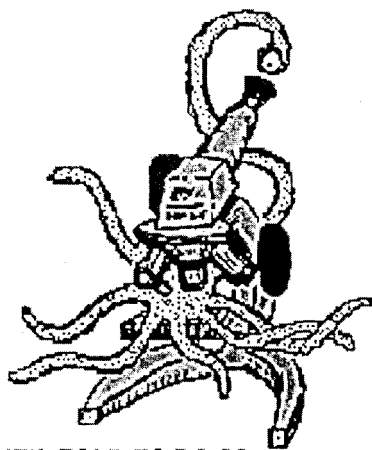


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GENERAL DIRECTIONS:

- 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. A simple scientific calculator with scientific and degree/radian capability is sufficient for the contest. Graphing calculators that do not have built-in or stored functionality that provides scientific information are allowed. Small hand-held computers are not permitted. Each contestant may bring one spare calculator. 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

Biology Questions (1 – 20)

1. All living things do all of the following except _____.
 - A) use energy
 - B) contain DNA
 - C) contain one or more cells
 - D) move around
 - E) make proteins
2. Which is a protein?
 - A) DNA
 - B) starch
 - C) hemoglobin
 - D) cholesterol
 - E) ATP
3. Which is/are characteristically produced by meiosis?
 - A) One cell which is identical to the original cell.
 - B) Two cells, each of which has the identical genetic composition.
 - C) Four cells, each of which has the identical genetic composition.
 - D) Two cells, each of which has a different genetic composition.
 - E) Four cells, each of which has a different genetic composition.
4. A physical characteristic which occurs in none of the children of a couple, but in one of the parents is most likely _____.
 - A) caused by a dominant gene
 - B) caused by a recessive gene
 - C) caused by polygenic inheritance
 - D) caused by an X-linked gene
 - E) not an inherited characteristic
5. The genetic code is made up of units containing ____ nucleotides.
 - A) 1
 - B) 2
 - C) 3
 - D) 4
 - E) 5
6. Smallpox is caused by a(n) _____.
 - A) animal
 - B) bacterium
 - C) fungus
 - D) parasitic plant
 - E) virus
7. Which is NOT a protist?
 - A) yeast
 - B) algae
 - C) paramecium
 - D) amoeba
 - E) seaweed
8. The animal phylum that contains the largest number of species is _____.
 - A) Annelida
 - B) Arthropoda
 - C) Chordata
 - D) Mollusca
 - E) Nematoda
9. The dividing cells at the tip of a plant root are protected by a(n) _____.
 - A) apical meristem
 - B) radicle
 - C) root hairs
 - D) root cap
 - E) none of the above
10. In seed plants, eggs are produced within the _____.
 - A) stigma
 - B) ovary
 - C) polar nuclei
 - D) anther
 - E) receptacle
11. Plants store carbohydrates in the form of _____.
 - A) cellulose
 - B) sucrose
 - C) starch
 - D) fats
 - E) glucose

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12. Storage of energy-containing compounds for nearly immediate use occurs in the ____.
- A) pancreas
 - B) small intestines
 - C) spleen
 - D) muscles
 - E) skeleton
13. Which have walls across which CO₂ readily moves?
- A) bronchioles and arterioles
 - B) bronchi and capillaries
 - C) alveoli and capillaries
 - D) bronchi and venules
 - E) alveoli and arterioles
14. Which transport(s) nearly all of the oxygen inside our bodies?
- A) red blood cells
 - B) white blood cells
 - C) hormones
 - D) water in the blood
 - E) lymphatic fluid
15. Which carry out functions of the immune system?
- A) red blood cells
 - B) white blood cells
 - C) platelets
 - D) both B and C above
 - E) A, B, and C above
16. The exocrine gland that contains patches of endocrine cells is the ____.
- A) adrenal cortex
 - B) liver
 - C) thymus
 - D) pancreas
 - E) small intestines
17. Which transmits signals from receptor cells towards the central nervous system?
- A) effector neuron
 - B) interneuron
 - C) motor neuron
 - D) sensory neuron
 - E) glial cell
18. Which is not a factor in natural selection?
- A) struggle for existence
 - B) inherited variation
 - C) inheritance of acquired characteristics
 - D) overproduction of offspring
 - E) survival of the best adapted
19. The relationship between an insect and the plants it pollinates is best described as ____.
- A) mutualism
 - B) competition
 - C) parasitism
 - D) commensalism
 - E) dependency
20. Which includes all of the others?
- A) ecosystem
 - B) biosphere
 - C) community
 - D) individual
 - E) population
- Chemistry Questions (21 – 40)**
21. 0.0003140 kilograms is ____ ounces. The non-SI units conversion factors are 1 pound per 453.6 grams and 16 ounces per pound.
- A) 1.11×10^{-2}
 - B) 1.108×10^{-2}
 - C) 1×10^{-2}
 - D) 1.1×10^{-2}
 - E) 1.1076×10^{-2}
22. In a chemical change, ____.
- A) the products are different substances from the starting materials
 - B) the original material can never be regenerated
 - C) a phase change never occurs
 - D) a phase change must occur
 - E) the process is not reversible

23. What quantity of energy (in calories) is required to heat a piece of gold weighing 1.3 g from 25°C to 46°C? (4.18 J/cal)?
The specific heat capacity of Au = 0.131 J/g°C.
- A) -3.6 cal
B) 3.6 cal
C) 15 cal
D) .86 cal
E) 2.3 cal
24. The symbol for the element antimony is ____.
- A) At
B) Sb
C) Al
D) An
E) Sn
25. The molecular weight of dichloromethane is ____.
- A) 42.5 g/mole
B) 5 g/mole
C) 48.5 g/mole
D) 96.9 g/mole
E) 84.9 g/mole
26. On a weight basis, a compound is 39.1% carbon, 52.2% oxygen and the rest is hydrogen. What is the empirical formula?
- A) C₂H₆O₂
B) CH₂O
C) C₃H₆O₂
D) C₂H₄O₂
E) C₃H₈O₃
27. How many grams of NaCl are required to prepare 350. mL of a 0.250 M solution of sodium chloride?
- A) 87.5 g
B) 41.7 g
C) 14.6 g
D) 8.75 g
E) 5.12 g
28. In a mixture containing multiple components, the number of moles of one of the components divided by the sum of the number of moles of all components is ____.
- A) none of the other answers
B) the mole fraction
C) the partial pressure
D) Raoult's Law
E) Dalton's Law
29. How many calcium atoms in a formula unit of calcium hydrogen carbonate?
- A) 3
B) 1
C) 2
D) 5
E) 4
30. Balance the following equation with the smallest whole number coefficients possible.
FeCl₃ + NH₃ + H₂O → Fe(OH)₃ + NH₄Cl
The sum of the coefficients in the balanced equation is ____.
- A) 15
B) 12
C) 10
D) 5
E) 11
31. When AgNO₃(aq) and CaCl₂(aq) are mixed together, the precipitate that forms is ____.
- A) AgCl₂
B) AgNO₃
C) Ca(NO₃)₂
D) AgCl
E) CaNO₃
32. Consider the reaction:
2 CH₄(g) + 3 O₂(g) + 2 NH₃(g) → 2 HCN(g) + 6 H₂O(g)
If 128 g each of NH₃ and CH₄ and an excess of O₂ are reacted, what mass of HCN can be produced?
- A) 203 g HCN
B) cannot be determined from information given
C) 216 g HCN
D) 419 g HCN
E) 610 g HCN

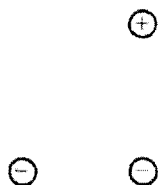
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33. The isotope that has 35 protons, 35 electrons, and 46 neutrons is ____.
- A) ${}_{46}^{81}\text{Pd}$
 B) ${}_{35}^{46}\text{Br}$
 C) ${}_{35}^{81}\text{Br}$
 D) ${}_{46}^{35}\text{Pd}$
 E) ${}_{46}^{81}\text{Br}$
34. In a given atom, how many electrons can occupy the 3d set of orbitals?
- A) 3
 B) 10
 C) 5
 D) 6
 E) 2
35. 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) vanadium
 B) cobalt
 C) argon
 D) The element cannot be identified from the information given.
 E) phosphorus
36. In the hydrogen chloride molecule, the atoms are held together by a/an ____.
- A) double bond
 B) nonpolar bond
 C) ionic bond
 D) none of these
 E) polar covalent bond
37. A 6.35 L sample of a gas is collected at 55°C and 0.892 atm. What volume will the gas occupy at 1.05 atm and 20°C ?
- A) 1.96 L
 B) 6.68 L
 C) 5.46 L
 D) 6.10 L
 E) 4.82 L
38. Consider the substances CaCl_2 , Br_2 , N_2 , Cl_2 , and H_2O . The order of increasing boiling points of these substances is ____.
- A) N_2 , Cl_2 , Br_2 , H_2O , CaCl_2
 B) CaCl_2 , N_2 , Br_2 , H_2O , Cl_2
 C) CaCl_2 , H_2O , N_2 , Cl_2 , Br_2
 D) Cl_2 , N_2 , H_2O , Br_2 , CaCl_2
 E) CaCl_2 , N_2 , H_2O , Br_2 , Cl_2
39. Glycerol, a non-electrolyte that can be used as antifreeze, has a density of 1.261 g/mL and a molecular weight of 92 g. If 100 mL of glycerol are mixed with 1 kg of water, at what temperature will this solution will freeze? For water, $k_f = 1.861^\circ\text{C}/\text{molality}$
- A) 0.0°C
 B) -12.4°C
 C) -2.6°C
 D) -4.8°C
 E) -0.23°C
40. Consider the following reaction:
 $\text{H}_2(\text{g}) + \text{CO}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{g}) + \text{CO}(\text{g})$
 ΔH_f° for $\text{CO}_2(\text{g}) = -22.5 \text{ kJ/mole}$
 ΔH_f° for $\text{CO}(\text{g}) = -6.3 \text{ kJ/mole}$
 ΔH_f° for $\text{H}_2\text{O}(\text{g}) = -13.8 \text{ kJ/mole}$
- A) ΔH of the reaction is zero.
 B) The reaction is exergonic.
 C) ΔH of the reaction is negative.
 D) ΔH of the reaction is positive.
 E) There is not enough information provided to answer the question.

Physics Questions (41 – 60)

41. The Second Law of Thermodynamics says
- A) Heat may never flow from an object to a warmer one.
 B) Entropy will tend to increase in an isolated system.
 C) Entropy and temperature are equivalent.
 D) Heat and energy are equivalent.
 E) Heat and entropy are equivalent.

42. A positively charged particle is fixed in place. The left negatively charged particle is also fixed in place below and to the left of the first charge. The right negatively charged particle is put down so the three particles form a right triangle as shown. Which way will the right negatively charged particle move when it is released?



- A) Down and to the left
 B) Down and to the right
 C) Up and to the left
 D) Up and to the right
 E) Directly to the left

43. Ann and Betsy are running on a straight track. They start at the same time, $T = 0$, and at position $X = 0$. Ann runs at a steady 3.00 m/s . Betsy starts running at 4.00 m/s , but after running 1.000 km , continues at a steady 2.00 m/s . At what distance from the starting point does Ann catch up with Betsy?

- A) $X = 1500 \text{ m}$
 B) $X = 2000 \text{ m}$
 C) $X = 2500 \text{ m}$
 D) $X = 3000 \text{ m}$
 E) $X = 3500 \text{ m}$

44. The non-rotating planet Coth has a radius of $R = 1000 \text{ km}$ and is a perfect sphere. Its surface gravity is exactly $1/5$ that of Earth's. Suppose an object of mass $m = 2.00 \text{ kg}$ is weighed on a train moving along the equator at $V = 1.00 \text{ km/s}$. What would its weight be?

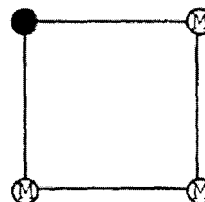
- A) zero
 B) 0.5 N
 C) 1.0 N
 D) 1.5 N
 E) 2.0 N

45. A uniform cable of total mass $m = 145 \text{ kg}$ is suspended between two walls. The points of suspension are at the same height, and the cable makes an angle $\theta = 42^\circ$ with the wall on each side. What is the tension T in the cable at the point where it meets the wall?



- A) 761 N
 B) 957 N
 C) 1138 N
 D) 1630 N
 E) 2701 N

46. Three point masses are at corners of a rigid square framework; the masses of the frame rods may be neglected. This object may rotate about a vertical axis through the fourth corner (on the upper left). The masses are each $M = 2.45 \text{ kg}$, and the square is 0.333 m on a side. What is the moment of inertia I about the axis?



- A) $0.543 \text{ kg}\cdot\text{m}^2$
 B) $0.815 \text{ kg}\cdot\text{m}^2$
 C) $1.087 \text{ kg}\cdot\text{m}^2$
 D) $1.630 \text{ kg}\cdot\text{m}^2$
 E) $2.173 \text{ kg}\cdot\text{m}^2$

47. Marie Curie is best known as a French physicist, but she was born in _____.

- A) England
 B) The United States
 C) Germany
 D) Poland
 E) Spain

48. A rectangular solid made of wood is square in shape. The square faces measure 6.00 cm on a side; it is 2.00 cm thick; its mass is $M = 0.75$ kg. It is lying on the ground, a square side down. How much work does it take to tilt it upward until it is resting on one of its narrow sides?

- A) 0.15 J
- B) 1.36 J
- C) 4.98 J
- D) 10.3 J
- E) 17.1 J

49. Two objects are approaching each other on a straight, horizontal, frictionless track. Just before collision, one, of mass 3.78 kg, is moving to the right with speed 2.78 m/s. The other, of mass 3.99 kg, is moving to the left with speed 3.66 m/s. After collision, the two stick together. What is the velocity of the two stuck-together objects?

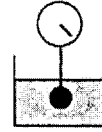
- A) 3.23 m/s to the right
- B) 2.01 m/s to the right
- C) zero
- D) 0.53 m/s to the left
- E) 2.91 m/s to the left

50. Three identical blocks of wood, each having mass M , are on a level table. They are being pulled to the right by a rope with tension T , and the acceleration is zero. What are the tensions U and V in the ropes joining the blocks?



- A) $U=V=T$
- B) $U=2T, V=3T$
- C) $U=3T/4, V=2T/3$
- D) $U=2T/3, V=T/3$
- E) Can't tell without knowing the coefficient of kinetic friction μ .

51. A rock of weight 26.6 N is dangling from the end of a spring scale in a pool of alcohol, the rock being completely submerged. The scale reads 17.8 N. What is the density ρ_r of the rock compared to ρ_a the density of alcohol?

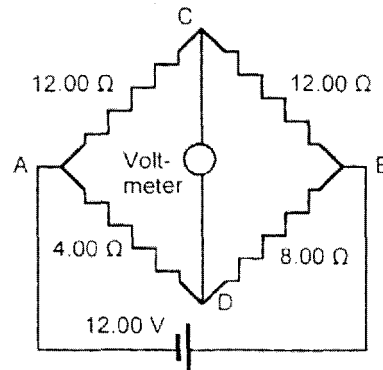


- A) $\rho_r = 2.2\rho_a$
- B) $\rho_r = 3.0\rho_a$
- C) $\rho_r = 4.1\rho_a$
- D) $\rho_r = 6.3\rho_a$
- E) $\rho_r = 8.8\rho_a$

52. Sam is driving at speed $V = 58.312$ km/hour when he comes to a hill. At this point the flat road angles upward at 6.22° . He takes his foot off the accelerator and coasts to the top of the hill. Just as he reaches the top he comes to a halt. Assuming that friction is irrelevant, how high is the hill?

- A) 13.4 m
- B) 11.0 m
- C) 9.3 m
- D) 7.9 m
- E) Can't tell without knowing the total mass of the car.

53. In the circuit shown below, what does the voltmeter read?



- A) Zero
- B) 2.00 V
- C) 4.00 V
- D) 6.00 V
- E) 8.00 V

54. A jet plane is flying horizontally directly overhead at speed Mach 4.43 at a height $H = 534$ m. It is a very cold day. How far from you in horizontal distance D will it be when you hear the sonic boom? Assume that the speed of sound at all altitudes is the same as at the Earth's surface.
- A) 1.662 km
 B) 1.906 km
 C) 2.366 km
 D) 4.925 km
 E) Can't tell without knowing the value of the speed of sound c_s .
55. John and Mary are twins. At birth, Mary is put on a rocket ship and travels to a star 10 light-years away at 50% of the speed of light c , where she waits for her brother. At birth, John is put on a ship to the same star but travels at 25% of c . When he arrives, they meet; who is younger and by how much?
- A) Mary is older by 2.52 years.
 B) Mary is older by 1.41 years.
 C) John and Mary are the same age.
 D) John is older by 1.41 years.
 E) John is older by 2.42 years.
56. An object is moving with speed 7.29 m/s. The x -, y -, and z - components of its velocity all have the same numerical value, but the x -component is negative and the y - and z -components are positive. Which of the following is the numerical value?
- A) 1.91 m/s
 B) 2.43 m/s
 C) 3.43 m/s
 D) 4.21 m/s
 E) 5.99 m/s
57. Which of the following is not a vector?
- A) Velocity
 B) Force
 C) Relative position
 D) Inertia
 E) Acceleration
58. A jeweler has a spring scale with a platform mass of 46.86 g. When a gem of mass 2.11 g is dropped on the scale, it oscillates up and down with a period of 3.81294 s. He stops the oscillation, removes the gem and places another gem on the scale. With the second gem, the period of oscillation is 3.80127 s. What is the mass of the second gem?
- A) 1.40 g
 B) 1.62 g
 C) 1.81 g
 D) 1.96 g
 E) 2.30 g
59. The kilogram (kg) is the SI unit of mass. To express the mass of a small object, one might want to use the unit μkg , but this is not a proper use of SI units. Instead, a μkg should be written as ____.
- A) mg
 B) ng
 C) $(k+\mu)\text{g}$
 D) g
 E) cg
60. A uniformly thick elliptical plate has a coefficient of linear expansion equal to $12 \times 10^{-6}(\text{C})^{-1}$. It has a square hole in it at its geometrical center. When the plate is uniformly cooled, what happens to the hole?



- A) The hole will become elongated and will generally enlarge.
 B) The hole will become uniformly larger.
 C) The hole will become elongated and will become flatter, but its area will remain the same.
 D) The hole will become uniformly smaller.
 E) The hole will become flatter and will generally shrink.

UIL HIGH SCHOOL SCIENCE CONTEST
ANSWER KEY

INVITATIONAL B • 2007

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