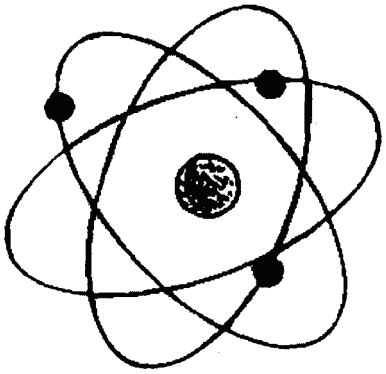
UIL

SCIENCE

Invitational A • 2009



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.

Periodic Table of the Elements

1A												3A	4A	5A	6A	7A	8A
1 H 1.008	2A							8B			1B						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				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. Which of the following are found in both prokaryotic AND eukaryotic cells?
   A) mitochondria
   B) chloroplasts
   C) vacuoles
   D) ribosomes
   E) nucleus

2. In order for diffusion to occur, there must be
   A) a membrane.
   B) a gradient.
   C) water.
   D) ATP.
   E) All of the above must be present.

3. Which of the following is present in DNA but not in RNA?
   A) adenine
   B) thymine
   C) uracil
   D) guanine
   E) cytosine

4. A cell with a diploid chromosome number of 48 will produce two cells at the end of mitosis, each with
   A) 24 chromosomes.
   B) 48 chromosomes.
   C) 12 pairs of chromosomes.
   D) 36 pairs of chromosomes.
   E) 12 chromosomes.

5. Which of the following is NOT required for aerobic respiration?
   A) O_2
   B) H_2O
   C) CO_2
   D) glucose
   E) All of the above are required for aerobic respiration.

6. An organism with two identical alleles for a given trait is
   A) homozygous.
   B) dominant.
   C) codominant.
   D) heterozygous.
   E) recessive.

7. Plague, which killed about 100 million people during the 14th century, was caused by which of the following types of organisms?
   A) rats
   B) fleas
   C) bacteria
   D) viruses
   E) fungi

8. Which of the following structures is found in Angiosperms but is NOT found in Gymnosperms?
   A) vascular tissue
   B) seeds
   C) fruits
   D) true roots
   E) pollen

9. In which of the following groups did the amniotic egg first appear?
   A) sharks
   B) bony fish
   C) amphibians
   D) reptiles
   E) mammals

10. The type of plant tissue that conducts photosynthesis and stores materials is
    A) collenchyma.
    B) meristematic.
    C) sclerenchyma.
    D) reproductive.
    E) parenchyma.

11. Most of the water absorbed by a plant enters through the
    A) root apical meristem.
    B) stomata.
    C) xylem vessels.
    D) root hairs.
    E) root cap.

12. Which of the following elements is obtained by plants directly from the atmosphere?
    A) nitrogen
    B) hydrogen
    C) iron
    D) carbon
    E) sulfur

13. The element needed for blood clotting, nerve signal transmission, and bone and tooth formation is
    A) iron.
    B) iodine.
    C) calcium.
    D) zinc.
    E) magnesium.

14. The mammalian aorta carries blood away from which chamber(s) of the heart?
    A) left atrium
    B) right atrium
    C) left ventricle
    D) right ventricle
    E) left and right ventricles

15. The blood cells that are directly involved in the human immune response are
    A) red blood cells.
    B) white blood cells.
    C) platelets.
    D) B and C.
    E) A, B, and C.

16. Which of the following glands is NOT an endocrine gland?
    A) pituitary
    B) thyroid
    C) adrenal
    D) thymus
    E) salivary

17. The type of muscle found in the wall of the aorta is
    A) striated muscle.
    B) smooth muscle.
    C) cardiac muscle.
    D) skeletal muscle.
    E) None of the above.

18. In evolutionary terms, an organism's fitness is measured by its
    A) health.
    B) genetic variability.
    C) mutation rate.
    D) stability in the face of environmental change.
    E) contribution to the gene pool of the next generation.

19. Competition is most intense between
    A) members of the same species.
    B) members of different species.
    C) occupants of the same community.
    D) members of opposite sex of the same species.
    E) the largest and the smallest organisms.

20. Which of the following is NOT a part of the scientific method?
    A) observation
    B) formation of a hypothesis
    C) experimentation
    D) personal conviction
    E) formation of conclusions

Chemistry Questions (21 – 40)

21. An example of a chemical change is _____ bread.
    A) cutting
    B) swallowing
    C) digesting
    D) dropping
    E) buttering

22. The heat of vaporization of gold is over 4 times greater than that of the heat of fusion of gold. This means that it is easier to _____ .
    A) purify gold by physical methods
    B) melt gold than to boil it
    C) boil gold than to melt it
    D) heat gold up than to cool it down
    E) cool gold down than to heat it up

23 The symbol for the element silver is
    A) Su
    B) Au
    C) Hg
    D) Si
    E) Ag

24. The formula weight of dichloromethane is _____ .
    A) 42.5 g/mole
    B) 48.5 g/mole
    C) 96.9 g/mole
    D) 84.9 g/mole
    E) 5 g/mole

25. An analysis of a compound used in the production of aluminum is 32.79% sodium, 12.83% aluminum and 54.19% fluorine. The empirical formula of the compound is _____ .
    A) Na_5AlF_8
    B) Na_3AlF_6
    C) NaAlF
    D) Na_3AlF_5
    E) Na_3AlF_3

26. How many grams of NaOH are in 4.00 L of a 0.500 M NaOH solution?
    A) 2.00 g
    B) 80.0 g
    C) 8.00 g
    D) 20.0 g
    E) 160.0 g

27. How many mL of 6.00 M HCl are needed to just react with 10.5 g of metallic zinc to produce H_2?
    A) 2.68 mL
    B) 26.8 mL
    C) 535 mL
    D) 53.5 mL
    E) 5.35 mL

28. The combustion of ammonia produces NO and water. If the chemical reaction for this process is properly balanced using the smallest set of integer coefficients, what is the sum of the coefficients for the products?
    A) 10
    B) 8
    C) 12
    D) 18
    E) 5

29. Magnesium reacts with sulfur to form
    A) MgS_2
    B) MgS
    C) none of these
    D) Mg_2S_3
    E) Mg_2S

30. How many electrons are there in one sulfide ion?
    A) 17
    B) 16
    C) 15
    D) 19
    E) 18

31. In the order of occupancy of electronic energy levels, the level occupied after 3d is ____ .
    A) 4p
    B) 4d
    C) 4f
    D) 6p
    E) 5d

32. A neutral isolated atom has the ground state configuration: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2\ 3d^3$. Identify the element.
    A) The question cannot be answered unless the atomic weight is known.
    B) cobalt
    C) vanadium
    D) phosphorus
    E) argon

33. Which of the following contains only covalent bonds?
    A) CCl_4
    B) $Ca(NO_3)_2$
    C) Na_2SO_4
    D) NaCl
    E) NaOH

34. The fraction of molecules in a condensed phase with a velocity sufficient to escape into the gas phase depends on ____ .
    A) the number of nuclei in the molecules
    B) the interaction energy of molecules
    C) all of the possibilities are important
    D) the polarity of the molecules
    E) the temperature

35. Calculate the enthalpy change for the following reaction.
$2\ SO_2(g) + O_2(g) \rightarrow 2\ SO_3(g)$
$\Delta H_f(SO_2(g)) = -16.9$ kJ/mole;
$\Delta H_f(SO_3(g)) = -21.9$ kJ/mole.
A) −10.0 kJ
B) +10.0 kJ
C) −5.0 kJ
D) −77.6 kJ
E) +5.0 kJ

36. A catalyst
A) changes the value of ΔG of the reaction.
B) is always a solid.
C) is used up in a chemical reaction.
D) does not take part in the reaction in any way.
E) lowers the activation energy of the reaction.

37. Which of the aqueous solutions listed below has the lowest pH?
A) 5.0×10^{-3} moles of hydrochloric acid in 500 ml solution
B) 0.12 grams of calcium hydroxide in 0.2 L of solution
C) 2.0×10^{-1} moles of ammonia in 0.25 L of solution
D) 5.0×10^{-3} moles sulfuric acid in 0.5 L of solution
E) 5.0×10^{-3} moles of acetic acid in 200 ml solution

38. A Bronsted-Lowry base is defined as a (an) _____ .
A) electron donor
B) H^+ donor
C) proton donor
D) proton acceptor
E) electron acceptor

39. What is the oxidation number of selenium, Se, in SeO_4^{2-}
A) +4
B) +8
C) +6
D) +2
E) −6

40. What particle is emitted when lead-214, undergoes natural radioactive decay to bismuth-214?
A) a beta particle
B) a neutron
C) a proton
D) an alpha particle
E) a deuteron

Physics Questions (41 – 60)

41. This UT theoretical physicist is a member of two departments at UT and has been awarded numerous prizes including both the Nobel Prize and the National Medal of Science. His/her research is on cosmology, elementary particle theory and quantum field theory and has taught at M.I.T. & Harvard prior to coming to UT.
A) Bryce DeWitt
B) Ilya Prigogine
C) E.C.G. Sudarshan
D) Steven Weinberg
E) John A. Wheeler

42. Speculatively the current model for describing the evolution of the universe after the "Big Bang" indicates that which of the following eras occurs approximately after the first 10^{-43} s (prior to which the fundamental forces in nature were unified)?
A) the grand unified (GUT) era
B) the hadron era
C) the lepton era
D) the radiation-dominated (radiation) era
E) the matter-dominated era

43. Which of the following particles is the mediator of the electroweak force as predicted by the electroweak theory?
A) Gluon (g)
B) Graviton
C) Higgs boson
D) Photon (γ)
E) Z boson (Z^0)

44. Which of the following is NOT a base unit in the International System of units (SI)?
A) ampere
B) candela
C) kelvin
D) kilogram
E) liter

52. Two boxes of mass m_1 and m_2 are placed on a frictionless horizontal surface from left to right respectively. They are connected by a massless horizontal string with that will have tension T_1 when uniformly accelerated to the right by a tension T_2 applied to another horizontal string that is attached to the right hand side of m_2. What is the ratio of the tensions T_1/T_2?
A) m_1/m_2
B) m_2/m_1
C) $(m_1 + m_2)/m_2$
D) $m_1/(m_1 + m_2)$
E) $m_2/(m_1 + m_2)$

53. A child rides on a merry-go-round and rotates with a period of 5.0 s. As described by a stationary observer on the ground, which of the following accelerations does the child experience?
I. A centripetal acceleration
II. A centrifugal acceleration
III. A tangential acceleration
IV. An angular acceleration
A) I
B) II
C) III & IV
D) I, III & IV
E) II, III & IV

54. A 3.00 kg rocket is launched straight up. It reaches a maximum height of 1.00×10^2 m above the location where its engine cuts out, while air resistance performs -8.00×10^2 J of work on the rocket during this portion of the motion. What would have been the height if there were no air resistance?
A) 86.2 m
B) 127 m
C) 182 m
D) 345 m
E) 1760 m

55. A 35 g ball of putty is released from rest at a height of 1.8 m above the floor. After striking the floor it comes to rest on the floor. If the ball is in contact with the floor for 0.25 s then what is the magnitude of the average force exerted upon the ball by the floor? You may neglect air resistance.
A) 0.34 N
B) 0.49 N
C) 0.83 N
D) 1.2 N
E) 5.9 N

56. The translational speed of the center of mass of a bowling ball that rolls without slipping along the horizontal section of the ball return is 3.50 m/s. It then moves through a vertical rise of 0.760 m on the way back to the ball rack. If you neglect frictional losses and assume that the mass of the ball is distributed uniformly, then what is the translational speed of the ball at the top of the rise?
A) 1.27 m/s
B) 1.52 m/s
C) 2.65 m/s
D) 4.78 m/s
E) It does not make it to the top of the rise.

57. If a silver dollar is to acquire a net charge of +2.4 μC, then how many electrons are transferred and are they added to or removed from the silver dollar?
A) 1.5×10^{13} added
B) 1.5×10^{13} removed
C) 6.7×10^{14} added
D) 3.8×10^{25} added
E) 3.8×10^{25} removed

58. A cube with edges 0.25 m long completely surrounds a +2.0 μC charge. What is the electric flux through this surface?
A) 0 $N \cdot m^2/C$
B) 2.3×10^5 $N \cdot m^2/C$
C) 6.0×10^5 $N \cdot m^2/C$
D) 9.0×10^5 $N \cdot m^2/C$
E) 3.6×10^6 $N \cdot m^2/C$

59. A charge of +9q is fixed to one corner of a square, while a charge of –8q is fixed to the diagonally opposite corner. Express in terms of q, what charge should be fixed to the center of the square, so that the potential is zero at each of the two empty corners? Assume that the potential is also zero infinitely far from the charges.

A) $-\sqrt{2}\ \ q$

B) $-\frac{\sqrt{2}}{2}\ \ q$

C) $+\frac{\sqrt{2}}{2}\ \ q$

D) $+\sqrt{2}\ \ q$

E) Depends upon the size of the square.

60. The magnetic force that two parallel wires with unequal currents flowing in opposite directions exert on each other are

A) attractive and unequal in magnitude.
B) repulsive and unequal in magnitude.
C) attractive and equal in magnitude.
D) repulsive and equal in magnitude.
E) both zero.

UIL HIGH SCHOOL SCIENCE CONTEST
ANSWER KEY

INVITATIONAL A • 2009

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

41. (D) Steven Weinberg is a member of both the Physics and Astronomy Departments and was awarded the 1979 Nobel Prize in Physics for his contributions to the theory of the unified weak and electromagnetic interaction between elementary particles.

42. (A) It is speculatively predicted that immediately after the "Big Bang" all of the fundamental forces of nature were unified and that $\sim 10^{-43}$ s later the gravitational force "condenses out" from the other still unified fundamental forces (as described by the grand unified theory) in a kind of "phase transition" which begins the grand unified era.

43. (E) The Z boson is the mediator of the electroweak force. The other mediators are: photon (electromagnetic), gluons (nuclear strong) & the hypothetical graviton (gravitational). While the Higgs boson explains the origin of the mass of the other fundamental particles.

44. (E) The liter is not a base SI unit, volume is measured in derived SI units of cubic meters.

45. (B) There are two significant digits, since leading zeros do not count.

46. (E) $9.80\ m/s^2 \times (1\ furlong/201.17\ m) \times (1.2096\times10^6\ s/1\ fortnight)^2 = 7.13\times10^{10}\ furlong/fortnight^2$

47. (D) $t = d/4 = (d+26)/6 \Rightarrow 6d = 4d + 104 \Rightarrow d = 52\ m$

48. (B) $y_{balloon} = y_{pellet} \Rightarrow 12 + 7t = 0 + 30t - 4.9t^2 \Rightarrow t = 4.10\ s\ \&\ 0.598\ s \Rightarrow y = 40.7\ m\ \&\ 16.2\ m$

49. (A) $B = (3.75^2 - 2.50^2)^{1/2} = 2.80\ km\ \&\ \theta = \cos^{-1}(2.50/3.75) = 48.2°\ E\ of\ S$

50. (A) $\tan25° = v_{train}/5 \Rightarrow v_{train} = 5\tan25° = 2.3\ m/s$

51. (C) From the free-body diagram (note: the static friction force will point down the wall) $F_N = F_A \sin40°$ & $F_{frs} = F_A \cos40° - 88.9N \Rightarrow F_{frs} = \mu_s F_N \Rightarrow F_A = 88.9/(\cos40° - \mu_s \sin40°) = 219N$

52. (D) From Newton's 2nd law for the system: $T_2 = (m_1+m_2)a$ & for m_1: $T_1 = m_1a \Rightarrow T_2 = (m_1+m_2)T_1/m_1 \Rightarrow T_1/T_2 = m_1/(m_1+m_2)$

53. (A) Since you are given a period, then this implies that the child is undergoing uniform circular motion then the observer will only measure a centripetal acceleration.

54. (B) $W_{non\text{-}cons} = \Delta E \Rightarrow -800 = 3(9.80)100 - \frac{1}{2}(3)v^2 \Rightarrow v = 49.93\ m/s\ \&\ \frac{1}{2}mv^2 = mgh \Rightarrow h = v^2/(2g) = (49.93)^2/(2\cdot9.80) = 127\ m$

55. (D) $v = (2\cdot9.80\cdot1.8)^{1/2} = 5.94\ m/s \Rightarrow \Delta\mathbf{p} = 0 - (0.035)\cdot(-5.94) = 0.208\ kg\cdot m/s\ (\Sigma\mathbf{F})_{avg} = 0.208/0.25 = 0.832\ N \Rightarrow (F_N)_{avg} = (\Sigma F)_{avg} + F_G = 0.832 + 0.343 = 1.2\ N$

56. (A) From conservation of mechanical energy: $\frac{1}{2}mv_0^2 + \frac{1}{2}I\omega_0^2 = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 + mgh$, with $v=r\omega$ & $I = (2/5)mr^2 \Rightarrow (7/10)\cdot(3.5)^2 = (7/10)v^2 + (9.80)0.76 \Rightarrow v = 1.27\ m/s$

57. (B) # electrons $= 2.4\times10^{-6}/1.6\times10^{-19} = 1.5\times10^{13}$ removed to make the dollar positively charged

58. (B) $\Phi_E = Q_{enclosed}/\varepsilon_0 = 2.0\times10^{-6}/8.85\times10^{-12} = 2.3\times10^5\ N\cdot m^2/C$

59. (B) $\Sigma V = k(+9q)/d + k(-8q)/d + kQ/(d/2^{1/2}) = 0 \Rightarrow q + 2^{1/2}Q = 0 \Rightarrow Q = -q/2^{1/2} = -2^{1/2}q/2$

60. (D) By Newton's 3rd law the forces will be equal in magnitude and opposite in direction and since the currents are in opposite directions the force on the wires will be repulsive.