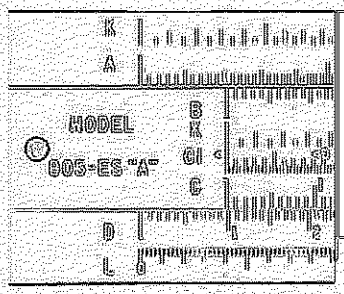

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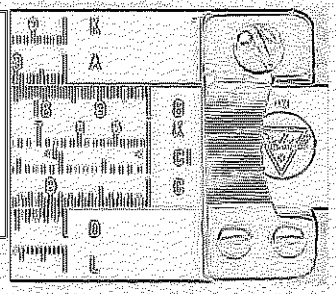

2008 UIL Science State Test
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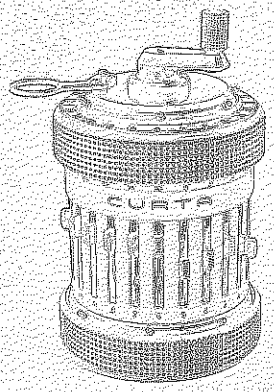

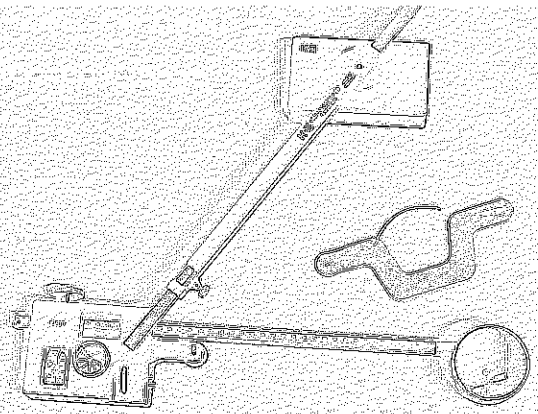

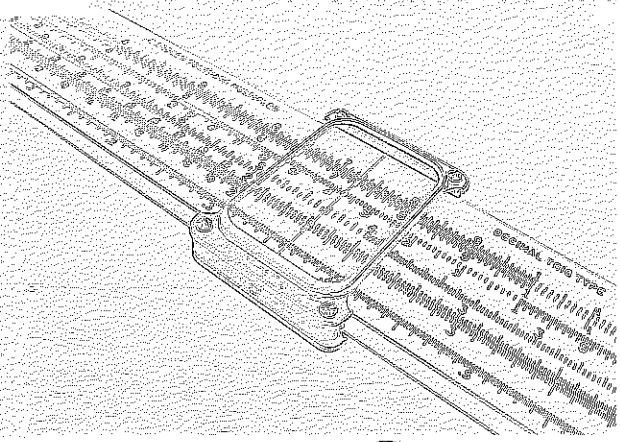

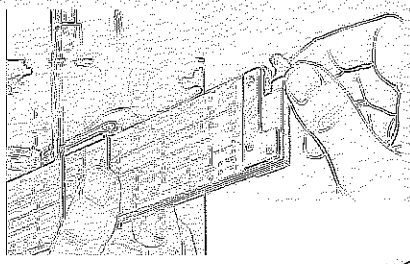

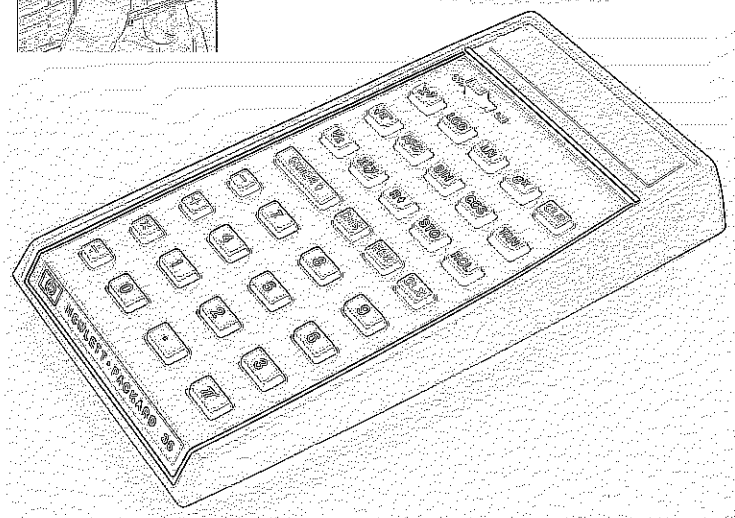

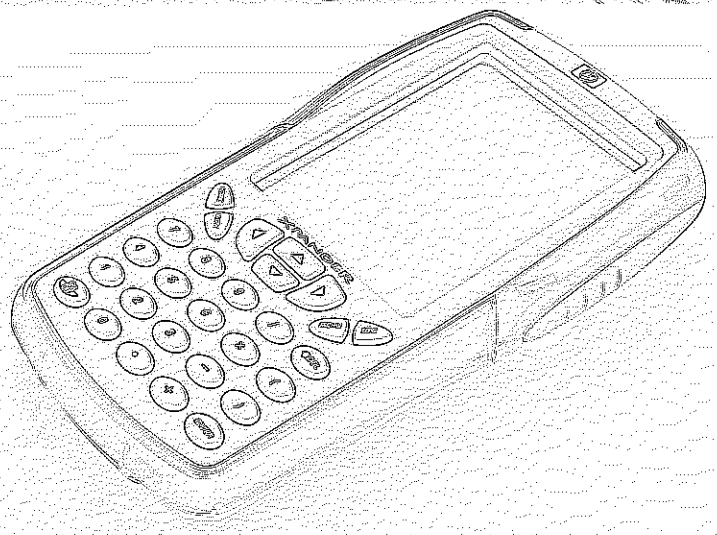

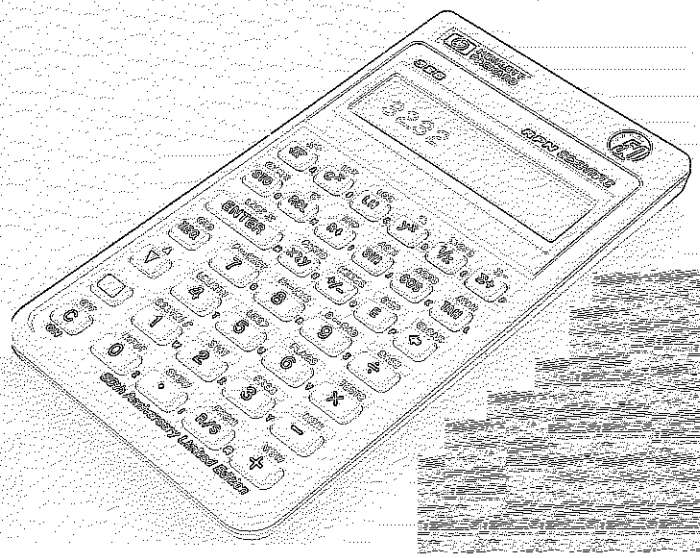

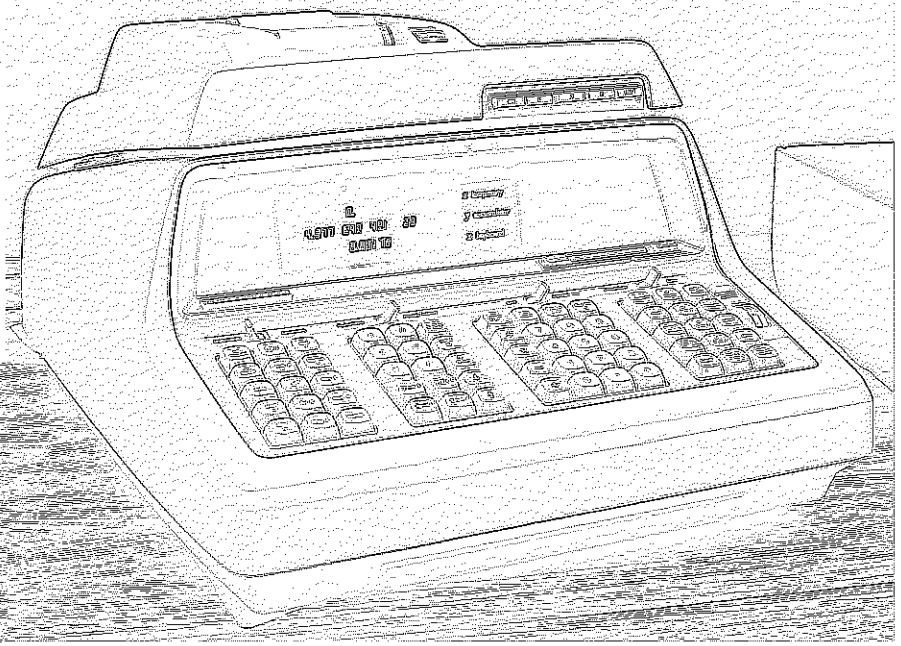

SCIENCE
STATE • 2008

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																	8A
1 H 1.008	2A											3A	4A	5A	6A	7A	2 He 4.003
3 Li 6.941	4 Be 9.012											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18
11 Na 23.00	12 Mg 24.31	3B	4B	5B	6B	7B	8B			1B	2B	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.06	17 Cl 35.45	18 Ar 39.95
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.90	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.70	29 Cu 63.55	30 Zn 65.38	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
37 Rb 85.47	38 Sr 87.62	39 Y 88.91	40 Zr 91.22	41 Nb 92.91	42 Mo 95.94	43 Tc (98)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Ha (262)	106 Unh (263)	107 Uns (262)		109 Une (267)									

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

See Reverse Page for Other Useful Information

OTHER USEFUL INFORMATION

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

Absolute zero = 0 K = -273.15°C

Atmospheric pressure, 1 atm = 1.013×10^5 N/m^2 = 101.3 kPa = 760.0 Torr = 760.0 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 cal/mol•K = 0.08206 atm•L/mol•K = 8.314 J/mol•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 m/s^2

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

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

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

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

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

Coulomb's law constant, $k = 1/4\pi\varepsilon_o = 8.988 \times 10^9$ N•m^2/C^2

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

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

Electron volt, 1 eV = 1.602×10^{-19} J

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

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

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

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

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

Proton Mass = 1.6726×10^{-27} kg = 1.00728 u = 938.3 MeV/c^2

Neutron Mass = 1.6749×10^{-27} kg = 1.008665 u = 939.6 MeV/c^2

Some standard values for water:

- Mass density, $\rho = 1.00$ g/cm^3 = 1,000 kg/m^3
- Heat capacity or Specific heat, c = 1.00 cal/gram•C° = 1.00 kcal/kg•C° = 4186 J/ kg•C°
- Latent heats, $L_F = 79.7$ kcal/kg = 3.33×10^5 J/kg & $L_V = 539$ kcal/kg = 22.6×10^5 J/kg
- Index of refraction, n = 1.33

Biology Questions (1 – 20)

1. Cilia and flagella ___ .
   A) are found only in motile cells
   B) are found only in sex cells and unicellular organisms
   C) are fundamentally the same structurally
   D) may also function as receptor sites for certain hormones
   E) are not membrane-bounded

2. In chloroplasts of plant cells, ATP is formed when ___ the thylakoid compartment.
   A) hydrogen ions enter
   B) electrons leave
   C) hydrogen ions leave
   D) electrons enter
   E) water is split in

3. Gametogenesis is ___ .
   A) always the immediate result of the process of meiosis
   B) the pairing of homologous chromosomes
   C) the fusion of gametes
   D) the separation of chromatids that immediately precedes anaphase in meiosis II
   E) the formation of sex cells

4. Mendel would not have seen four different phenotypes in the F_2 generation of his dihybrid crosses if ___ .
   A) the genes had been on the same chromosome
   B) the P_1 generation had been homozygous
   C) purple had been dominant to white
   D) the F_1 generation had been allowed to self-pollinate
   E) the F_1 generation had been heterozygous

5. Which of the following was the first disease called a "molecular disease" after the specific defective product of the mutant gene was identified?
   A) cystic fibrosis
   B) sickle-cell anemia
   C) phenylketonuria
   D) Tay-Sachs disease
   E) retinoblastoma

6. Which of the following are infective proteins?
   A) retroviruses
   B) viroids
   C) spores
   D) prions
   E) None of the above is true, because proteins cannot cause disease.

7. Which of the following is NOT a protozoan parasite of humans?
   A) *Trypanosoma*
   B) *Chlamydomonas*
   C) *Plasmodium*
   D) *Entamoeba*
   E) *Trichomonas*

8. Which of the following types of cells would NOT be observed in life cycles of fungi?
   A) haploid
   B) diploid
   C) triploid
   D) dikaryotic
   E) zygote

9. Which of the following groups of animals played a huge role in the diversification of angiosperms?
   A) mammals
   B) nematodes
   C) birds
   D) insects
   E) dinosaurs

10. Which of the following is NOT a function of parenchyma tissue?
    A) support
    B) wound healing
    C) food storage
    D) photosynthesis
    E) water and mineral uptake

11. Which of the following statements relating to seed germination is NOT true?
    A) The movement of water into a seed is known as imbibition.
    B) Water is attracted to hydrophilic proteins in the seed.
    C) The shoot system is the first part of an embryo to grow.
    D) When a seed begins germinating, it starts carrying out aerobic respiration.
    E) Germination is completed once the root extends outside of the seed.

12. Which of the following is NOT true of stem cells?
    A) They can continue to divide indefinitely.
    B) They produce cells that can become specialized for a specific function.
    C) They can produce more stem cells.
    D) They could possibly be used to produce functioning cells in tissues that cannot carry out their normal functions.
    E) Adult stem cells are more plastic than embryonic stem cells.

13. Which of the following includes all of the others?
    A) actin
    B) myofibril
    C) myosin
    D) myofilament
    E) muscle fiber

14. Interneurons are ___ .
    A) in the dorsal root
    B) in the spinal cord
    C) sensory neurons
    D) motor neurons
    E) in the autonomic nervous system

15. Which of the following glands has the primary function of promoting the body's immune response?
    A) pineal
    B) thymus
    C) thyroid
    D) gonads
    E) adrenal

16. Which immunoglobin is able to cross the placenta and protect the fetus from pathogens?
    A) IgG
    B) IgA
    C) IgD
    D) IgM
    E) IgE

17. Which of the following is NOT a function of the liver?
    A) inactivation of drugs
    B) assembly and storage of fats
    C) breakdown of worn-out blood cells
    D) formation of glucagons
    E) conversion of ammonia into urea

18. Which of the following statements is NOT true?
    A) Neutral mutations are not expressed.
    B) The effect of mutation is based upon the environment where it is found.
    C) Mutations are random but their frequency can be predicted.
    D) Mutations are more likely to be harmful because they represent a difference from alleles that have been retained over years of selection.
    E) Some harmful genes may build up in a population because of their location close to a favorable gene on a chromosome.

19. Phylogeny refers to what aspects of individuals?
    A) morphological traits
    B) evolutionary relationships
    C) physiological characteristics
    D) behavioral features
    E) all of the above

20. Chemosynthetic organisms are ___ .
    A) primary consumers
    B) secondary consumers
    C) tertiary consumers
    D) primary producers
    E) secondary producers

Chemistry Questions (21 – 40)

21. Balance the following redox reaction that occurs in a basic solution using the smallest set of integer coefficients.
$MnO_4^-(aq) + NO_2^-(aq) \rightarrow MnO_2(s) + NO_3^-(aq)$
What is the coefficient of MnO_4^- ?
A) 4
B) 1
C) 2
D) 5
E) 3

22. Which of the following reactions is a disproportionation reaction?
A) $KClO_4 + H_2SO_4 \rightarrow KHSO_4 + HClO_4$
B) $CH_4 + 2\ O_2 \rightarrow CO_2 + 2\ H_2O$
C) no disproportionation reaction is shown here
D) $3\ NaClO \rightarrow NaClO_3 + 2\ NaCl$
E) $2\ NO_2 \rightarrow N_2O_4$

23. Evidence that an electron carries an electric charge is furnished by ____ .
A) Rutherford's experiment showing bending and reflection of a beam of particles when it passes through gold foil.
B) the deflection of an electron beam in a cathode ray tube by electric and magnetic fields.
C) the line spectra produced by an electric discharge through a tube containing an inert gas.
D) the fact that impact by an electron beam in a cathode ray tube can set a small pinwheel in motion.
E) the fact that a beam of electrons hitting a target made of any metal can produce x-rays.

24. What is the maximum number of spatial orientations for an f orbital?
A) 7
B) 3
C) 9
D) 5
E) 1

25. The difference between the d_{xy} and $d_{x^2-y^2}$ orbitals is ____ .
A) the $d_{x^2-y^2}$ orbital is smaller than the d_{xy} orbital
B) the $d_{x^2-y^2}$ orbital only has 2 lobes while the d_{xy} has 4 lobes
C) the lobes of the $d_{x^2-y^2}$ orbital lie on the x and y axes while those of d_{xy} lie between the x and y planes
D) in a neutral atom, the $d_{x^2-y^2}$ orbital is at higher energy than the d_{xy} orbital and gets filled after the d_{xy} orbital
E) the d_{z^2} orbital

26. The Lanthanide series consists of elements filling ____ orbitals?
A) f
B) p
C) d
D) s
E) g

27. Coordinate covalent bond formation is a process in which
A) both electrons in the covalent bond are supplied by the same atom.
B) one atom gives up an electron to another atom.
C) one atom gives up more than one electron to another atom.
D) one electron in the covalent bond is supplied by each atom.
E) two atoms share more than one pair of electrons.

28. How many π bonds are in one molecule of acetylene?
A) 4
B) 0
C) 1
D) 2
E) 3

29. Which of the following would be expected to act as a Lewis acid?
    A) H_3O^+
    B) NH_3
    C) OH^-
    D) NH_4^+
    E) BF_3

30. 36.0 mL of 0.160 M $KMnO_4$ is required to oxidize 25.0 mL of an $FeSO_4$ solution. What is the molarity of the $FeSO_4$ solution? The reaction is $8\ H^+ + MnO_4^- + 5\ Fe^{2+} \rightarrow 5\ Fe^{3+} + Mn^{2+} + 4\ H_2O$
    A) .65 M
    B) 3.30 M
    C) 1.15 M
    D) 1.95 M
    E) 0.20 M

31. Which of the following statements is false?
    A) The shape of a meniscus depends on the difference between the strengths of cohesive forces and adhesive forces.
    B) High heats of vaporization are associated with liquids that have strong cohesive forces.
    C) In the absence of a phase change, the viscosity of a liquid increases as temperature decreases.
    D) Evaporization of liquids can occur below their normal boiling points at one atmosphere pressure.
    E) All other factors being equal, if adhesive forces are strong, capillary action is likely to occur less readily than if adhesive forces are weak.

32. Typical soaps and detergents usually clean up grease or oil by _____ .
    A) decomposing the oil and grease
    B) forming a precipitate
    C) making cation and anions of the oil and grease
    D) emulsifying it
    E) forming a truly homogeneous solution

33. To calculate the standard molar entropy of vaporization of water, we need to know _____ .
    A) the standard molar enthalpy of vaporization of water at 25°C
    B) the standard molar enthalpy of vaporization of water at 100°C and heat capacity data
    C) the standard molar entropy of formation of water
    D) K_c for the reaction $H_2O(l) \leftrightarrows H_2O(g)$
    E) the standard molar Gibbs free energy change for vaporization of water at 100°C

34. Consider the two-step reaction mechanism
    $A + X \rightarrow A^* + X \quad k_1$
    $A^* + X \rightarrow A + X \quad k_{-1}$
    $A^* \rightarrow B + C \quad k_2$,
    where A* is an energetically activated A molecule. If $k_1 = 3 \times 10^{-2}\ M^{-1}\ sec^{-1}$, $k_{-1} = 2 \times 10^{-2}\ M^{-1}\ sec^{-1}$ and $k_2 = 10^{-5}\ sec^{-1}$. For [X] = large, the rate law is d[B]/dt = _____.
    A) $k_1[A]$
    B) $(k_1k_2/k_{-1})[A]$
    C) $k_1[A][X]$
    D) $k_1[A^*][X]$
    E) $(k_1k_2/k_{-1})[A][X]$

35. After 100 mL of a 0.4 M solution of HClO is titrated to the equivalence point by the addition of 1.6 M NaOH, what is the pH of the solution? K_a for HClO is 3.5×10^{-8}.
    A) 8.5
    B) 9.5
    C) 10.5
    D) 7.5
    E) 3.5

36. After mixing two solutions, the new solution is 1.0×10^{-5}M in manganese nitrate and 1.5×10^{-3}M in aqueous ammonia. $K_b = 1.8 \times 10^{-5}$ for aqueous ammonia and $K_{sp} = 2.0 \times 10^{-13}$ for manganese hydroxide. Will manganese hydroxide precipitate?
    A) Yes, because $K_b > K_{sp}$.
    B) No, because $Q_{sp} > K_{sp}$.
    C) Yes, because $K_{sp} > Q_{sp}$.
    D) No, because $K_{sp} > Q_{sp}$.
    E) At most a tiny amount because K_{sp} and Q_{sp} are nearly equal.

37. Consider the cell
Pt | H_2(1 atm) / H^+(? M) || Hg_2Cl_2(s) / Cl^-(1 M) | Hg
$Hg_2Cl_2 + 2\ e^- \rightarrow 2\ Hg + 2\ Cl^-$, $E° = 0.268$ V
The measured cell potential for the cell is 0.416 volts. What is the pH of the solution? Assume room temperature.
A) 3.2
B) 4.9
C) 6.6
D) less than 1.00
E) 2.5

38. A 1093.2 mL sample of hydrogen was collected over water at 21.0°C on a day when the barometric pressure was 760.8 torr. What volume would the dry hydrogen occupy under standard conditions? The vapor pressure of water at 21.0°C is 19.0 torr.
A) 990 ml
B) 690 ml
C) 2180 ml
D) 1390 ml
E) 1780 ml

39. At T = 782.°C, $K_c = 2.109 \times 10^{-2}$ for the gas-phase reaction A + B → C + D. Starting with 1.00 mole of A and 0.500 moles of B in a 5.00 liter container, at equilibrium [C] = _____ at T = 782.°C?
A) 0.05 M
→ B) 0.1 M
C) 0.2 M
D) 0.3 M
E) 0.5 M

40. You prepare 0.5 liters of a solution by adding 0.75 moles of a weak acid, HA, to water. For HA, $K_a = 10^{-1}$. Finally, you dilute this solution to a final volume of 2.0 liters. What is the pH of the diluted solution?
A) 0.8
B) 0.5
C) 1.8
D) 1.2
E) 0.9

Physics Questions (41 – 60)

41. A 125 kg block is attached to a second 15.0 kg block hanging from a negligible pulley. The 125 kg block rests on a rough plane that is inclined at 15.0° above the horizontal. The coefficient of kinetic friction between the block and the plane is 0.220. Once the system is set in motion so that the 125 kg block moves down the incline, what is the magnitude of the acceleration of the system? Note: you may neglect all of the contributions of the pulley to the system.
A) 0.645 m/s^2
B) 0.723 m/s^2
C) 3.07 m/s^2
D) 5.54 m/s^2
E) 6.09 m/s^2

42. According to the Bohr model of the atom, what is the maximum wavelength of a photon that can be absorbed by a hydrogen atom in its ground state?
A) 91.3 nm
B) 103 nm
C) 122 nm
D) 195 nm
E) 657 nm

43. What is the correct expression of a tesla, the derived unit for the magnetic field, in terms of entirely basic units in the International System of units, i.e., the S.I. units?
A) V•s/m^2
B) N/(A•m)
C) Wb/m^2
D) kg/(A•s^2)
E) kg/(C•s)

44. A capacitor is charged to a potential difference of 12.0 V and is then connected to a voltmeter that has an internal resistance of 12 MΩ. After 5.00 s the voltmeter reads 4.0 V. What is the capacitance of the capacitor?
A) 281 nF
B) 379 nF
C) 417 nF
D) 1.03 μF
E) 2.68 μF

45. A uniform 5.0 m ladder is leaned against a smooth (frictionless) wall. The mass of the ladder is 25.0 kg and the bottom of the ladder rests on the ground at a distance of 2.5 m away from the wall. Given that the ladder begins to slip when a 75.0 kg person climbs up to a point that is 85% of the entire length of the ladder. What is the coefficient of static friction between the ground and the ladder?
    A) 0.289
    B) 0.341
    C) 0.440
    D) 0.883
    E) 1.76

46. A basketball is released 2.20 m above the floor at 42.0° above the horizontal. The basket is located 3.05 m above the ground and the ball is released at a horizontal distance of 12.5 m away from the basket. With what initial speed was the ball thrown if it is to go directly into the basket without hitting the backboard? You may neglect air resistance for this problem.
    A) 2.81 m/s
    B) 3.26 m/s
    C) 5.07 m/s
    D) 10.7 m/s
    E) 11.5 m/s

47. Two electrons are released from rest. If they were initially 5.0 mm apart, then what is the speed of the electrons once they are very far away from one another? You may assume that the electrons are infinitely far apart when calculating their speeds.
    A) 2.2×10^2 m/s
    B) 3.2×10^2 m/s
    C) 3.2×10^3 m/s
    D) 4.5×10^3 m/s
    E) Can't tell from the given information.

48. The center-to-center distance between the Earth and the Moon is 3.84×10^5 km. Where along the line measured from the Earth is the center of mass of the Earth-Moon system expressed in Earth radii? Given that the mass of the Earth is 5.98×10^{24} kg, the mass of the Moon is 7.35×10^{22} kg and the radius of the Earth is 6.38×10^6 m.
    A) $7.31 \times 10^{-4}\ R_{Earth}$
    B) $7.31 \times 10^{-1}\ R_{Earth}$
    C) $1.37 \times 10^{0}\ R_{Earth}$
    D) $7.39 \times 10^{0}\ R_{Earth}$
    E) $1.37 \times 10^{3}\ R_{Earth}$

49. Two identical projectiles are fired from the same height with the same initial speed of 25.0 m/s and both land at the same location. However, the first is fired vertically upward while the second is fired vertically downward. If you neglect air resistance, then how much time has elapsed until the first projectile hits the ground after the second projectile has hit?
    A) 0.00 s
    B) 2.55 s
    C) 5.10 s
    D) 10.2 s
    E) Can't tell from the given information.

50. A 250 kg merry-go-round with radius 2.0 m is to be modeled as a uniform cylinder that is rotated about its center. If you want to accelerate the merry-go-round from rest to a rotational rate of 20 rpm in 10 s, then what is the net torque acting on the merry-go-round? Note: you may neglect any resistive effects for this problem.
    A) 1.0×10^2 Nm
    B) 2.0×10^2 Nm
    C) 5.0×10^2 Nm
    D) 1.0×10^3 Nm
    E) 2.0×10^3 Nm

51. Whose main contribution to the development of the quantum theory came out of his research on radiative processes in thermodynamics?
    A) Rutherford
    B) Bohr
    C) Heisenberg
    D) Planck
    E) Schrödinger

52. Two charges q_1 and q_2 are unlike charges of equal magnitude, which are located at (0,0) and (25 cm, 0) respectively. A third charge q_3 of arbitrary sign is added to the system at a position where q_3 will be in electrostatic equilibrium. Where on the x-axis should q_3 be placed?
    A) −12.5 cm
    B) +12.5 cm
    C) +37.5 cm
    D) −12.5 cm & +37.5 cm
    E) there is no equilibrium position

53. An astronomical refracting telescope has an angular magnification of −175. The eyepiece has a focal length of 2.5 mm. What is the power of the objective lens?
    A) 0.0023 D
    B) 0.44 D
    C) 0.70 D
    D) 2.3 D
    E) 14.3 D

54. A circular coil is positioned so that the loops of the coil lie in the horizontal plane. A bar magnet is positioned above the center of the coil with the south end of the magnet facing down. The magnet is then released and passes through the coil. As you look down on the coil in what direction is the induced current as the magnet approaches the coil and subsequently moves away from the coil?
    A) clockwise for both
    B) clockwise and then counter-clockwise
    C) counter-clockwise and then clockwise
    D) counterclockwise for both
    E) there is no induced current

55. A stereo is plugged into a wall outlet that has an rms voltage of 120 V. If it draws a peak current of 2.50 A, then what is the peak power drawn by the stereo?
    A) 48.0 W
    B) 67.8 W
    C) 212 W
    D) 300 W
    E) 424 W

56. A bullet is fired from a rifle. The end of the rifle is a circular aperture. Is diffraction a measurable effect?
    A) No, because only charged particles have de Broglie wavelengths.
    B) No, because a circular aperture never causes diffraction.
    C) No, because the de Broglie wavelength of the bullet is too large.
    D) No, because the de Broglie wavelength of the bullet is too small.
    E) Yes.

57. A mass is located on a horizontally rotating turntable, which is rotating at a constant 45 rpm. If the mass is located more than 25 cm away from the axis of rotation, then it will slide off of the turntable. What is the coefficient of static friction between the mass and the turntable?
    A) 0.12
    B) 0.33
    C) 0.57
    D) 0.75
    E) 1.1

58. A water supply line with an internal radius of 6.5 mm is connected to a showerhead that has 12 holes. The speed of the water in the supply line is 1.5 m/s. If the effective radius of one of the holes is 0.40 mm, then with what speed does the water pass through each hole? Note: you may assume that the fluid is incompressible.
    A) 2.0 m/s
    B) 24 m/s
    C) 33 m/s
    D) 180 m/s
    E) 400 m/s

59. A vertical spring with spring constant 450 N/m is attached to a horizontal surface and compressed 25.0 cm. How high will a 450-gram ball reach once it is released? Measure the distance from the original compressed location of the ball. Note: you may neglect the mass of the spring and air resistance for this calculation.

A) 2.94 m
B) 3.19 m
C) 3.44 m
D) 6.89 m
E) 32.9 m

60. An ideal gas has its pressure cut in half slowly, while being kept in a rigid wall container. In this process, 300kJ of heat left the gas. What was the change in internal energy of the gas during the process?

A) -300 kJ
B) -150 kJ
C) 0.00 kJ
D) +150 kJ
E) +300 kJ

UIL HIGH SCHOOL SCIENCE CONTEST
ANSWER KEY

STATE • 2008

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

41. (A) From Newton's 2nd Law for each block: $F_{G||} - F_{frk} - F_T = m(-a)$ & $F_G - F_T = ma$, which are: $125(9.80)\sin 15° - 0.220[125(9.80)\cos 15°] - F_T = -125\ a$ & $15(9.80) - F_T = 15\ a$, which solve to give $a = 0.645\ m/s^2$

42. (C) For a maximum wavelength it must be a minimum energy difference, thus it is a transition from the ground state (n=1) to the first excited state (n=2). Where $E_n = -13.6\ eV/n^2$, thus $\lambda = c/f = hc/|\Delta E| = [(6.63\times10^{-34})(3.00\times10^8)]/[(13.6 - 3.4)(1.60\times10^{-19})] = 122\ nm$

43. (D) $T = N/(A\bullet m) = (kg\bullet m/s^2)/(A\bullet m) = kg/(A\bullet s^2)$ Note: A coulomb is not a basic S.I. unit.

44. (B) Since $V(t) = V_o \exp(-t/RC)$, which gives $12 = 4\exp\{-5/[(12\times10^6)C]\}$ and solves as $C = 379\ nF$

45. (C) From the conditions for equilibrium: $F_N - F_{person} - F_G = 0$, $F_{wall} - F_{frs} = 0$ & for the pivot at the ground $F_{wall}(5^2-2.5^2)^{1/2} - F_{person}[(0.85)2.5] - F_G[1/2(2.5)] = 0$ Thus, $\mu_s = F_{frs}/F_N = 431.4/980 = 0.440$

46. (E) From kinematics: $12.5 = 0 + v_o \cos 42°\ t$ & $3.05 = 2.20 + v_o \sin 42°\ t - 4.9t^2$, which solves to give $v_o = 11.5\ m/s$

47. (A) $\Delta KE = -\Delta PE = -q\Delta V$, thus $2(1/2\ mv^2) = -q[0 - (kq/r)]$ or $v = [(ke^2)/(mr)]^{1/2} = 225\ m/s$

48. (B) $x_{cm} = [0 + 7.35\times10^{22}(3.84\times10^8)]/[5.98\times10^{24} + 7.35\times10^{22}] = 4.66\times10^6\ m \Rightarrow 4.66\times10^6/6.38\times10^6 = 0.731\ R_{Earth}$

49. (C) the time difference is equal to the time that it takes to return to the firing position. From kinematics: $0 = 0 + 25t - 4.9t^2$ or $t = 5.10\ s$

50. (A) $\Sigma\tau = \Delta L/\Delta t = [I\omega - 0]/\Delta t = [1/2(250)2^2][2\pi/3]/10 = 1.0\times10^2\ Nm$

51. (D) Planck's description of the relationship between the energy and the frequency of blackbody radiation was based on the revolutionary idea that the energy emitted by a resonator could only take on discrete values or quanta.

52. (E) Since q_1 & q_2 are unlike charges of equal magnitude then the electric field is non-zero in between them and beyond them you will always be closer to one and further from the other so the electric field values can't cancel out, thus there is no equilibrium position for q_3.

53. (D) $-175 = -f_o/2.5\ mm \Rightarrow f_o = 437.5\ mm$ & $P = 1/f = 1/0.4375 = 2.3\ D$

54. (B) The magnetic flux increases as the magnet approaches, thus the induced magnetic field will oppose the field from the magnet and point down through the coil. Therefore the induced current is clockwise. As the magnet moves away the magnetic flux decreases, thus the induced magnetic field will coincide with the field of the magnet and point up through the coil. Therefore the induced magnetic field is counter-clockwise.

55. (E) $P_{peak} = I_{peak}V_{peak} = 2.50[120(2)^{1/2}] = 424\ W$

56. (D) $\lambda = h/p = (6.63\times10^{-34})/(mv)$, thus for any reasonable momentum of the bullet the de Broglie wavelength will be significantly smaller than the opening of the barrel.

57. (C) From Newton's 2nd Law: $F_{frs} = \mu_s F_N = \mu_s mg$ & $F_{frs} = mr\omega^2$ Thus, $\mu_s = [0.25(3\pi/2)^2]/9.8 = 0.57$

58. (C) $A_1v_1 = A_2v_2 \Rightarrow v_2 = [\pi(6.5\times10^{-3})^2 1.5]/[12\pi(0.4\times10^{-3})^2] = 33\ m/s$

59. (B) By energy conservation: $1/2kx^2 = mgh \Rightarrow h = [1/2(0.45)0.25^2]/[0.45(9.8)] = 3.19\ m$

60. (A) Since it is in a rigid walled container it is an Isochoric Process. Since $W = 0$ for these processes, then $\Delta U = Q + 0 = -300\ kJ$