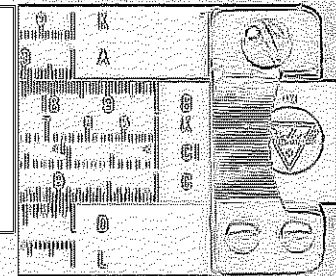
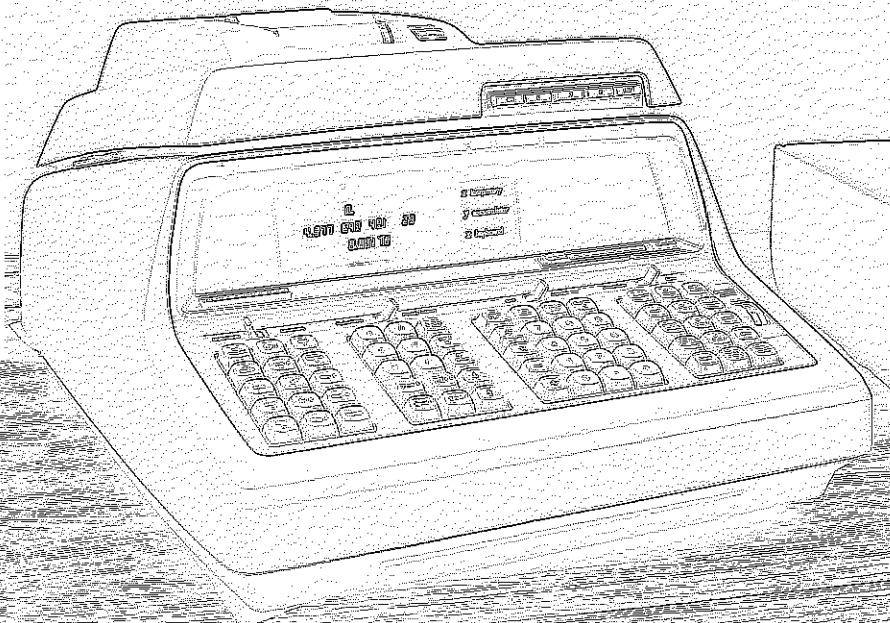
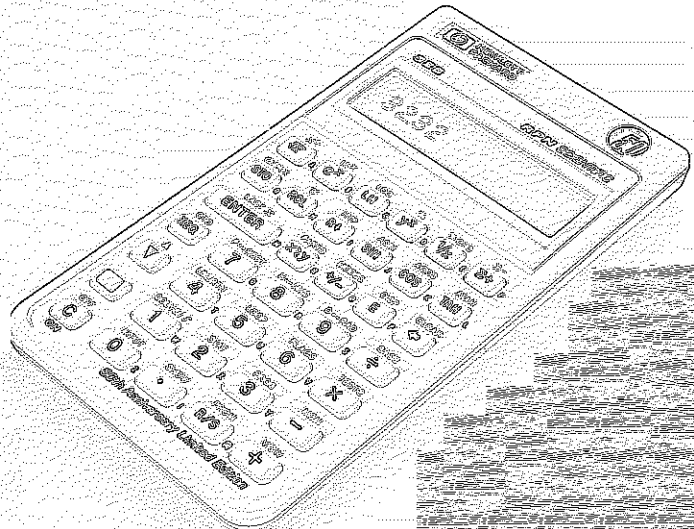
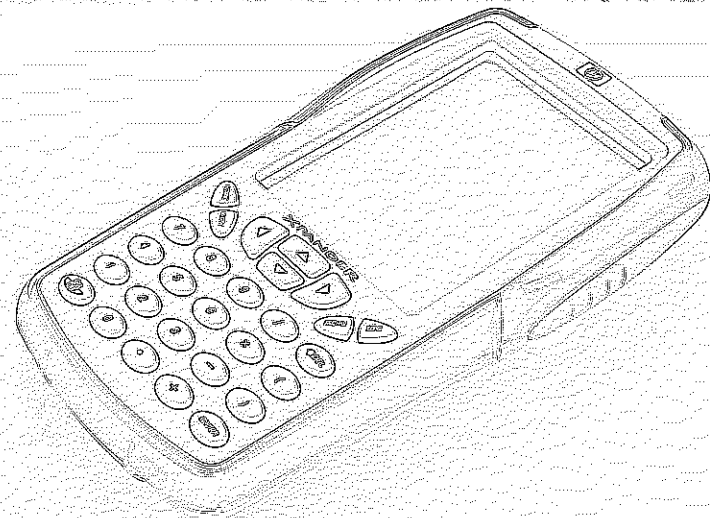
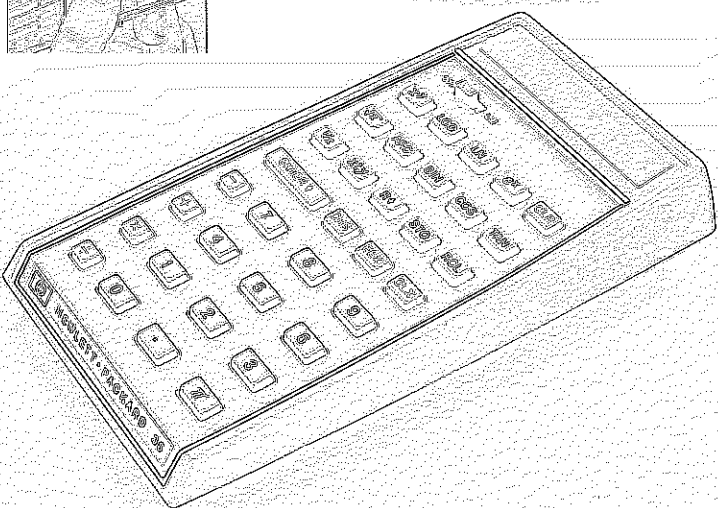
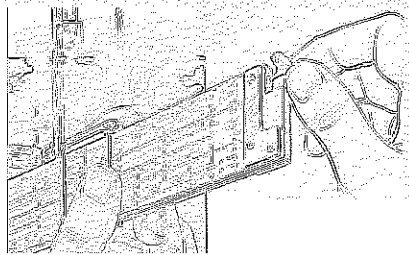
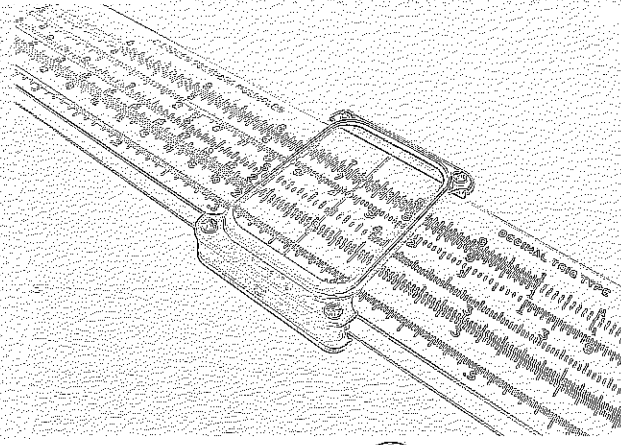
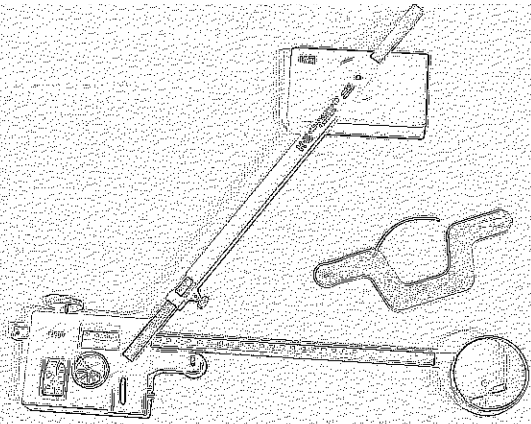
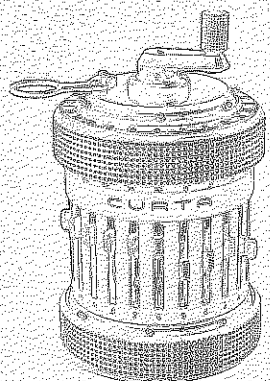


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2008 UIL Science District 2 Test
(12 pages)





SCIENCE

DISTRICT 2 • 2008



GENERAL DIRECTIONS:

- DO NOT OPEN EXAM UNTIL TOLD TO DO SO.
- Ninety minutes should be ample time to complete this contest, but since it is not a race, contestants may take up to two hours. If you are in the process of actually writing an answer when the signal to stop is given, you may finish writing that answer.
- Papers may not be turned in until 30 minutes have elapsed. If you finish the test in less than 30 minutes, remain at your seat and retain your paper until told to do otherwise. You may use this time to check your answers.
- All answers must be written on the answer sheet provided. Indicate your answers in the appropriate blanks provided on the answer sheet.
- You may place as many notations as you desire anywhere on the test paper except on the answer sheet, which is reserved for answers only.
- You may use additional scratch paper provided by the contest director.
- All questions have ONE and only ONE correct (BEST) answer. There is a penalty for all incorrect answers.
- If a question is omitted, no points are given or subtracted.
- On the back of this page is printed a copy of the periodic table of the elements. You may wish to refer to this table in answering the questions, and if needed, you may use the atomic weights and atomic numbers from the table. Other scientific relationships are listed also.
- Silent hand-held calculators that do not need external wall plugs may be used. Graphing calculators that do not have built-in or stored functionality that provides additional scientific information are allowed. Small hand-held computers are not permitted. Calculators that accept memory cards or memory sticks are not permitted. Each contestant may bring one spare calculator. All memory must be cleared.
- Answers within 5% of the exact answer will be considered correct.

SCORING:

All questions will receive 6 points if answered correctly; no points will be given or subtracted if unanswered; 2 points will be deducted for an incorrect answer.

UNIVERSITY INTERSCHOLASTIC LEAGUE

Making a World of Difference

Periodic Table of the Elements

1A	1																	8A	
	H																	He	
	1.008																	4.003	
	3	2A												3A	4A	5A	6A	7A	
	Li	Be											B	C	N	O	F	Ne	
	6.941	9.012											10.81	12.01	14.01	16.00	19.00	20.18	
	11	12											13	14	15	16	17	18	
	Na	Mg											Al	Si	P	S	Cl	Ar	
	23.00	24.31											26.98	28.09	30.97	32.06	35.45	39.95	
	19	20	21	22	23	24	25	8B			29	30	31	32	33	34	35	36	
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
	39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.70	63.55	65.38	69.72	72.59	74.92	78.96	79.90	83.80	
	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
	85.47	87.62	88.91	91.22	92.91	95.94	(98)	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3	
	55	56	57	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86	
	Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
	132.9	137.3	138.9	178.5	180.9	183.9	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	(209)	(210)	(222)	
	87	88	89	104	105	106	107			109									
	Fr	Ra	Ac	Rf	Ha	Unh	Uns			Uue									
	(223)	226.0	227.0	(261)	(262)	(263)	(262)			(267)									

	58	59	60	61	62	63	64	65	66	67	68	69	70	71
Lanthanides	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb	Lu
	140.1	140.9	144.2	(145)	150.4	152.0	157.3	158.9	162.5	164.9	167.3	168.9	173.0	175.0
	90	91	92	93	94	95	96	97	98	99	100	101	102	103
Actinides	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No	Lr
	232.0	231.0	238.0	237.0	(244)	(243)	(247)	(247)	(251)	(252)	(257)	(258)	(259)	(260)

See Reverse Page for Other Useful Information

OTHER USEFUL INFORMATION

Avogadro's Number, $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$

Absolute zero = 0 K = -273.15°C

Atmospheric pressure, 1 atm = $1.013 \times 10^5 \text{ N/m}^2 = 101.3 \text{ kPa} = 760.0 \text{ Torr} = 760.0 \text{ mmHg}$

Standard temperature and pressure (STP) is 0°C and 1 atm

Gram molecular volume at STP = 22.4 L

Mechanical equivalence of heat, 1 kcal = 1 Cal = 1,000 cal = 4,186 J

Gas constant, $R = 1.987 \text{ cal/mol}\cdot\text{K} = 0.08206 \text{ atm}\cdot\text{L/mol}\cdot\text{K} = 8.314 \text{ J/mol}\cdot\text{K}$

Dulong and Petit's constant = 6.0 amu·cal/gram·K

Faraday's constant, 1 F = 96,485 C/mol

Acceleration of gravity at Earth's surface, $g = 9.80 \text{ m/s}^2$

Gravitational constant, $G = 6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$

Horsepower, 1 hp = 746 W = 550 ft·lbs/s

Boltzmann's constant, $k_B = 1.38 \times 10^{-23} \text{ J/K}$

Stefan-Boltzmann constant, $\sigma = 5.67 \times 10^{-8} \text{ W/m}^2\cdot\text{K}^4$

Elementary charge, $e = 1.602 \times 10^{-19} \text{ C}$

Coulomb's law constant, $k = 1/4\pi\epsilon_0 = 8.988 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$

Permittivity of free space, $\epsilon_0 = 8.85 \times 10^{-12} \text{ C}^2/\text{N}\cdot\text{m}^2$

Permeability of free space, $\mu_0 = 4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$

Electron volt, 1 eV = $1.602 \times 10^{-19} \text{ J}$

Vacuum speed of light, $c = 3.00 \times 10^8 \text{ m/s}$

Planck's constant, $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s} = 4.136 \times 10^{-15} \text{ eV}\cdot\text{s}$

Planck's reduced constant, $\hbar = h/2\pi = 1.054 \times 10^{-34} \text{ J}\cdot\text{s} = 6.582 \times 10^{-16} \text{ eV}\cdot\text{s}$

Atomic mass unit, 1 amu = 1 u = $1.66 \times 10^{-27} \text{ kg} = 931.5 \text{ MeV}/c^2$

Electron rest mass, $m_e = 9.11 \times 10^{-31} \text{ kg} = 0.000549 \text{ u} = 0.511 \text{ MeV}/c^2$

Proton Mass = $1.6726 \times 10^{-27} \text{ kg} = 1.00728 \text{ u} = 938.3 \text{ MeV}/c^2$

Neutron Mass = $1.6749 \times 10^{-27} \text{ kg} = 1.008665 \text{ u} = 939.6 \text{ MeV}/c^2$

Some standard values for water:

Mass density, $\rho = 1.00 \text{ g/cm}^3 = 1,000 \text{ kg/m}^3$

Heat capacity or Specific heat, $c = 1.00 \text{ cal/gram}\cdot\text{C}^\circ = 1.00 \text{ kcal/kg}\cdot\text{C}^\circ = 4186 \text{ J/kg}\cdot\text{C}^\circ$

Latent heats, $L_f = 79.7 \text{ kcal/kg} = 3.33 \times 10^5 \text{ J/kg}$ & $L_v = 539 \text{ kcal/kg} = 22.6 \times 10^5 \text{ J/kg}$

Index of refraction, $n = 1.33$

Biology Questions (1 – 20)

1. Which of the following is the organelle that is composed of a system of canals, tubes, and sacs that transport molecules inside the cytoplasm of a cell?
 - A) mitochondrion
 - B) chloroplast
 - C) nucleolus
 - D) endoplasmic reticulum
 - E) Golgi body

2. The light-independent reactions of photosynthesis _____.
 - A) fix carbon dioxide
 - B) involve the liberation of oxygen
 - C) cannot occur in the presence of light
 - D) are known as photolysis
 - E) generate ATP

3. Anaphase _____.
 - A) involves the lining up of the chromosomes along the equatorial plate
 - B) is the same in mitosis and meiosis I and II
 - C) is initiated when the newly divided centromeres begin to move apart
 - D) results in an unequal distribution of chromosomes to the resulting cells
 - E) occurs immediately after DNA replication

4. If all offspring of a cross have the genotype *Aa*, the parents of the crosses would most likely be _____.
 - A) *AA* × *aa*
 - B) *Aa* × *Aa*
 - C) *Aa* × *aa*
 - D) *AA* × *Aa*
 - E) *aa* × *aa*

5. In the comparison between a spiral staircase and a DNA molecule, the steps would correspond to ____ in the DNA.
 - A) sugars
 - B) hydrogen bonds
 - C) nucleotides
 - D) base pairs
 - E) phosphates

6. Which of the following is NOT characteristic of viruses?
 - A) nucleic acid core
 - B) noncellular organization
 - C) protein coat
 - D) enzymes of respiration
 - E) require host to reproduce

7. Which of the following is NOT true of *Escherichia coli*?
 - A) It is normally found in the human intestinal tract.
 - B) It is always pathogenic.
 - C) It produces Vitamin K.
 - D) It may produce shiga toxins.
 - E) It is a bacterium.

8. Which of the following could NOT be used to describe any fungi?
 - A) saprophytic
 - B) decomposer
 - C) parasitic
 - D) autotrophic
 - E) heterotrophic

9. Which of the following phyla contains plants that lack vascular tissue?
 - A) Bryophyta
 - B) Pterophyta
 - C) Coniferophyta
 - D) Anthophyta
 - E) Cycadophyta

10. Which of the following is NOT a strengthening or supporting tissue in plants?
 - A) collenchyma
 - B) parenchyma
 - C) xylem
 - D) sclerenchyma
 - E) cork

11. Theoretically, a plant should still be able to reproduce sexually even though its ___ have been removed.
- A) stamens
 - B) sepals
 - C) anthers
 - D) ovaries
 - E) carpels
12. Which of the following body systems is the only one to have direct interactions with the other four?
- A) digestive
 - B) urinary
 - C) circulatory
 - D) respiratory
 - E) reproductive
13. Which of the following does NOT have the same type of skeleton as the others?
- A) beetle
 - B) snake
 - C) bird
 - D) human
 - E) frog
14. Which of the following parts of a mammalian brain is disproportionately larger than the corresponding part of a fish brain?
- A) medulla oblongata
 - B) thalamus
 - C) pons
 - D) cerebellum
 - E) cerebrum
15. The digestion of ___ begins in the mouth.
- A) carbohydrates
 - B) proteins
 - C) lipids
 - D) amino acids
 - E) nucleic acids
16. Which of the following types of cells occur as either T cells or B cells?
- A) macrophages
 - B) lymphocytes
 - C) complement cells
 - D) platelets
 - E) erythrocytes
17. The process of cleavage most commonly produces a ___ .
- A) zygote
 - B) blastula
 - C) gastrula
 - D) morula
 - E) embryo
18. Which of the following has no part in today's concept of natural selection?
- A) inheritance of acquired characteristics
 - B) struggle for existence
 - C) inherited variation
 - D) overproduction of offspring
 - E) survival of the best adapted
19. Macroevolution refers to change in all but which of the following?
- A) phyla
 - B) classes
 - C) species
 - D) genera
 - E) kingdoms
20. Which of the following groups of plants formed the basis for the development of agriculture and the spread of civilization?
- A) grasses
 - B) legumes
 - C) potato and tomato family
 - D) sunflower family
 - E) dicots

Chemistry Questions (21 – 40)

21. The oxidation state of chromium in potassium dichromate is _____.
 A) 3.5
 B) 2.5
 C) 12
 D) 6
 E) 5
22. In the reaction of HCl(aq) and NaOH(aq), the precipitate is _____.
 A) H₂O
 B) NaOH
 C) there is no precipitate
 D) HCl
 E) NaCl
23. The number of valence electrons in a gallium atom is _____.
 A) 13
 B) 1
 C) 2
 D) 31
 E) 3
24. The uranium isotope used in nuclear reactors and atomic bombs is ²³⁵U. How many neutrons are in an atom of ²³⁵U?
 A) 146
 B) 92
 C) 143
 D) 235
 E) 238
25. The higher the energy of electromagnetic radiation, the _____.
 A) higher the velocity of light
 B) greater its mass
 C) longer its wavelength
 D) lower its frequency
 E) shorter its wavelength
26. Is $n = 5, l = -3, m_l = -2, m_s = +1/2$ a valid set of quantum numbers for a hydrogen atom?
 A) Yes.
 B) No, because l cannot be negative.
 C) No, because m cannot be negative.
 D) No, because n cannot be as large as 5.
 E) No, because l must be equal to $n - 1$.
27. Which of the following is a poor conductor of electricity?
 A) potassium
 B) molten sodium chloride
 C) sulfur
 D) copper
 E) mercury
28. The hybrid orbitals that produce a tetrahedral geometry around a central atom are _____.
 A) sp²d
 B) sp²
 C) sp³
 D) sp
 E) spd
29. One millimole of HCl would neutralize exactly _____ millimole(s) of barium hydroxide.
 A) 1/2
 B) 2
 C) 3
 D) 1
 E) 3/2
30. Calculate the energy required to heat 25g of liquid CCl₃F from -20°C to its boiling point of 24°C. The specific heat of CCl₃F is 0.208 cal/g°C.
 A) 9.15 cal
 B) 20.8 cal
 C) 1100 cal
 D) insufficient information provided
 E) 229 cal
31. A 100 mL solution that is 0.02 M in Na⁺ can be prepared by adding _____ g of sodium sulfate to water and diluting to a final volume of 100 mL.
 A) 0.045
 B) 0.28
 C) 0.028
 D) 0.14
 E) 23.8

32. For a given reaction ΔG is very negative. Which of the following is FALSE?
- The reaction should occur very rapidly because ΔG is very negative.
 - The entropy of the universe must increase as a result of this reaction occurring.
 - The entropy for the reaction may be positive or negative.
 - If ΔS is positive then the reaction will probably be more spontaneous at higher temperatures.
 - The reaction is termed spontaneous.
33. Which of the following statements is true?
- The rate-law for a reaction can be predicted from the balanced chemical equation.
 - The exponents in the rate-law must match the coefficients in the balanced equation for the reaction.
 - If the exponents in the rate-law match the coefficients in the balanced chemical equation, then we know that the reaction takes place in one step.
 - If the exponents in the rate-law do not match the coefficients in the balanced equation, then we know that the reaction does not take place in one step.
 - Most chemical reactions have simple rate laws.
34. Consider: $\text{H}_3\text{O}^+(\text{aq}) + \text{OH}^-(\text{aq}) \rightleftharpoons 2 \text{H}_2\text{O}$
If the initial concentrations are
 $[\text{H}_3\text{O}^+(\text{aq})] = 0.1 \text{ M}$
 $[\text{OH}^-(\text{aq})] = 0.7 \text{ M}$
at equilibrium, $[\text{OH}^-(\text{aq})]$ will be _____.
- 0.5 M
 - 0.6 M
 - 0.8 M
 - 0.7 M
 - 0.0 M
35. What is the pH at the point in a titration at which 20.0 mL of 1.00 M KOH has been added to 25.0 mL of 1.00 M HBr?
- 0.95
 - 2.71
 - 1.22
 - 1.67
 - 3.84
36. The solubility product constant of barium fluoride is $K_{sp} = 2 \times 10^{-6}$. How many moles of barium fluoride dissolve in one liter of water?
- $8 \times 10^{-3} \text{ mol}$
 - $1 \times 10^{-6} \text{ mol}$
 - $2 \times 10^{-6} \text{ mol}$
 - $1 \times 10^{-3} \text{ mol}$
 - $4 \times 10^{-3} \text{ mol}$
37. The half reaction that occurs at the anode during the electrolysis of molten sodium bromide is _____.
- $\text{Na} \rightarrow \text{Na}^+ + \text{e}^-$
 - $2 \text{Br}^- \rightarrow \text{Br}_2 + 2 \text{e}^-$
 - $\text{Br}_2 + 2 \text{e}^- \rightarrow 2 \text{Br}^-$
 - $2 \text{H}_2\text{O} + 2 \text{e}^- \rightarrow 2 \text{OH}^- + \text{H}_2$
 - $\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$
38. For the reaction $? \text{N}_2 + ? \text{H}_2 \rightarrow ? \text{NH}_3$, a maximum of _____ grams of NH_3 could be formed from 3.913 grams of N_2 and 1.072 grams of H_2 .
- 3.33 g
 - 4.76 g
 - 6.66 g
 - 1.90 g
 - 10.47 g
39. How many molecules are contained in 1704 mL of O_2 gas at 46.4°C and 569. torr?
- 2.93×10^{22}
 - 2.34×10^{21}
 - 4.40×10^{21}
 - 1.17×10^{22}
 - 6.45×10^{23}

40. The vapor pressures of pure benzene, C_6H_6 , and pure toluene, C_7H_8 , at $60.0^\circ C$ are 380 torr(torr) and 140 torr, respectively. Calculate the total vapor pressure of a solution made up of 50.0 grams of benzene and 50.0 grams of toluene at $60.0^\circ C$.
- A) 108 torr
 B) 378 torr
 C) 270 torr
 D) 189 torr
 E) 594 torr
43. A wire of length 0.650 m carries a current 18.0 A in the presence of a 750 mT magnetic field. If the wire experiences a force of magnitude 5.50 N, then what must be the smallest acute angle between the wire and the magnetic field?
- A) 12.8°
 B) 25.6°
 C) 38.8°
 D) 51.2°
 E) 77.6°

Physics Questions (41 – 60)

41. According to Kepler's law as a satellite transitions from a lower orbit (closer to the Earth) to a higher orbit (farther from the Earth), what happens to the kinetic energy of the satellite? Note: assume that the gravitational force of the Earth is the net external force acting on the satellite.
- A) The kinetic energy increases, because the potential energy decreases.
 B) The kinetic energy increases, because the potential energy increases.
 C) The kinetic energy remains constant due to conservation of energy.
 D) The kinetic energy decreases, because the potential energy decreases.
 E) The kinetic energy decreases, because the potential energy increases.
42. A 1.50 kg ball is released from rest at 1.00 m above a horizontal surface, is in contact with the surface for 2.50 ms and then rebounds to 60.0 cm above the surface. What is the net impulse delivered to the surface?
- A) 1.50 kg•m/s, down
 B) 11.8 kg•m/s, down
 C) 599 kg•m/s, down
 D) 4710 kg•m/s, down
 E) None of these the direction is up not down.
44. How many megabytes are in a terabyte?
- A) 10^{-6}
 B) 10^{-3}
 C) 10^0
 D) 10^3
 E) 10^6
45. A capacitor in a RC circuit is charged to 75.0% of its maximum value in 950 ms. What is the time constant of the circuit?
- A) 0.303 s
 B) 0.685 s
 C) 0.730 s
 D) 1.46 s
 E) 3.30 s
46. A 2.0 kg brick with dimensions 20 cm \times 9.0 cm \times 6.0 cm is placed upon a flat surface. What is the minimum total number of whole bricks that will need to be stacked on top of one another so that the pressure exerted on the surface by the bottom most brick is equal to atmospheric pressure, 1.013×10^5 Pa?
- A) 28
 B) 62
 C) 93
 D) 274
 E) None of these.

47. Three objects are fired from the same location many meters above the ground with the same velocity. The first is fired at an angle of 55° above the horizontal, the second is fired horizontally and the third is fired at 55° below the horizontal. Which of these objects will hit the ground first? You may neglect air resistance in the calculation of your answer.
- The one that is fired above the horizontal will hit first.
 - The one that is fired horizontally will hit first.
 - The one that is fired below the horizontal will hit first.
 - Two of them will hit at the same time.
 - All of them will hit at the same time.
48. An electron and a proton have the same de Broglie wavelength. Which of the following statements is TRUE?
- The electron has more kinetic energy and a higher speed.
 - The electron has less kinetic energy but a higher speed.
 - The electron has less kinetic energy and a lower speed.
 - The electron and the proton have the same kinetic energy but the electron has the higher speed.
 - The proton has more kinetic energy but the two have the same speed.
49. A 200 kg crate slides 5.0 m down a 15° incline and is prevented from accelerating by a worker pushing on it. The worker pushes with a constant force that is parallel to the incline and opposite to the direction of the motion of the crate. If the coefficient of kinetic friction is 0.25 between the crate and the incline, then calculate the net amount of work done on the crate.
- 170 J
 - 34 J
 - 0.0 J
 - 34 J
 - 170 J
50. A plastic light pipe has an index of refraction of 1.53. For total internal reflection, what is the minimum angle of incidence if the pipe is completely submerged in water with an index of refraction 1.33?
- 7.94°
 - 40.8°
 - 48.8°
 - 60.4°
 - 89.6°
51. Assuming that the Earth orbits the Sun in a circular path with radius 1.50×10^8 km, what is the average speed of the Earth after it completes one quarter of a revolution about the Sun? Neglect any contribution from the rotation of the Earth about its own axis.
- 0.00 m/s
 - 7.47×10^3 m/s
 - 2.69×10^4 m/s
 - 2.99×10^4 m/s
 - 5.38×10^4 m/s
52. What is the maximum magnification of a magnifying glass with power + 3.0 D for a person with a near point of 10 cm?
- $0.033 \times$
 - $0.30 \times$
 - $1.0 \times$
 - $1.3 \times$
 - $1.8 \times$
53. A 5.0 kg block is placed against the front vertical surface of a truck. If the coefficient of static friction is 0.65 between the two surfaces, then what is the minimum acceleration of the truck in order for the block to remain stationary against the front of the truck?
- 9.8 m/s^2
 - 15 m/s^2
 - 22 m/s^2
 - 28 m/s^2
 - No matter what the acceleration the block will fall due to gravity.

54. A uniform 55-gram meter stick is suspended by two strings that are attached at the 10-cm mark on the left and at the 75-cm mark on the right. What are the tensions in the strings?
- A) $T_{10\text{cm}} = 0.21 \text{ N}$ & $T_{75\text{cm}} = 0.33 \text{ N}$
 B) $T_{10\text{cm}} = 0.33 \text{ N}$ & $T_{75\text{cm}} = 0.21 \text{ N}$
 C) $T_{10\text{cm}} = 0.18 \text{ N}$ & $T_{75\text{cm}} = 0.36 \text{ N}$
 D) $T_{10\text{cm}} = 0.36 \text{ N}$ & $T_{75\text{cm}} = 0.18 \text{ N}$
 E) $T_{10\text{cm}} = 0.30 \text{ N}$ & $T_{75\text{cm}} = 0.36 \text{ N}$
55. Light of wavelength 650 nm passes through a slit that is $4.50 \mu\text{m}$ wide and falls on a screen that is 1.55 m away from the slit. What is the distance between the third order dark fringes on either side of the central maximum?
- A) 0.468 m
 B) 0.745 m
 C) 0.935 m
 D) 1.10 m
 E) 1.49 m
56. Who was the first to verify the theoretical prediction by Prince Louis-Victor de Broglie that matter (electrons) had wave properties?
- A) Moseley
 B) Bohr
 C) Compton
 D) Davisson & Germer
 E) Thompson & Thompson
57. A spark plug consists of two metal conductors that are separated by a gap. Under the application of a potential difference between the conductors an electric field is created and an electric discharge occurs (a spark jumps between the two conductors). If the gap between two particular conductors is 0.75 mm and the magnitude of the electric field created is $4.5 \times 10^7 \text{ V/m}$, then what is the magnitude of the potential difference applied to the conductors?
- A) $3.4 \times 10^4 \text{ V}$
 B) $3.4 \times 10^6 \text{ V}$
 C) $3.4 \times 10^7 \text{ V}$
 D) $6.0 \times 10^7 \text{ V}$
 E) $6.0 \times 10^{10} \text{ V}$
58. Which of the following is NOT a final state of a star (one that has exhausted all of its fuel in its core)?
- A) Black hole
 B) Neutron Star
 C) Pulsar
 D) Red giant star
 E) White dwarf star
59. A ceiling fan runs on low speed at 200 rpm for 20 minutes before being turned on high speed at 350 rpm for the next 40 minutes. Through how much angle does a blade on the ceiling fan turn during the hour interval?
- A) $2.6 \times 10^3 \text{ rad}$
 B) $2.9 \times 10^3 \text{ rad}$
 C) $2.6 \times 10^4 \text{ rad}$
 D) $2.9 \times 10^4 \text{ rad}$
 E) $1.1 \times 10^5 \text{ rad}$
60. The intensity of sunlight reaching the top of the Earth's atmosphere is about 1390 W/m^2 . Given that the distance between the Sun and the Earth is $1.50 \times 10^8 \text{ km}$, what is the total power radiated by the Sun?
- A) $3.93 \times 10^{20} \text{ W}$
 B) $9.83 \times 10^{25} \text{ W}$
 C) $1.31 \times 10^{26} \text{ W}$
 D) $3.93 \times 10^{26} \text{ W}$
 E) $1.97 \times 10^{37} \text{ W}$

UIL HIGH SCHOOL SCIENCE CONTEST
ANSWER KEY

DISTRICT 2 • 2008

- | | | | | | |
|-----|---|-----|---|-----|---|
| 1. | D | 21. | D | 41. | E |
| 2. | A | 22. | C | 42. | B |
| 3. | C | 23. | E | 43. | C |
| 4. | A | 24. | C | 44. | E |
| 5. | D | 25. | E | 45. | B |
| 6. | D | 26. | B | 46. | A |
| 7. | B | 27. | C | 47. | C |
| 8. | D | 28. | C | 48. | A |
| 9. | A | 29. | A | 49. | C |
| 10. | B | 30. | E | 50. | D |
| 11. | B | 31. | D | 51. | D |
| 12. | C | 32. | A | 52. | D |
| 13. | A | 33. | D | 53. | B |
| 14. | E | 34. | B | 54. | A |
| 15. | A | 35. | A | 55. | E |
| 16. | B | 36. | A | 56. | D |
| 17. | B | 37. | B | 57. | A |
| 18. | A | 38. | B | 58. | D |
| 19. | C | 39. | A | 59. | E |
| 20. | A | 40. | C | 60. | D |

PHYSICS KEY for Science Contest • District 2 • 2008

41. (E) As it moves farther away from the Earth the PE will increase (become less negative), thus by conservation of energy the KE must decrease.
42. (B) $v_o = (2g(1))^{1/2} = 4.43\text{m/s}$ & $v = (2g(0.6))^{1/2} = 3.43\text{m/s}$, thus for the ball:
 $\mathbf{J}_{\text{net}} = \Delta\mathbf{p} = 1.5(+3.43 - (-4.43)) = +11.78\text{ kg m/s}$, therefore for the table: $\mathbf{J}_{\text{net}} = 11.8\text{ kg m/s}$, down
43. (C) $\theta = \sin^{-1}[F/(ILB)] = \sin^{-1}[5.5/\{(18)(0.65)(0.75)\}] = 38.8^\circ$
44. (E) $(1 \times 10^{12})/(1 \times 10^6) = 10^6$
45. (B) Since $Q = Q_o[1 - e^{-t/\tau}]$, with $Q = 0.75 Q_o$, thus $\tau = -0.95/\ln(1 - 0.75) = 0.685\text{ s}$
46. (A) Since $P = F/A$, then min. # bricks = $[(0.09)(0.06)](1.013 \times 10^5)/(2g) = 28$
47. (C) The one that is fired below the horizontal will hit first, since the time of flight is determined solely by the vertical motion and thus it will reach the ground first. However, they all hit with the same speed.
48. (A) Since they have the same de Broglie wavelength this implies that they will have the same momentum. Due to their difference in mass the velocity of the electron has to be greater than that of the proton and by $\text{KE} = p^2/(2m)$ it is seen that the KE of the electron must be larger as well.
49. (C) Since the acceleration of the crate is zero the net force is zero and thus the net work done on the crate is zero.
50. (D) $\theta = \sin^{-1}(1.33/1.53) = 60.4^\circ$
51. (D) avg. speed = distance/time = $(2\pi R/4)/(T/4) = (2\pi \cdot 1.5 \times 10^{11})/(3.156 \times 10^7) = 2.99 \times 10^4\text{ m/s}$
52. (D) $M = N/f + 1 = PN + 1 = (3)(0.1) + 1 = 1.3 \times$
53. (B) $F_{\text{frs}} = F_G \rightarrow \mu_s F_N \geq mg$, Thus, $F_N = ma \geq 75.4\text{N}$ since it is the net force and so, $a \geq 15\text{m/s}^2$
54. (A) $T_L + T_R = F_G = 0.539\text{N}$ & with the pivot at the 10 cm mark the net torque is:
 $-0.539(0.4) + T_R(0.65) = 0$, which solve to give $T_R = 0.33\text{N}$ & $T_L = 0.21\text{N}$
55. (E) $\theta = \sin^{-1}[(m\lambda)/D] = \sin^{-1}[3(650 \times 10^{-9})/(4.5 \times 10^{-6})] = 25.7^\circ$,
 Thus, $y = 2L \tan\theta = 2(1.55) \tan 25.7^\circ = 1.49\text{ m}$
56. (D) In 1927 Davisson & Germer observed diffraction of an electron beam through a crystal.
57. (A) $V = E \cdot d = (4.5 \times 10^7)(0.75 \times 10^{-3}) = 34,000\text{ V}$
58. (D) A red giant star has not completely exhausted the fuel in its core.
59. (B) total # rev. = $(200)(20) + (350)(40) = 18000\text{ rev.} = 1.1 \times 10^5\text{ rad}$
60. (D) Since $S = P/(4\pi r^2)$, then $P = 4\pi (1.5 \times 10^{11})^2 1390 = 3.93 \times 10^{26}\text{W}$