pyruvic acid

9. Which of the following statement(s) are true about meiosis?
- **A)** Before meiosis begins, the DNA of the diploid gamete cells are copied two times
- **B)** Meiosis I results in the formation of two haploid cells
- **C)** Meiosis II results in the formation of four diploid cells
- **D)** Crossing over usually occurs during Prophase II
- **E)** Crossing over usually occurs during Metaphase II

10. If you consider the mass of DNA in a human egg cell to be 1, what would the relative value be for the DNA mass of a cell in the G2 phase of the cell cycle?
- **A)** 1
- **B)** 2
- **C)** 3
- **D)** 4
- **E)** 5

11. In Mendel's ground-breaking experiments in genetics, what was the relationship in phenotypes between the p-generation of pea plants and the F2 generation of pea plants?
- **A)** The F2 generation looked entirely like the dominant allele in the p-generation
- **B)** The F2 generation showed a blending in traits; thus, not resembling the p-generation at all
- **C)** The F2 generation resembled both parents in the p-generation
- **D)** The F2 generation looked like the recessive allele in the F1 generation and thus nothing like the p-generation
- **E)** None of the following statements above are correct

12. In a dihybrid cross, how many different phenotypes would be expected to appear in the F1 generation if a scientist crossed two organisms that were heterozygous for both traits?
- **A)** 2
- **B)** 4
- **C)** 6
- **D)** 8
- **E)** 9

13. In minks, black fur is dominant to white fur. A mink breeder wanted to determine whether his black furred mink was purebred or hybrid. How could the mink breeder solve this dilemma?
- **A)** He could look at the phenotype of the black furred mink's parents
- **B)** He could look at the phenotype of the offspring when mating the black furred mink with another black furred mink
- **C)** He could look at the phenotype of the offspring when mating the black furred mink with a white furred mink
- **D)** He could perform a test cross
- **E)** Both C and D are correct

14. The offspring of two short tailed mice have a 25 percent chance of having no tail, a 25 percent of having a long tail, and a 50 percent chance of having a short tail. Using this information, what can you determine about the genotypes of the p-generation and the method in which tail length is inherited?
- **A)** Each short tailed parent has two codominant alleles, one for a long tail and one for no tail
- **B)** Each short tailed parent has a mutation on their chromosome causing their offspring to have no tails
- **C)** Each short tailed parent has two incompletely dominant alleles, one for a long tail and one for no tail
- **D)** Each short tailed parent has an allele for a long tail and no tail on their X and Y chromosomes, respectively
- **E)** Each short tailed parent has an allele for a long tail and short tail on the X and Y chromosomes, respectively

15. Which of the following would occur if a DNA sequence lacked a promoter region?
- **A)** RNA polymerase would be unable to bind and transcription would not be able to begin
- **B)** Helicase would be unable to bring the correct nucleotide sequence
- **C)** DNA polymerase would not be able to separate the DNA strands
- **D)** The enzymes would adapt and find another way to their jobs
- **E)** Both B and C would occur

16. Why do embryonic stem cells seem to show more promise in medical treatment than adult stem cells?
- **A)** Embryonic stem cells are genetically identical to the cells of a transplant recipient
- **B)** Embryonic stem cells have the potential to grow into any cell type
- **C)** Embryonic stem cells can reproduce indefinitely
- **D)** Embryonic stem cells have a limited life span when used in the laboratory
- **E)** Both B and C are correct

17. How is the genetic disorder, *Tay Sach,* inherited?
- **A)** Sex Linked and Dominant
- **B)** Sex Linked and Recessive
- **C)** Autosomal and Dominant
- **D)** Autosomal and Recessive
- **E)** Autosomal and Co-Dominant

18. How does the principle of *biogenesis* pose a scientific question regarding the origin of life on Earth?
- **A)** It doesn't explain why there was no oxygen in the early atmosphere
- **B)** It doesn't explain how the first life arose
- **C)** It doesn't explain why coacervates contain amino acids
- **D)** It doesn't explain why Miller-Urey produced amino acids
- **E)** It doesn't explain the role of isotopes in Earth's formation

19. Which scientist's work helped to contribute to Charles Darwin's ideas?
- **A)** Jean Baptiste Lamarck
- **B)** Alfred Wallace
- **C)** Thomas Malthus
- **D)** Charles Lyell
- **E)** Both C and D are correct

20. Humans have developed and used antibiotics to kill disease causing-bacteria. As antibiotic use has increased, many populations of bacteria have evolved adaptations to resist the effects of some antibiotics. This is an example of what evolutionary phenomenon:
- **A)** Divergent Evolution
- **B)** Convergent Evolution
- **C)** Co-evolution
- **D)** Artificial Selection
- **E)** Phylogeny

21. How are plants different from fungi?
- **A)** The cell walls of plants contain cellulose while the cell walls of fungi contain chitin
- **B)** Plants contain eukaryotic cells while fungi contain prokaryotic cells
- **C)** The cell membrane of plants lack proteins while the cell membrane of fungi lack carbohydrates
- **D)** The genetic material of plants is stored in the nucleus while the genetic material of fungi is stored in the nucleoid
- **E)** All of the above statements are differences between plants and fungi

22. Which of the following ecosystems would have the highest rate of net primary productivity?
- **A)** Temperate Grasslands
- **B)** Savanna
- **C)** Estuary
- **D)** Open Ocean
- **E)** Chaparral

23. Raccoons naturally live in forests and eat insects, fruits, and other small organisms. However, encroachment by humans changed their habitat to urban environments and the raccoons have begun to live off of trash and other waste products. This change in behavior is an example of which ecological phenomenon:

A) Interspecific versus Interspecific Competition
B) Mutualism versus Parasitism
C) Fundamental versus Realized Niche
D) Competitive Exclusion versus Resource Partitioning
E) Commensalism versus Mutualism

24. Why would there be a decrease in urine output if a person has lost a large amount of blood?

A) The body will be in shock so all the systems begin to shut down due to the decrease in blood volume
B) The large intestine would absorb water in the formation of waste products due to the decrease in blood volume
C) The kidney would retain more water due to the decrease in blood volume
D) The lungs would limit the amount of water vapor being exhaled due to the decrease in blood volume
E) The skin would not excrete any water due to the decrease in blood volume

25. A patient visits a neurologist complaining of balance issues. The neurologist runs a series of tests and determines that the patient has had damage to which part of the brain?

A) Temporal Lobe
B) Pons
C) Medulla
D) Cerebellum
E) Frontal Lobe

26. When referring to Newton's Third Law of Motion, the "reaction" force does not cancel the "action" force because:

A) The action force is greater than the reaction force.
B) The action force is less than the reaction force.
C) They act on different bodies.
D) They are in the same direction.
E) The reaction exists only after the action force is removed.

27. A car of mass 1500 kg is accelerated uniformly from rest at a stop sign to a speed of 20 m/s in 10 s. The magnitude of the net force accelerating the car is:

A) 1000 N
B) 2000 N
C) 3000 N
D) 20,000 N
E) 30,000 N

28. If the net force on an object is doubled while at the same time the mass of the object is cut in half, then the acceleration of the object is

A) 1/4 as great.
B) 1/2 as great.
C) 2 times greater.
D) 4 times greater.
E) unchanged

29. What happens to the inertia of an object when its velocity is doubled?

A) the object's inertia becomes 1/2 as great
B) the object's inertia becomes 2 times greater
C) the object's inertia becomes 4 times greater
D) the object's inertia becomes 8 times greater
E) the object's inertia is unchanged

30. The S.I. unit of force is named the Newton (N) in honor of Sir Isaac Newton and his contributions to physics. Which of the following is a Newton written in SI fundamental units?

A) kg

B) $kg\frac{m}{s}$

C) $kg\frac{m^2}{s}$

D) $kg\frac{m}{s^2}$

E) $kg\frac{m^2}{s^2}$

31. Neil Armstrong, the first astronaut to set foot on the moon, has a mass of 80 kg while sitting in the Lunar Lander on top of the Atlas 5 rocket on the launch pad at Cape Canaveral just before launch. Upon reaching the moon surface which has an acceleration of gravity 1/6 that of earth surface, what was his mass?

A) Zero.

B) 13 kg

C) 40 kg

D) 80 kg

E) 560 kg

32. A child whirls a ball at the end of a string in a uniform circular motion. Which of the following statements is **NOT** true?

A) The speed of the ball is constant

B) The velocity is of the ball is constant

C) The radius is constant

D) The magnitude of the ball's acceleration is constant

E) The acceleration of the ball is directed radially inwards towards the center

33. A ball is thrown off a high cliff with no horizontal velocity. It lands 6.0 s later with a velocity of 40 m/s. What was the initial velocity of the ball?

A) 100 m/s up

B) 20 m/s up

C) Zero

D) 20 m/s down

E) 100 m/s down

34. What is the accepted SI unit for momentum?

A) m/s

B) kg/s

C) $kg*m/s^2$

D) $kg*m/s$

E) $kg*m^2/s^2$

35. A satellite of mass ***M*** orbits the earth in circular orbit of radius ***R*** and period ***T***. Another satellite of mass 2***M*** needs to have the same orbital period ***T***. At what radius should this more massive satellite be inserted to accomplish this?

A) $\frac{1}{2}R$

B) $\sqrt{2}R$

C) R

D) $2R$

E) $4R$

36. The Kepler Space Probe just discovered a star system 1200 light years away they are calling ***Kepler-62***. One of the planets, ***Merckos***, has a mass that is 4 times the mass of the Earth. The radius of the Earth is ***R***. The gravitational field strength at the surface of Merckos is equal to that at the surface of the Earth if the radius of Merckos is equal to

A) $\frac{1}{2}R$

B) R

C) $2R$

D) $\sqrt{R}$

E) R^2

37. A mass ***M*** suspended by a spring with force constant ***k*** has a period ***T*** when set into oscillation on Earth. Its period on Mars is most nearly which of the following? Mars has a mass is about 1/9 and radius 1/2 that of Earth.

A) $\frac{T}{3}$

B) $\frac{2T}{3}$

C) T

D) $\frac{3T}{2}$

E) $3T$

38. A freely floating toy boat is pushed underwater by that mean little kid down the street. Which of the following statements is accurate in describing this situation?

A) When floating, the boat displaces its volume of water, but when submerged it displaces a volume of water equal to its weight.

B) When floating, the boat displaces a volume of water equal to its weight, but when submerged it displaces its volume of water.

C) When floating AND submerged, the boat displaces a volume of water equal to its weight.

D) When floating AND submerged, the boat displaces its weight of water.

E) When floating, the boat displaces only part of its weight of water, but when submerged it displaces all of its weight of water..

39. The direction of an Electric Field is defined as

A) the direction an electron experiences a force when placed inside the field.

B) the direction a proton experiences a force when placed inside the field.

C) the direction a neutron experiences a force when placed inside the field.

D) the direction that opposes any magnetic field present at the same time.

E) arbitrary, depends on the situation.

40. Two small spheres have equal charges ***Q*** and are separated by a distance ***D***. The force exerted on each sphere by the other has magnitude ***F***. If the charge on each sphere is doubled and the distance between them is cut in half, the force on each sphere has magnitude

A) ***F***

B) 2***F***

C) 4***F***

D) 8***F***

E) 16***F***

41. As resistors are added in parallel to a circuit without changing the battery,

A) the total current decreases.

B) the total current remains the same.

C) the total voltage increases.

D) the total resistance decreases.

E) the total resistance increases.

42. The product of (1 *Ampere* x 1 *Volt* x 1 *Second*) is equal to

A) 1 Coulomb

B) 1 Watt

C) 1 Newton

D) 1 Joule

E) 1 What?

43. The effective resistance of a 4-Ω, a 6-Ω, and a 12-Ω resistor in series is

A) 2-Ω
B) 4-Ω
C) 11-Ω
D) 12-Ω
E) 22-Ω

44. The effective resistance of a 4-Ω, a 6-Ω, and a 12-Ω resistor in parallel is

A) 2-Ω
B) 4-Ω
C) 11-Ω
D) 12-Ω
E) 22-Ω

45. During a physics lab, you hear a sound of 700 Hz that was created on the other side of the lab room. The speed of sound in the lab room is approximately 350 m/s. What is the wavelength of this sound?

A) 0.5 m
B) 1 m
C) 2 m
D) 245 m
E) 700 m

46. Which station broadcasts with 3.27 m radio waves?

A) 91.7 MHz
B) 92.5 MHz
C) 98.5 MHz
D) 102.5 MHz
E) 106.3 MHz

47. In a photoelectric effect lab, you notice that the maximum speed of the photoelectrons emitted by a metal surface when it is illuminated by electromagnetic radiation depends on which of the following?

I. Intensity of the light
II. Frequency of the light
III. Type and property of the metal surface

A) I only
B) III only
C) I and II only
D) II and III only
E) I, II, and III

48. The following equation is an example of what kind of nuclear reaction?

$$^{12}C_6 + {}^{4}He_2 \rightarrow {}^{16}O_8 + \text{energy}$$

A) Fission
B) Fusion
C) Alpha decay
D) Beta decay
E) Positron decay

49. During another physics lab activity, you record that a nucleus of $^{235}_{92}U$ disintegrates to $^{207}_{82}Pb$ in about a billion years (you have very long physics lab sessions and lots of time on your hands...) by emitting 7 alpha particles and how many beta particles?

A) 3
B) 4
C) 5
D) 6
E) 7

50. A newly discovered element, Merckium, designated by $^{2013}_{200}Mk$, undergoes triple alpha and triple beta decay. This results in the startling element Oooium, symbol "Oo". What is the proper designation of the element Oo?

A) $^{2013}_{200}Oo$
B) $^{2001}_{200}Oo$
C) $^{2001}_{194}Oo$
D) $^{2013}_{197}Oo$
E) $^{2001}_{197}Oo$

51. Of the materials listed below, the best tool you could use in the identification of the mineral calcite would be:

A) your finger nail
B) dilute hydrochloric acid
C) glass
D) a steel nail
E) a streak plate

52. Of the materials listed below, the best tool you could use in the identification of the mineral hematite would be:

A) your finger nail
B) dilute hydrochloric acid
C) a UV lamp
D) a magnet
E) a streak plate

53. Of the materials listed below, the best tool you could use in the identification of the rock anthracite would be:

A) water
B) alcohol
C) fire
D) acid
E) a magnet

54. A rock contains pieces of extinct plants and animals. It is safe to assume this rock is

A) chemical sedimentary
B) extrusive igneous
C) high grade metamorphic
D) clastic sedimentary
E) organic sedimentary

55. A rock contains elongated bands of deformed minerals. It is safe to assume this rock is

A) chemical sedimentary
B) extrusive igneous
C) high grade metamorphic
D) clastic sedimentary
E) organic sedimentary

56. A rock predominantly contains sodium chloride. It is safe to assume this rock is

A) chemical sedimentary
B) extrusive igneous
C) high grade metamorphic
D) clastic sedimentary
E) organic sedimentary

57. If you wanted to live in a region of relatively low seismicity, you would choose

A) California
B) New England
C) Iran
D) Alaska
E) Iceland

58. When you are standing in a coal mine, you are in a location which many millions of years ago was a
- **A)** shallow ocean bottom
- **B)** swamp
- **C)** glacier
- **D)** alpine valley
- **E)** n/a: the Earth is not that old

59. Based on stellar evolution theory, all of the following are true of Red Supergiants, except
- **A)** they were originally Red Dwarfs
- **B)** their mass exceeds the Chandra limit
- **C)** they will go supernova
- **D)** they may have come from Blue-White main sequence stars.
- **E)** their cores are fusing elements up to Fe

60. _____ main sequence stars fuse for _____ periods of time, and emit _____ energy EMR.
- **A)** Cooler / Longer / Higher
- **B)** Hotter / Shorter / Lower
- **C)** Cooler / Shorter / Higher
- **D)** Hotter / Longer / Higher
- **E)** Hotter / Shorter / Higher

61. The strongest hypothesis for the Moon's formation is
- **A)** captured satellite
- **B)** volcanic emission
- **C)** early impactor
- **D)** divine intervention
- **E)** the Big Bang

62. The following supports the understanding that our Sun is at least a 2nd generation star:
- **A)** Our solar system contains a variety of planets.
- **B)** Water can be found in many parts of our solar system.
- **C)** Our solar system resides in a galaxy.
- **D)** The Sun contains all 92 naturally occurring elements.
- **E)** the Sun is a yellow, medium mass star.

63. The positions of celestial objects are plotted on a grid of
- **A)** x & y coordinates
- **B)** latitude & longitude
- **C)** declination & right ascension
- **D)** mercator projection
- **E)** space & time

64. With ocean depth, temperature _____ pressure _____ and salinity _____.
- **A)** increases / increases / decreases
- **B)** increases / may vary / increases
- **C)** may vary / decreases / increases
- **D)** decreases / increases / may vary
- **E)** may vary / may vary / may vary

65. Which statement is false
- **A)** The atmosphere is heated directly by the Sun
- **B)** The ocean and atmosphere directly impact each other
- **C)** Global human caused climate change is just a theory
- **D)** In the past, the Earth has had periods of warming greater than what we are presently experiencing.
- **E)** The melting of the Arctic Ice Cap will not directly raise global sea level.

66. With altitude, temperature _____, pressure _____, and humidity _____.
- **A)** may vary / decreases / decreases
- **B)** increases / may vary / increases
- **C)** decreases / decreases / decreases
- **D)** increases / increases / increases
- **E)** may vary / may vary / may vary

67. Which of the following formation events are in the correct order?
- **A)** Life, Moon, Sun, Earth, Big Bang
- **B)** Big Bang, Sun, Earth, Moon, Life
- **C)** Sun, Big Bang, Moon, Earth, Life
- **D)** Earth, Big Bang, Life, Sun, Moon
- **E)** Moon, Earth, Sun, Life, Big Bang

68. If all of the universe's existence were analogously scaled down to fit in one year, on approximately what date would life appear on Earth?
- **A)** January 1
- **B)** March 31
- **C)** July 4
- **D)** September 21
- **E)** December 31

69. The fossil record clearly shows that short-necked giraffes went extinct, leaving the Earth with the long necked giraffes we see today. The best explanation for this phenomenon is
- **A)** The long necked giraffes were lucky.
- **B)** The long necked giraffes were short necked giraffes who grew their necks long during their lifetimes and passed on new long neck genes to their offspring.
- **C)** The long necked giraffes killed off the short necked giraffes.
- **D)** The short necked giraffes were killed in Noah's flood.
- **E)** Short necked giraffe were weaker that the long necked giraffes.

70. Tsunamis cause the greatest destruction when
- **A)** the deep water wave becomes a shallow water wave.
- **B)** they are first propagated.
- **C)** they hit a mountainous shore line.
- **D)** they have travelled that greatest distance.
- **E)** they interact with a boat far from shore.

71. Ocean surface currents are _____ and _____, while ocean deep water currents are _____ and _____.
- **A)** warmer / density driven / colder / wind driven
- **B)** colder / density driven / warmer / wind driven
- **C)** warmer / wind driven / colder / density driven
- **D)** colder / wind driven / warmer / density driven
- **E)** none of the above

72. In the Northern Hemisphere, _____ systems spin_____, while in the Southern Hemisphere, _____ systems spin _____.
- **A)** high pressure / counterclockwise / low pressure / counterclockwise.
- **B)** low pressure / clockwise / high pressure / counterclockwise.
- **C)** high pressure / counterclockwise / low pressure / clockwise.
- **D)** low pressure / counterclockwise / high pressure / counterclockwise.
- **E)** low pressure / clockwise / high pressure / clockwise.

73. Which of the following statements is false?
- **A)** An object in the tropics is travelling eastward at a faster rate than an object near the poles.
- **B)** The way a toilet flushes has nothing to do with the spin of the Earth.
- **C)** Warm, moist air is the densest air.
- **D)** There are 6 major convection cells in the Earth's atmosphere.
- **E)** There is a rain forest located around the world at approximately 60º north latitude.

74. It is now theorized that the principal source of the salinity in our oceans come from
- **A)** comets and asteroids.
- **B)** runoff from major city snow removal.
- **C)** underground salt mines.
- **D)** erosional runoff from the land.
- **E)** hydrothermal vents and volcanoes.

75. The San Andreas Fault is most associated with _____ motion.

A) convergent boundary
B) strike-slip
C) dip-slip
D) spreading center
E) isostatic rebound

76. Which correctly pairs the name and formula?

A) Na_2SO_3 sodium sulfate
B) NaClO sodium chlorate
C) $NaNO_2$ sodium nitrate
D) Na_3PO_3 sodium phosphate
E) $NaClO_4$ sodium perchlorate

77. Consider the following reaction:

$$Ni(NO_3)_2 + S + 2\,NO_2 + 2H_2O \rightarrow NiS + 4\,HNO_3$$

How many moles of HNO_3 can be produced by reacting 2.0 mole $Ni(NO_3)_2$, 3 .0 mole S, 3.0 mole NO_2 and sufficient water, in the reaction above?

A) 2.0
B) 4.0
C) 6.0
D) 8.0
E) 12.0

78. The cation Mg^{2+} is isoelectronic with

A) Ca^{2+} (aq)
B) F^-
C) Mg
D) Na
E) Ne

79. Which molecule is nonpolar?

A) CBr_3Cl
B) SO_2
C) PCl_3
D) BCl_3
E) OF_2

80. What is the total number of moles of atoms in 78.6 grams $Na_2Cr_2O_7$?

A) 0.3 moles
B) 3.3 moles
C) 11 moles
D) 78.6 moles
E) 20593 moles

81. What is the pressure exerted by 88g CO_2, as it occupies 30.0 L at 25°C

A) 0.137 atm
B) 0.613 atm
C) 1.63 atm
D) 123 atm
E) 1470 atm

82. Given the following:

$2\ H_2(g) + O_2(g) \rightarrow 2\ H_2O(l)$ $\Delta H = -572$ kJ

$C_2H_4(l) + 3\ O_2(g) \rightarrow 2H_2O(l) + 2CO_2(g)$ $\Delta H = -1401$ kJ

$2\ C_2H_6(l) + 7\ O_2(g) \rightarrow 6\ H_2O(l) + 4\ CO_2(g)$ $\Delta H = -3100$ kJ

Determine the enthalpy for:

$$C_2H_4(g) + H_2(g) \rightarrow C_2H_6(g)$$

A) -5072 kL/mole
B) -3237 kJ/mole
C) -274 kJ/mole
D) -137 kJ/mole
E) +149 kJ/mole

83. Data for the reaction:

$$CO\ (g) + NO_2\ (g) \rightarrow CO_2\ (g) + NO\ (g)$$

are given in the following table

	Reactant Concentration (mol/L)		**Initial rate**
	[CO]	**[NO_2]**	**mol/L · h**
1	5.0×10^{-4}	0.36×10^{-4}	3.4×10^{-8}
2	5.0×10^{-4}	0.18×10^{-4}	1.7×10^{-8}
3	1.0×10^{-3}	0.36×10^{-4}	6.8×10^{-8}
4	1.5×10^{-3}	0.72×10^{-4}	?

Determine the rate constant for the reaction.

A) 1.8×10^{8} mole^2/L^2 ·
B) 6.12×10^{-6} mole^3/L^3 · h
C) 0.529 L^3/mole^3 · h
D) 1.89 mole/L · h
E) 1.89 l/mole · h

84. The scientist most responsible for determining the charge on the electron is:

A) Antoine Lavoisier
B) Robert Millikan
C) J. J. Berzelius
D) Dmitri Mendeleev
E) Ernest Rutherford

85. The scientist who transformed chemistry from a science of observation to a science of measurements is:

A) Antoine Lavoisier
B) Robert Millikan
C) John Dalton
D) J. J. Berzelius
E) Ernest Rutherford

86. The scientist who worked out the modern technique of chemical formula notation is:

A) Antoine Lavoisier
B) Robert Millikan
C) Dmitri Mendeleev
D) J. J. Berzelius
E) Ernest Rutherford

87. The scientist credited with producing the first X-ray images of the DNA double helix is:

A) Iréne Joliot-Curie
B) Lise Meitner
C) Rosalind Franklin
D) Hazel Bishop
E) Ruth Benerito

88. Which pair contains an element and a pure compound that is made from that element?
A) iron and rust
B) water and air
C) mercury and water
D) salt and sea water
E) chlorine and swimming pool water

89. Which element is a liquid at 25°C?
A) water
B) gallium
C) bromine
D) iodine
E) alcohol

90. Which are properties of all metals?
I. malleability
II. high melting point
III. high density
IV. low viscosity
V. electrical conductivity

A) I & II only
B) I & V only
C) I, II, III, and V only
D) II, III, and V only
E) all of the above

91. Water is an unusual material because it:
I. expands when it freezes.
II. the solid form floats in its liquid form.
III. has a high specific heat.
IV. is a liquid at room temperature compared to molecules of the same size and molar mass.
A) III only
B) I & II only
C) III & IV only
D) I, II, and IV only
E) all of the above

92. What is the correct way to express 82397000 seconds in scientific notation using 3 significant figures?
A) 8.23E07
B) 8.23×10^7
C) 8.24E7 sec
D) 82397×10^3 sec
E) 8.24×10^7 sec

93. Student A makes four measurements of the diameter of a coin using a tool called a micrometer. Student B measures the same coin using a ruler. They report the following results:

Student A	Student B
28.245 mm	27.9 mm
28.244 mm	28.1 mm
28.246 mm	27.8 mm
28.248 mm	28.1 mm

According to the U.S. Mint, the coin has a diameter of 28.054 mm. Which student was more accurate?

A) Student A because she used more significant figures
B) Student A because her results had the smallest difference between the smallest and largest value
C) Student A because she used a more precise tool.
D) Student B because two results are exactly the same
E) Student B because the average is closer to the U.S. Mint's figure

94. John Dalton (1766-1844) is best known for his pioneering work in the development of modern atomic theory. In the early 1800's he published the main points of his theory.

I. Elements are made of extremely small particles called atoms.
II. Atoms of a given element are identical in size, mass, and other properties; atoms of different elements differ in size, mass, and other properties
III. Atoms cannot be subdivided, created, or destroyed.
IV. Atoms of different elements combine in simple whole-number ratios to form chemical compounds
V. In chemical reactions, atoms are combined, separated, or rearranged.

Which part(s) of Dalton's theory generally is still true today, after some 200 years of further experimentation?

A) I only
B) I and V only
C) I, II, and V only
D) I, IV, and V only
E) all are still true

95. Magnesium has an atomic mass of 24.305 and consists of 3 natural isotopes? Based on the data below, what is the natural abundance (%) of Mg-25 and Mg-26?

mass number	isotopic mass (amu)	natural abundance (%)
24	23.9850	78.99
25	24.9858	?
26	25.9826	?

A) Mg-25 = 0.01%, Mg-26 = 21.00%
B) Mg-25 = 10.00%, Mg-26 = 11.01%
C) Mg-25 = 10.505%, Mg-26 =10.505%
D) Mg-25 = 11.01%, Mg-26 = 10.00%
E) Mg-25 = 21.00%, Mg-26 = 0.01%

96. Which are properties of ionic compounds?

I. held together by electrostatic forces
II. high melting point
III. generally 1 or more pi (π) bonds
IV. discrete molecules

A) I only
B) I, and II only
C) I, II, and III only
D) I, II, and IV only
E) all of the above

97. Analysis shows that 0.586 g of potassium metal combines with 0.480 g of O_2 gas to give a white solid having a formula of K_xO_y. What is the molar mass of this compound?

A) 55.1 g/mol
B) 94.2 g/mol
C) 71.9 g/mol
D) 47.0 g/mol
E) 219.0 g/mol

98. Which compound would be LEAST soluble in water?

A) $AgNO_3$
B) $(NH_4)_2SO_4$
C) $Mg(OH)_2$
D) $K_2Cr_2O_7$
E) PbS

99. Which pair have the same oxidation number for the indicated element?

A) NO_3^- and NH_4^+ (N)
B) H_3PO_4 and P_4O_{10} (P)
C) CH_4 and CO_2 (C)
D) H_2SO_4 and Fe_2S_3 (S)
E) K_2CrO_4 and $Cr(ClO_3)_2$ (Cr)

100. Which statement is true for the cell as it discharges?

$$Zn|Zn^{2+}_{(1.0M)}||Sn^{2+}_{(1.0M)}|Sn$$

A) Oxidation occurs at the tin electrode.
B) Electrons will flow from the tin electrode to the zinc electrode.
C) The concentration of Zn^{2+} will increase.
D) The mass of the tin electrode will decrease.
E) The $\Delta G°$ for the cell is positive.

END OF TEST

Merck State Science Day 2013 **INTEGRATED SCIENCE**
Answer Section

MULTIPLE CHOICE

1. E
2. C
3. C
4. B
5. E
6. D
7. E
8. D
9. B
10. D
11. C
12. B
13. E
14. C
15. A
16. E
17. D
18. B
19. E
20. C
21. A
22. C
23. C
24. C
25. D
26. C
27. C
28. D
29. E
30. D
31. D
32. B
33. B
34. D
35. C
36. C
37. C
38. B
39. B
40. E
41. D
42. D
43. E
44. A
45. A
46. A
47. D
48. B
49. B
50. E
51. B
52. D
53. C
54. E
55. C
56. A
57. B
58. B
59. A
60. E
61. C
62. D
63. C
64. D
65. A
66. A
67. B
68. D
69. A
70. A
71. C
72. D
73. C
74. E
75. B
76. E
77. C
78. B
79. D
80. B
81. C
82. D
83. E
84. B
85. A
86. D
87. C
88. A
89. C
90. B
91. E
92. E
93. E
94. D
95. B
96. B
97. C
98. E
99. B
100. C