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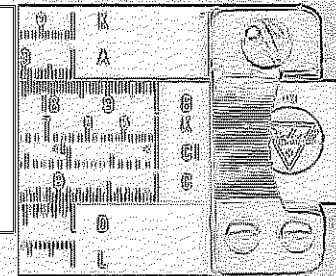
2008 UIL Science Regional Test
(14 pages)

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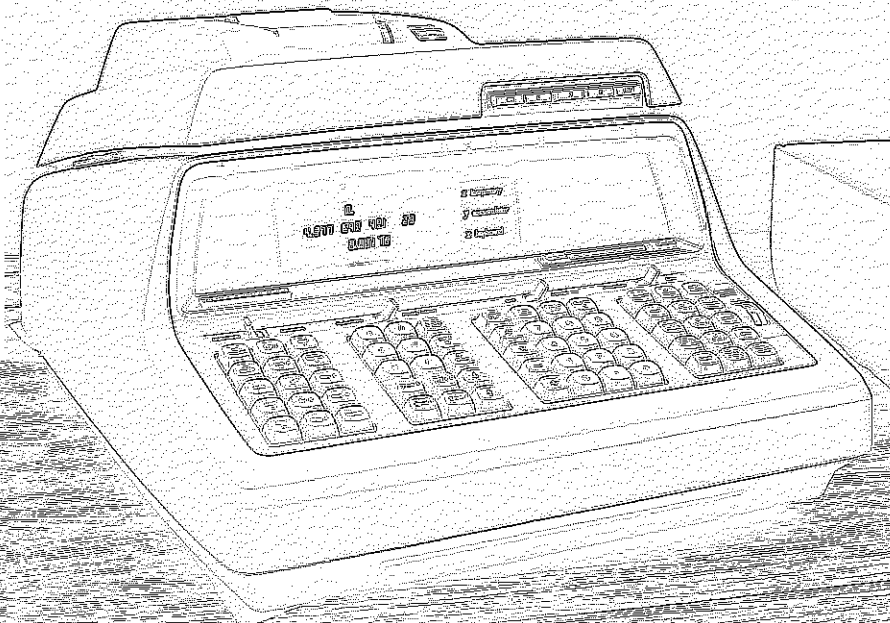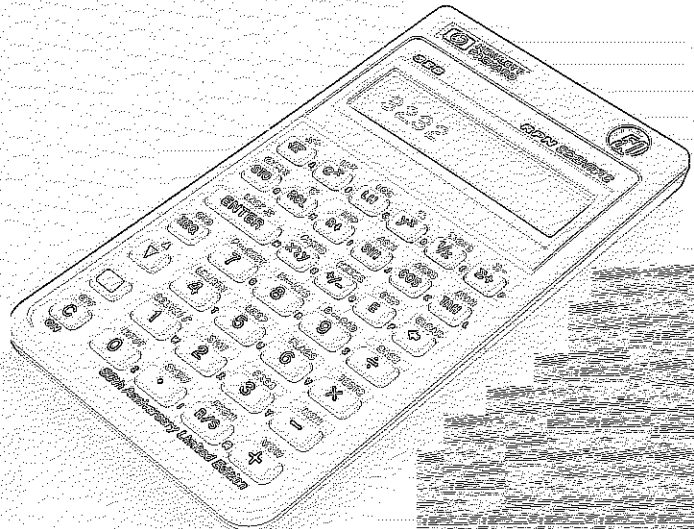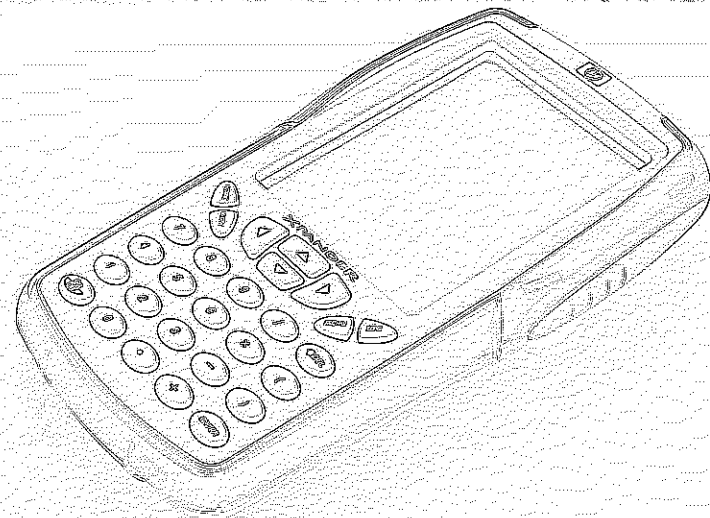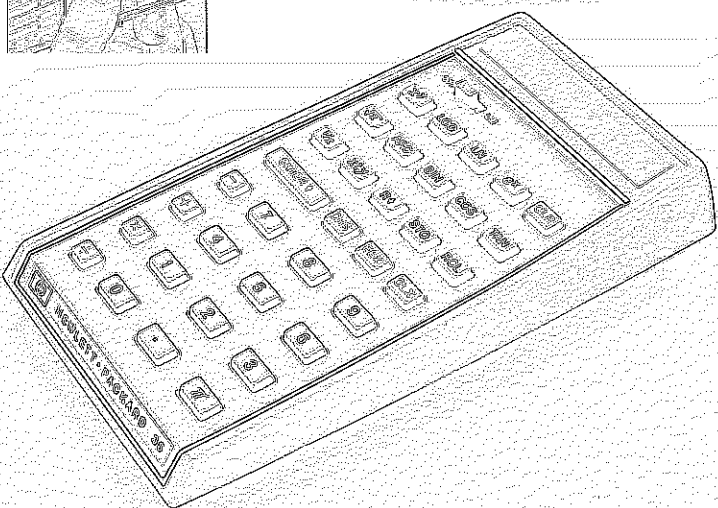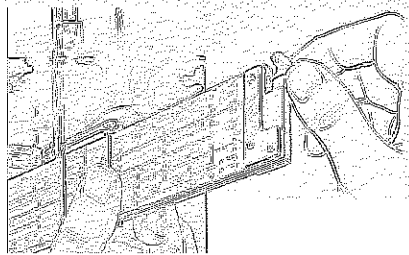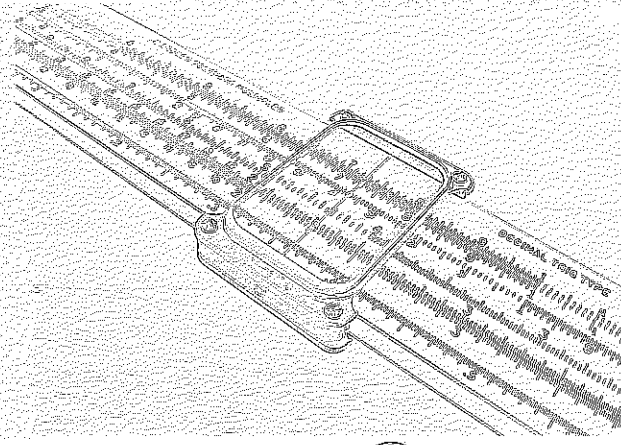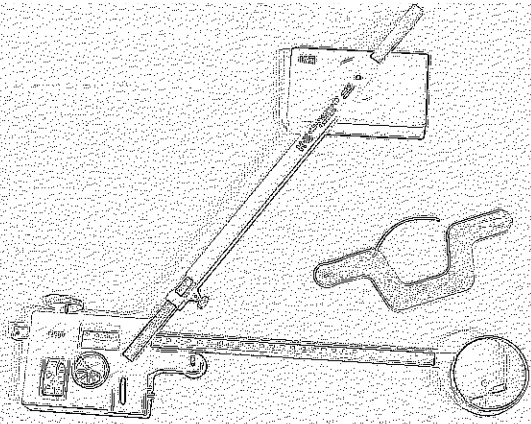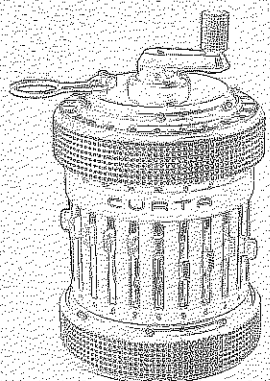
SCIENCE
REGIONAL • 2008

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																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 $= 1.013 \times 10^5$ 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 $= 1/4\pi\varepsilon_0 = 8.988 \times 10^{9}$ N•m^2/C^2

Permittivity of free space, $\varepsilon_0 = 8.85 \times 10^{-12}$ C^2/N•m^2

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

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

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

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

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

Atomic mass unit, 1 amu $= 1$ u $= 1.66 \times 10^{-27}$ 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 $= 1.6726 \times 10^{27}$ kg $= 1.00728$ u $= 938.3$ MeV/c^2

Neutron Mass $= 1.6749 \times 10^{27}$ 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 $= 3.33 \times 10^5$ J/kg & $L_V = 539$ kcal/kg $= 22.6 \times 10^5$ J/kg

   Index of refraction, n $= 1.33$

Biology Questions (1 – 20)

1. Which of the following move chromosomes inside cells?
   A) cilia
   B) flagella
   C) microtubules
   D) microfilaments
   E) Golgi bodies

2. Which of the following is true of the products of the light-dependent reactions of photosynthesis?
   A) They are used in the light-independent reactions.
   B) They are complex carbohydrates.
   C) They are stored in the vacuoles of the cell.
   D) They are oxygen and glucose.
   E) They are simple sugars.

3. The two molecules of DNA that are attached to a centromere following replication are called ___ .
   A) chromosomes
   B) dyads
   C) homologs
   D) chromatids
   E) alleles

4. The F_2 phenotypic ratio of a monohybrid cross with complete dominance is ___ .
   A) 1:1
   B) 2:1
   C) 9:3:3:1
   D) 1:2:1
   E) 3:1

5. After three replications of a single DNA molecule, what percent of the resulting double helices contain one strand of the original DNA?
   A) none
   B) 25%
   C) 50%
   D) 75%
   E) 100%

6. Pandemics of influenza are caused by the spread of ___ .
   A) pathogenic bacteria
   B) RNA viruses
   C) DNA viruses
   D) parasitic protozoans
   F) pathogenic fungi

7. In order for an organism to be considered truly multicellular, which of the following must be true?
   A) Its cells must be heterotrophic.
   B) The organism cannot be parasitic.
   C) The organism must have division of labor and cellular specialization.
   D) The organism must be motile.
   E) Individual cells of the organism must be able to survive independently.

8. Which of the following is the group of fungi in which mushrooms are classified?
   A) Ascomycetes
   B) Basidiomycetes
   C) Deuteromycetes
   D) Oomycetes
   E) Zygomycetes

9. The first haploid cell in the life cycle of a plant is the ___ .
   A) zygote
   B) gamete
   C) gametophyte
   D) spore
   E) spore mother cell

10. If certain cell walls were not perforated, which of the following would happen?
   A) Gas exchange could not occur through the stomata.
   B) Water would not be able to enter the epidermal cells of the root.
   C) Xylem and phloem would not be able to function as vascular tissue.
   D) The terminal bud would not be able to grow and elongate the stem.
   E) Sperm cells would not be able to reach egg cells in flowers.

11. "Alternation of generations" refers to the ___ .

A) expression of recessive traits

B) presence of haploid and diploid phases in the life cycle of plants

C) presence of female and male reproductive parts in different plants

D) occurrence of a sexually reproducing diploid stage followed by an asexually reproducing haploid stage during the life cycle of plants

E) production of male flowers on a plant one year and the production of females flowers on the same plant the following year

12. Which of the following is NOT a function of the lymphatic system?

A) fighting infection

B) reclaiming fluids

C) harboring white blood cells

D) transporting dissolved gases

E) All of the above are functions of the lymphatic system.

13. Which of the following is the correct sequence involved in the regulation of organ systems?

A) stimulus, receptor, integrator, response, effector

B) stimulus, response, integrator, receptor, effector

C) stimulus, receptor, integrator, effector, response

D) stimulus, integrator, receptor, effector, response

E) stimulus, effector, integrator, receptor, response

14. Functionally speaking, a nerve impulse is ___ .

A) a flow of electrons along the outside of the plasma membrane of a neuron

B) the movement of cytoplasmic elements through the core of a neuron

C) a lengthening and shortening of the membrane extensions of an individual neuron

D) a chemical that is released from one neuron and stimulates an adjacent neuron

E) a series of changes in membrane potentials

15. Leutenizing hormone ___ .

A) stimulates ovulation

B) has no function in males

C) is produced by the corpus luteum

D) stimulates milk production

E) promotes sperm formation

16. Bile ___ .

A) contains enzymes needed to digest fats

B) is produced by the liver and is stored in the gallbladder

C) helps in the digestion of complex carbohydrates in the small intestine

D) is an essential nutrient found in normal diets

E) inactivates toxic chemicals in the blood

17. Which of the following is produced at the end of gastrulation?

A) hollow ball of cells

B) embryo with germinal layers

C) solid ball of cells

D) zygote

E) fetus

18. If the frequency of a gene in a population under genetic equilibrium is 40%, in the next generation the frequency of that gene would be ___ .

A) 20%

B) 40%

C) 60%

D) 80%

E) none of the above, because other information is needed to make this calculation

19. The control group in an experiment ___ .

A) is exposed to experimental treatments

B) is an additional replicate for statistical purposes

C) makes the experiment valid

D) allows a standard of comparison for the experimental group

E) minimizes experimental inaccuracy

20. A J-shaped population growth curve is converted to an S-shaped one ___.
    A) when the parents are past reproductive age
    B) if the data are plotted in reverse
    C) when the carrying capacity is reached
    D) if reproduction stops
    E) only for fast-growing populations such as bacteria

Chemistry Questions (21 – 40)

21. The salt formed by the complete neutralization reaction of phosphoric acid and sodium hydroxide is ___.
    A) $Na_2(PO_4)_3$
    B) $NaPO_4$
    C) Na_3PO_4
    D) $Na_3(PO_4)_2$
    E) $Na(PO_4)_2$

22. The number of valence electrons in one Se^{2-} ion is _____.
    A) 6
    B) 18
    C) 2
    D) 8
    E) 7

23. The logical relationship between the existence of atomic line spectra and the belief in quantized energy levels in atoms was furnished by _____.
    A) the law of conservation of energy
    B) Pauli's exclusion principle saying that no two electrons can have all of their quantum numbers the same
    C) Bohr's hypothesis that $\Delta E = h\nu$
    D) the Heisenberg uncertainty principle concerning the simultaneous measurement of a particle's position and momentum
    E) the discovery that the beams in cathode ray tubes consist of streams of electrons

24. There are two naturally occurring isotopes of boron. ^{10}B has an isotopic mass of 10.01 amu and a natural abundance of 19.78%. The isotopic mass of the other isotope ^{11}B is $11.00 + x$ and $x =$ ____ .
    A) –0.03 amu
    B) –0.01 amu
    C) 0.01 amu
    D) 0.03 amu
    E) 0.05 amu

25. The designation for electrons in an orbital with the quantum numbers $n = 5$ and $l = 2$ is _____ .
    A) 5d
    B) 5s
    C) 7s
    D) 5f
    E) 5p

26. Which of the following electron configurations would represent a transition metal?
    A) $[Ne]\ 3s^2$
    B) $[Ar]\ 4s$
    C) $[Ne]\ 3s^2\ 3p^5$
    D) $[He]\ 2s^2\ 2p^3$
    E) $[Ar]\ 3d^5\ 4s^2$

27. How many oxygen nuclei are present in one molecule of calcium acetate?
    A) 4
    B) 5
    C) 1
    D) 3
    E) 2

28. On the basis of valence shell electron pair repulsion theory, the electronic geometry of XeF_2 is _____ .
    A) linear
    B) trigonal bipyramidal
    C) square planar
    D) octahedral
    E) trigonal planar

29. The name of the acid $HClO_4$ is _____ .
    A) chloric acid
    B) hypochlorous acid
    C) perchloric acid
    D) hydrochlorate acid
    E) perchlorous acid

30. The point in a titration at which stoichiometrically equivalent amounts of acid and base have reacted is called the _____ point.
    A) indicative
    B) neutralized
    C) end
    D) standardized
    E) equivalence

31. The vapor pressure of a liquid _____ .
    A) is directly proportional to the Centigrade temperature
    B) is inversely proportional to the Kelvin temperature
    C) is directly proportional to the Kelvin temperature
    D) is inversely proportional to the Centigrade temperature
    E) is non-linearly related to the Kelvin temperature

32. The information provided on a bottle containing a NaOH solution reads density = 1.330 g/mL; 30% NaOH(w/w). What is the molarity of NaOH in the solution?
    A) 0.30 M
    B) 10. M
    C) 0.56 M
    D) 1.4 M
    E) 6.3 M

33. For a 1:1 mixture of A and B and the following reaction: $A + B \rightarrow C$, $\Delta G° = +120$ J/mol rxn
    A) All of A and B will react to form C if enough time is allowed for the reaction.
    B) Nothing can be said about the reaction since ΔH and ΔS are not given.
    C) The reaction is considered spontaneous.
    D) No C will be formed since $\Delta G°$ is positive.
    E) Some C will be formed if enough time is allowed for the reaction to occur.

34. The overall reaction
    $NO_2(g) + CO(g) \rightarrow NO(g) + CO_2(g)$ is proposed to proceed by the following mechanism:
    $2 NO_2 (g) \rightarrow NO_3(g) + NO(g)$, slow
    $NO_3(g) + CO(g) \rightarrow NO_2 (g) + CO_2 (g)$, fast
    Which of the following rate laws would be consistent with this mechanism?
    A) rate = $k[NO_2][CO]$
    B) rate = $k[NO_3][CO]$
    C) None of the rate laws given here
    D) rate = $k[NO_2]^2$
    E) rate = $k[NO][CO_2]/\{[NO_2][CO]\}$

35. A 100 ml sample of 0.100 M NH_3 solution is titrated to the equivalence point with 0.200 M HCl. What is the equilibrium $[H_3O^+]$? The ionization constant of NH_3 is 1.8×10^{-5}.
    A) 6.1×10^{-6} M
    B) 8.6×10^{-6} M
    C) 1.1×10^{-3} M
    D) 3.7×10^{-11} M
    E) 1.0×10^{-7} M

36. Suppose copper(I) bromide(s) is added to a 0.05 M sodium bromide aqueous solution. What is the equilibrium concentration of the copper(I) ion? $K_{sp} = 5.3 \times 10^{-9}$ for copper(I) bromide.
    A) 2.2×10^{-1} M
    B) 1.1×10^{-7} M
    C) 7.3×10^{-5} M
    D) 2.5×10^{-3} M
    E) 1.6×10^{-5} M

37. What weight of Cl_2 gas will be produced by electrolysis of NaCl(liq) when a current of 4.35 amps flows for 15.0 hours?

    A) 0.0250 g
    B) 19.8 g
    C) 1.44 g
    D) 86.3 g
    E) 43.2 g

38. Determine the density of a gas (in g/L) given the following data:
    Molecular weight = 54.6 g/mol.
    Pressure = 429 torr.
    Temperature = 68.4°C

    A) 1.5 g/L
    B) 0.77 g/L
    C) 2.4 g/L
    D) 0.44 g/L
    E) 1.1 g/L

39. Given the following reaction and thermodynamic data:
    $COCl_2(g) \longleftrightarrow CO(g) + Cl_2(g)$

Species	$\Delta H_{f298}°$ (kJ/mol)	$S_{298}°$ (J/mol-K)
$COCl_2$ (g)	−223.0	289.2
CO(g)	−110.5	197.6
Cl_2 (g)	0	223.0

    Estimate K_p at 561 K .

    A) 6×10^4
    B) 2×10^4
    C) 1×10^{-3}
    D) 2×10^{-4}
    E) 6×10^{-4}

40. Calculate the percent ionization for a 0.05 M aqueous ammonia, $K_b = 1.8 \times 10^{-5}$.

    A) 4.2
    B) 0.76
    C) 1.9
    D) 3.4
    E) 1.3

Physics Questions (41 – 60)

41. A uniform 125 kg horizontal beam rests upon supports that are placed at each end. A 250 kg object is at rest upon the beam. The center of mass of the object is located one third of the way from the right end of the beam. What is the magnitude of the force exerted by each of the supports?

    A) F_{Left} = 146 N & F_{Right} = 229 N
    B) F_{Left} = 204 N & F_{Right} = 1021 N
    C) F_{Left} = 1430 N & F_{Right} = 2250 N
    D) F_{Left} = 1840 N & F_{Right} = 1840 N
    E) Can't tell from the given information.

42. An airplane is scheduled to travel with a heading of 40.0° south of west. However a steady wind is blowing from the south at 120 km/hr. If the airspeed of the plane is 550 km/hr, then in what direction should the plane head?

    A) 9.62° S of W
    B) 30.4° S of W
    C) 49.6° S of W
    D) 80.4° S of W
    E) None of these, the direction is N of W

43. The peak sensitivity of the human eye is at 5.5×10^{14} Hz. How many wavelengths of this color light can fit across your thumb? For this problem assume that your thumb has a width of 2.0 cm.

    A) 3.7×10^6 wavelengths
    B) 3.7×10^4 wavelengths
    C) 1.1×10^{-8} wavelengths
    D) 3.6×10^{-15} wavelengths
    E) 3.6×10^{-17} wavelengths

44. A stunt pilot flies a plane in a vertical circular arc with radius 250 m. What is the required minimum speed of the plane so that the passengers do not fall out of their seat while inverted at the top of the arc?

    A) 0.00 m/s
    B) 5.05 m/s
    C) 15.8 m/s
    D) 25.0 m/s
    E) 49.5 m/s

45. A 600 turn solenoid that has a length of 10.0 cm and a diameter of 5.00 cm carries a current of 4.50 A. What is the magnitude of the magnetic field at the geometric center of the solenoid?
    A) 6.66×10^{-6} T
    B) 6.66×10^{-5} T
    C) 3.39×10^{-3} T
    D) 3.39×10^{-2} T
    E) 53.0 T

46. Two small insulating spheres are equally charged and separated such that their center-to-center distance is 15.0 cm. If the magnitude of the repulsive electrostatic force between them is 3.69×10^{-20} N, then how many excess electrons are present upon each sphere? Note: you may treat the spheres as point charges for this calculation.
    A) 9.50×10^2 electrons
    B) 1.90×10^3 electrons
    C) 4.90×10^3 electrons
    D) 1.90×10^5 electrons
    E) 3.04×10^{16} electrons

47. A 2.50 kg model rocket is launched vertically straight up with sufficient initial speed to reach a maximum height of 125 m, even though air resistance performs -7.50×10^2 J of work on the rocket. How high would the rocket have gone in the absence of air resistance?
    A) 156 m
    B) 202 m
    C) 6.22 m
    D) 1.49×10^4 m
    E) 1.94×10^4 m

48. If an external agent does work on a system, then according to the first law of thermodynamics which of the following must be true?
    A) The internal energy of the system must increase.
    B) The internal energy of system must decrease.
    C) Heat must be transferred into the system.
    D) Heat must be transferred out of the system.
    E) Can't tell from the given information.

49. A household circuit uses 15.0 m of copper wire that has a cross-sectional area of 3.25 mm^2. Given the following data for copper: $\rho = 1.68 \times 10^{-8}$ Ω•m at 20.0°C and $\alpha = 0.0068$ $(C°)^{-1}$ which is constant over the entire temperature range, what is the resistance of the wire at 30.0°C. Note: you may neglect any contributions due to thermal expansion.
    A) 8.28×10^{-2} Ω
    B) 3.24×10^{-2} Ω
    C) 8.28×10^{-4} Ω
    D) 3.24×10^{-4} Ω
    E) 8.28×10^{-8} Ω

50. Three crates are placed on a frictionless horizontal surface in contact with one another in a row from left to right with masses 15 kg, 25 kg and 20 kg as you go from left to right respectively. If a 75 N force is applied horizontally to the right on the leftmost 15 kg crate, then what are the contact forces between the crates as you go from left to right?
    A) $F_{Left} = 0.0$ N & $F_{Right} = 100$ N
    B) $F_{Left} = 19$ N & $F_{Right} = 25$ N
    C) $F_{Left} = 25$ N & $F_{Right} = 19$ N
    D) $F_{Left} = 25$ N & $F_{Right} = 56$ N
    E) $F_{Left} = 56$ N & $F_{Right} = 25$ N

51. Which of these following statements are postulate(s) of Einstein's theory of special relativity:
    I. Light propagates through empty space with a definite speed, c, independent of the speed of the source or the observer.
    II. Moving clocks run slow.
    III. Moving objects are contracted along the direction of the motion of the object.
    IV. The laws of physics have the same form in all inertial reference frames.
    V. $E_o = mc^2$.
    A) V
    B) I & IV
    C) II & III
    D) II, III, & V
    E) I, II, III, IV & V

52. Three equal +1.75 µC point charges are placed so that they form the vertices of an equilateral triangle with a side length of 12.5 cm. What is the electric potential energy of the system? Note: you should assume that the electric potential energy is zero at infinite charge separation.
    A) 0.221 J
    B) 0.662 J
    C) 1.32 J
    D) 1.76 J
    E) 5.29 J

53. What is the correct expression of a farad, the derived unit of capacitance, in terms of entirely basic units in the International System of units, i.e., the S.I. units?
    A) C/V
    B) J/V^2
    C) (A•s)/V
    D) $(s^4•A^2)/(m^2•kg)$
    E) $(s^2•C^2)/(m^2•kg)$

54. A solid rock is found that is composed solely of quartz and gold. The rock has a mass of 15.0 kg and a volume of 3.50×10^{-3} m^3. Given that the density of quartz and gold are respectively 2,660 kg/m^3 and 19,300 kg/m^3, what is the mass of the gold contained in the rock?
    A) 1.47 kg
    B) 5.10 kg
    C) 6.60 kg
    D) 8.40 kg
    E) 13.5 kg

55. Who worked under both J.J. Thompson and Rutherford before becoming one of the major contributors to the "modern revolution" in physics in the early 1900's?
    A) Einstein
    B) Bohr
    C) Compton
    D) de Broglie
    E) Schrödinger

56. In a collision between a car and an insect which of the following is true about the forces involved in the collision?
    A) The car exerts the greatest amount of force.
    B) The insect exerts the greatest amount of force.
    C) In order to determine which object exerted the greater force you will need to know the length of time of the collision.
    D) In order to determine which object exerted the greatest force you will need to know both of the masses of the objects.
    E) Both the car and the insect exert the same amount of force on each other.

57. White light is incident upon two slits that are separated by 0.25 mm and then displayed upon a viewing screen that is 1.75 m away from the slits. Given that white light contains wavelengths from 450 nm to 650 nm, what is the width of the second order spectrum?
    A) 1.40 mm
    B) 2.80 mm
    C) 18.2 mm
    D) 45.8 mm
    E) 91.7 mm

58. An ice skater with his arms outstretched goes into his final spin rotating at a rate of 3.5 rad/s. He then brings his arms in so that his moment of inertia decreases by 12.5%. What is the percent increase in the skater's angular velocity? Note: you may neglect any resistive effects for this problem.
    A) 14%
    B) 88%
    C) 114%
    D) 400%
    E) 700%

59. A woman has been diagnosed with hyperopia and she has a near point located at 150 cm. She is to be prescribed corrective lenses that will correct her near point to 25 cm. If she intends to wear glasses and the lens eye distance for her glasses is 2.5 cm, then what is the required power of the lenses?

A) 0.038 D

B) 0.27 D

C) 3.3 D

D) 3.8 D

E) 5.1 D

60. A ball is dropped from the roof of a 15.0 m high building. When the ball is 7.50 m above the ground a second ball is thrown from the same location on the roof so that both balls hit the ground simultaneously. What was the initial velocity of the second ball?

A) 6.06 m/s

B) 12.9 m/s

C) 26.8 m/s

D) 31.8 m/s

E) 37.9 m/s

UIL HIGH SCHOOL SCIENCE CONTEST
ANSWER KEY

REGIONAL • 2008

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

41. (C) From the sum of the force: $F_L + F_R = 3675$ N, and one possibility for the sum of the torques: $-L(F_L) + L/2(1225) + L/3(2450) = 0$, gives $F_L = 1429$ N & $F_R = 2246$ N

42. (C) Draw the vector addition triangle of $V_{PG} = V_{PA} + V_{AG}$, then move the angle into the triangle and use the law of sines to get $\theta = \sin^{-1}[120/550*\sin(40°+90°)] = 9.62°$, therefore the plane must head at $40°+9.62°=49.62°$ S of W. Note: The solution can be obtained by using the component equations, but it is not as elegant or simple as this method of solution.

43. (B) $\# = d/\lambda = d(f/c) = (0.02 * 5.5\times10^{14})/(3\times10^8) = 3.7\times10^4$ wavelengths

44. (E) From Newton's second law: $v_{min} = (gR)^{1/2} = (9.8 * 250)^{1/2} = 49.5$ m/s

45. (D) $B = \mu_o nI = 4\pi\times10^{-7} (600/0.1) 4.5 = 3.39\times10^{-2}$ T

46. (B) Since the charges are identical from Coulomb's law: $q = (F_E r^2/k)^{1/2} = [3.69\times10^{-20}(0.15)^2/9\times10^9] = 3.04\times10^{-16}$ C $\Rightarrow 1.90\times10^3$ electrons

47. (A) With $W_{NC} = \Delta E$, $-7.5\times10^2 = 2.5(9.8)125 - \frac{1}{2}(2.5)v_o^2 \Rightarrow v_o = 55.226$ m/s. Thus, $h = v_o^2/(2g) = 55.226^2/(2 * 9.8) = 156$ m

48. (E) From $\Delta U = Q - W \Rightarrow W = Q - \Delta U$. Thus with W<0 and no stated process it is possible that there could be both a change in the internal energy of the system or a transfer of heat combined together.

49. (A) With $R = \rho L/A$ & $\rho=\rho_o(1+\alpha\Delta T) \Rightarrow R = 1.68\times10^{-8}[1+0.0068(10)](15/3.25\times10^{-6}) = 8.28\times10^{-2}$ Ω

50. (E) $a = \Sigma F/m = 75/60 = 1.25$ m/s^2, Thus for the rightmost crate, $F_{Right} = 20(1.25) = 25$ N & for the leftmost crate, $75 - F_{Left} = 15(1.25) \Rightarrow F_{Left} = 56.25$ N

51. (B) I & IV are the postulates of special relativity, the rest are consequences of these postulates.

52. (B) For any two of these charges $U_E = kq_1q_2/r = (9\times10^9)(1.75\times10^{-6})^2/(0.125) = 0.2205$ J and you need one for each set of unique pairings, so $U_{total} = 3U_E = 0.6615$ J

53. (D) $F = C/V = (A\bullet s)/(J/C) = (A\bullet s)^2/(kg\bullet m^2/s^2) = (s^4\bullet A^2)/(m^2\bullet kg)$ Note: A coulomb is not a basic S.I. unit.

54. (C) Thus, $m_{gold} + m_{quartz} = 15$ & $V_{gold} + V_{quartz} = 3.5\times10^{-3}$ use $V = \rho/m$ to obtain a system of two equations and two unknowns that gives $m_{gold} = 6.60$ kg

55. (B) After completing his Doctoral degree in 1911, Niels Bohr when on to work in the laboratories of both J.J. Thompson and Rutherford for a year each before returning back to Copenhagen University.

56. (E) By Newton's third law, the forces are the same. Because they have different masses their reactions to the forces are different.

57. (B) Use $\theta = \sin^{-1}(m\lambda/d)$ to get $\theta_{450nm} = 0.206265°$ & $\theta_{650nm} = 0.297939°$ and then use $y = L\bullet\tan\theta$ to get $y_{450nm} = 6.30$ mm & $y_{650nm} = 9.10$ mm subtract to get the width $\Delta y = 2.80$ mm

58. (A) $I_o(3.5) = I\omega = [I_o-0.125\bullet I_o]\omega$, thus $\omega = 4$ rad/s and the percent increase is: $(4-3.5)/3.5\times100\% = 14\%$

59. (D) $P = 1/(.25-.025) + 1/[-(1.50-.025)] = 3.8$ D

60. (C) Use $t = (2h/g)^{1/2}$ to get: $t_{1/2} = (2\bullet7.5/9.8)^{1/2} = 1.237$ s and $t_{total} = (2\bullet15/9.8)^{1/2} = 1.7496$ s, thus $\Delta t = 0.5125$ s and use as follows: $0 = 15 - v_o(0.5125) - 4.9(0.5125)^2 \Rightarrow v_o = 26.76$ m/s