

**TMSCA HIGH SCHOOL  
SCIENCE  
TEST #2 ©  
OCTOBER 28, 2017**

**GENERAL DIRECTIONS**

1. DO NOT OPEN EXAM UNTIL TOLD TO DO SO.
  2. You will be given 120 minutes to take this test.
  2. All answers must be written on the answer sheet/Scantron form/Chatsworth card provided. If you are using an answer sheet, be sure to use **CAPITAL BLOCK PRINTED LETTERS**.
  3. If using a Scantron answer form, be sure to correctly denote the number of problems not attempted.
  4. You may write anywhere on the test itself. You must write only answers on the answer sheet.
  5. You may use additional scratch paper provided by the contest director.
  6. All problems have **ONE** and **ONLY ONE** correct (BEST) answer. There is a penalty for all incorrect answers.
  7. On the back of this page is a copy of the periodic table of the elements as well as a list of some potentially useful information in answering the questions. Other scientific relationships are listed also.
  8. The following is a list of UIL approved calculators for this test:
    - **Casio FX-260 Solar**
    - **Sharp EL-501X**
    - **TI-30Xa**
- Only the models listed above are allowed during the contest. NO GRAPHING CALCULATORS.**
9. All problems answered correctly are worth **SIX** points. **TWO** points will be deducted for all problems answered incorrectly. No points will be added or subtracted for problems not answered.
  10. In case of ties, percent accuracy will be used as a tie breaker.
  11. If a question is omitted, no points are given or subtracted.

B01. Which of the following macromolecules is composed of amino acids?

- A) proteins
- B) polysaccharides
- C) nucleic acids
- D) triglycerides
- E) starch

B02. Which enzyme is used to add the appropriate nucleotides using the base pairing rules during DNA replication?

- A) RNA polymerase
- B) helicase
- C) topoisomerase
- D) DNA polymerase
- E) ligase

B03. Which of the following cellular organelles contains the enzyme catalase which converts  $H_2O_2$  to  $H_2O$  and  $O_2$ ?

- A) peroxisome
- B) lysosome
- C) Golgi apparatus
- D) nucleolus
- E) ribosome

B04. Which functional group is always found on the five prime end of nucleic acids?

- A) amino
- B) phosphate
- C) carboxyl
- D) carbonyl
- E) hydroxyl

B05. The primary structure of a protein would best be described as...

- A) the amino acid sequence of the active site
- B) when more than one polypeptide makes up a functional protein
- C) the interaction of R groups between adjacent amino acids
- D) the folding of a polypeptide to create beta pleated sheets and alpha helices
- E) the order of amino acids

B06. Which part of cellular respiration produces the majority of the  $CO_2$  released into the lungs of vertebrates?

- A) fermentation
- B) glycolysis
- C) Krebs cycle
- D) electron transport chain
- E) Calvin cycle

B07. Choose the structures cut out of primary transcripts during RNA processing.

- A) poly A tail
- B) RNA primer
- C) exons
- D) introns
- E) five prime cap

B08. What does the **Polymerase Chain Reaction** actually do?

- A) determines a DNA fingerprint
- B) produces thousands of copies of DNA
- C) determines the optimum pH of an enzyme
- D) determines nucleotide sequence
- E) creates a phylogenetic tree

B09. Which of the following hypotheses was Lamarck most famous for?

- A) natural selection
- B) Genetic drift
- C) sexual selection
- D) parsimony
- E) inheritance of acquired characteristics

B10. Choose the level of biological organization that includes all of the others?

- A) species
- B) genus
- C) family
- D) order
- E) phylum
- F) class

B11. Which of the following floral organs produces pollen?

- A) pedals
- B) sepals
- C) carpel
- D) stigma
- E) stamen

B12. Which of the following would be found in both a mushroom and a cricket?

- A) cell wall
- B) thorax
- C) chitin
- D) hyphae
- E) chloroplasts

B13. Choose the organ system that includes the thyroid, pancreas and adrenal glands

- A) endocrine
- B) circulatory
- C) lymphatic
- D) excretory
- E) digestive

B14. Which vitamin would a veterinarian most likely suggest adding to a pet's diet if the pet is having trouble with bone calcification?

- A) vitamin C
- B) vitamin B
- C) vitamin A
- D) vitamin E
- E) vitamin D

B15. Which of the following blood vessels would have the smallest diameter?

- A) arteries
- B) veins
- C) venules
- D) capillaries
- E) arterioles

B16. During which phase of the cell cycle are chromosomes lined up in the center of the cell?

- A) prophase
- B) metaphase
- C) anaphase
- D) telophase
- E) interphase

B17. Choose the biological process that produces sugars as the final product.

- A) cellular respiration
- B) fermentation
- C) carbon fixation
- D) Krebs cycle
- E) chemiosmosis

B18. What percentage of the air in the troposphere is composed of oxygen?

- A) 99%
- B) < 1%
- C) 20%
- D) 80%
- E) 50%

B19. Similar species are able to coexist in a community due to what important biological concept?

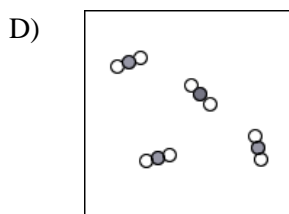
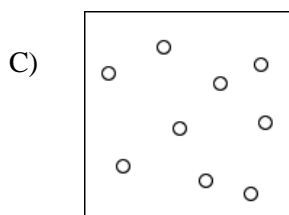
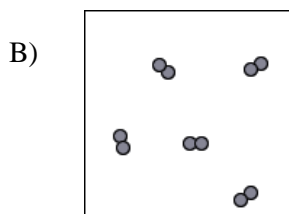
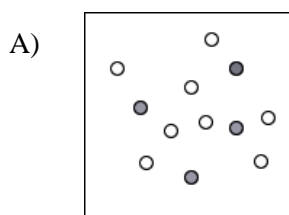
- A) ecological succession
- B) Gause's law
- C) genetic drift
- D) resource partitioning
- E) K selection

B20. What important membrane component helps produce the resting potential of a neuron?

- A) simple diffusion
- B) sodium-potassium pump
- C) cotransport
- D) cholesterol
- E) glycoproteins

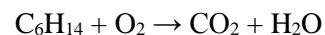
- C01. At the same temperature and pressure, which of the following gases has the greatest density?
- CO<sub>2</sub>
  - NH<sub>3</sub>
  - O<sub>2</sub>
  - N<sub>2</sub>
  - At the same temperature and pressure, all of the gases have the same density.

- C02. Which of the following figures represents a chemical compound?



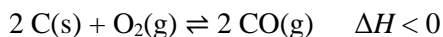
- E) both B and C

- C03. When the following equation is balanced with lowest possible integers, the sum of the coefficients of the reactants is equal to \_\_\_\_.



- 24
  - 21
  - 16
  - 12
  - 9
- C04. A crystalline substance is a solid at room temperature and soluble in water. The resulting solution is not electrically conductive. The substance is most likely \_\_\_\_\_.
- non-polar molecular
  - polar molecular
  - ionic
  - metallic
  - network covalent
- C05. What is the concentration of chloride ions when 10.8 grams of calcium chloride is dissolved into 355 mL of solution?
- 0.274 M
  - 0.402 M
  - 0.548 M
  - 0.623 M
  - 0.804 M
- C06. Which of the following bonds has the greatest covalent character?
- Cl – Cl
  - H – Cl
  - Be – Cl
  - N – Cl
  - Na – Cl
- C07. What is the formula of cobalt (II) sulfate?
- CoSO<sub>4</sub>
  - Co<sub>2</sub>SO<sub>4</sub>
  - CoSO<sub>3</sub>
  - Co(SO<sub>3</sub>)<sub>2</sub>
  - Co(SO<sub>4</sub>)<sub>2</sub>

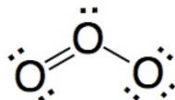
- C08. Some carbon and oxygen are placed into a sealed container and the system reaches the following equilibrium:



Which of the following will increase the equilibrium concentration of CO in the container.

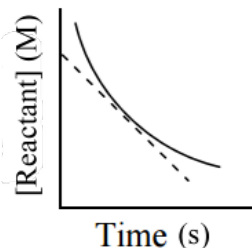
- A) increasing the mass of carbon  
 B) adding He(g) into the container  
 C) raising the temperature  
 D) lowering the temperature  
 E) more than one of the choices above are correct

- C09. In the following Lewis structure of ozone, what is the formal charge of the central oxygen?



- A) -1  
 B) -2  
 C) 0  
 D) +2  
 E) +1
- C10. The pH of pure water is 6.63 at 50°C. What is the value of  $K_w$  at 50°C?
- A)  $4.6 \times 10^{-15}$   
 B)  $1.0 \times 10^{-14}$   
 C)  $2.3 \times 10^{-14}$   
 D)  $3.6 \times 10^{-13}$   
 E)  $5.5 \times 10^{-14}$

- C11. The diagram below shows the concentration of a reactant as a function of time. What does the dashed line represent?

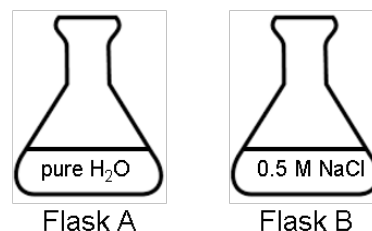


- A) equilibrium constant  
 B) average rate  
 C) activation energy  
 D) instantaneous rate  
 E) rate constant

- C12. Complete combustion of 20.0 grams of a compound containing only carbon, hydrogen and oxygen produces 40.9 grams of  $\text{CO}_2$  and 12.6 grams of  $\text{H}_2\text{O}$ . What is the empirical formula of the compound?

- A)  $\text{CH}_2\text{O}$   
 B)  $\text{C}_2\text{H}_3\text{O}$   
 C)  $\text{C}_2\text{H}_2\text{O}$   
 D)  $\text{C}_3\text{H}_4\text{O}_2$   
 E)  $\text{CH}_2\text{O}_2$

- C13. Consider the following:



Both flasks are at 25°C. Which of the following statements is correct?

- A) Flask A has the higher boiling point and the higher vapor pressure.  
 B) Flask A has the higher boiling point, flask B has the higher vapor pressure.  
 C) Flask B has the higher boiling point, flask A has the higher vapor pressure  
 D) Flask B has the higher boiling point and the higher vapor pressure.  
 E) The two flasks has the same temperature and vapor pressure.

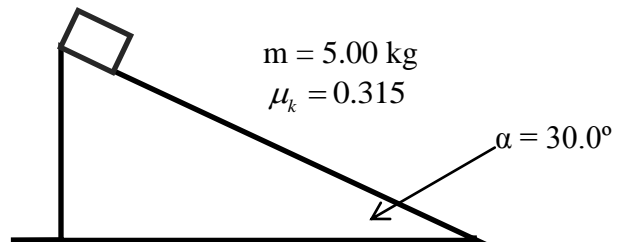
- C14. Aluminum can be obtained by the electrolysis of molten  $\text{AlCl}_3$ . How long (in minutes) is needed to obtain 25.0 grams of aluminum with this process using a current of 3.5 amperes?

- A) 7.09 hrs  
 B) 17.5 hrs  
 C) 21.3 hrs  
 D) 28.6 hrs  
 E) 52.1 hrs

- C15. A 250.0 mL portion of 0.500 M  $\text{Pb}(\text{NO}_3)_2$  solution is added to 150.0 mL portion of 1.00 M KI solution. The precipitate is filtered and dried. What is the maximum mass of the precipitate that can be produced?
- A) 576 g  
B) 128 g  
C) 346 g  
D) 218 g  
E) 286 g
- C16. Anthony's chemistry teacher, Mrs. Boyd instructs him to collect  $3.71 \times 10^{22}$  silver atoms. The only source of the silver is solid  $\text{AgNO}_3$ . How many grams of  $\text{AgNO}_3$  does Anthony need?
- A) 10.5 g  
B) 12.6 g  
C) 14.7 g  
D) 15.2 g  
E) 0.0567 g
- C17. The first ionization energy of oxygen is smaller than the first ionization energy of nitrogen. What is the best explanation of this?
- A) The electron ionized from oxygen experience smaller nuclear attraction than the electron ionized from nitrogen  
B) The electron ionized from oxygen experience greater electron repulsion than the electron ionized from nitrogen  
C) The electron ionized from oxygen is in a lower energy level than the electron ionized from nitrogen  
D) Oxygen has a larger electronegativity than nitrogen  
E) Oxygen has a smaller atomic radius than nitrogen
- C18. How many of the following are chemical changes?
- Sublimation of solid  $\text{CO}_2$
  - Acid neutralize base
  - Water boiling
  - Formation of precipitate
- A) 0  
B) 1  
C) 2  
D) 3  
E) 4
- C19. Using the table of average bond energies, approximate the enthalpy of combustion of methane.
- A)  $-426 \frac{\text{kJ}}{\text{mol}}$   
B)  $-498 \frac{\text{kJ}}{\text{mol}}$   
C)  $-625 \frac{\text{kJ}}{\text{mol}}$   
D)  $-713 \frac{\text{kJ}}{\text{mol}}$   
E)  $-806 \frac{\text{kJ}}{\text{mol}}$
- C20. A 2.50 L sealed container is filled with 3.10 g of  $\text{N}_2$  and 4.95 g of He. The total pressure in the container is 10.5 atm. What is the temperature inside the container?
- A) 32 °C  
B) 24 °C  
C) 18 °C  
D) -12 °C  
E) -36 °C

- P1. According to Neil deGrasse Tyson, \_\_\_\_\_ was the first and only element in the Periodic Table to be discovered someplace other than Earth.
- Antimony
  - Krypton
  - Helium
  - Palladium
  - Xenon
- P2. According to Neil deGrasse Tyson, this Belgian physicist and priest is generally recognized as the “father” of big bang cosmology.
- Jozef Devreese
  - Leon Van Hove
  - Jean Bricmont
  - Georges Lemaitre
  - Marc Henneaux
- P3. According to Neil deGrasse Tyson, the nearest galaxy larger than our own is two million light years away. This spiral galaxy, historically dubbed \_\_\_\_\_, is a somewhat more massive and luminous twin of the Milky Way.
- the Great Nebula in Andromeda
  - the Whirlpool Galaxy
  - the Sombrero Galaxy
  - Messier 109
  - Cosmos Redshift 7
- P4. \_\_\_\_\_ is the largest moon of Saturn. It was discovered in 1655 by Christiaan Huygens. It is the only moon with a dense atmosphere. It is the only solar system body besides Earth in which there is clear evidence of stable bodies of surface liquid.
- Ganymede
  - Tethys
  - Europa
  - Rhea
  - Titan
- P5. One million meters is equal to one \_\_\_\_\_.
- gigameter
  - megameter
  - terameter
  - kilometer
  - petameter

- P6. A projectile is launched from the roof of a 28.4-m-tall building at a speed of 33.5 m/s and at an angle of  $52.4^\circ$  above the horizontal. How long does it take the projectile to reach the ground?
- 5.89 s
  - 6.11 s
  - 6.33 s
  - 6.55 s
  - 6.77 s

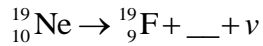


- P7. A wooden block is placed at the top of an inclined plane and released. The block travels 3.20 m down the incline to the lower end. How fast is the block traveling just as it reaches the lower end?
- 3.05 m/s
  - 3.23 m/s
  - 3.41 m/s
  - 3.59 m/s
  - 3.77 m/s
- P8. A 5.25 kg rifle fires a 0.055 kg bullet at a speed of 150 m/s. What is the recoil velocity of the rifle?
- 1.46 m/s
  - 1.57 m/s
  - 1.68 m/s
  - 1.79 m/s
  - 1.90 m/s
- P9. The platter of the hard disk on a computer rotates at 6000 rpm. If the reading head of the drive is located 4.00 cm from the rotation axis, what is the linear speed of a point on the disk directly below the reading head?
- 18.8 m/s
  - 20.9 m/s
  - 23.0 m/s
  - 25.1 m/s
  - 27.2 m/s

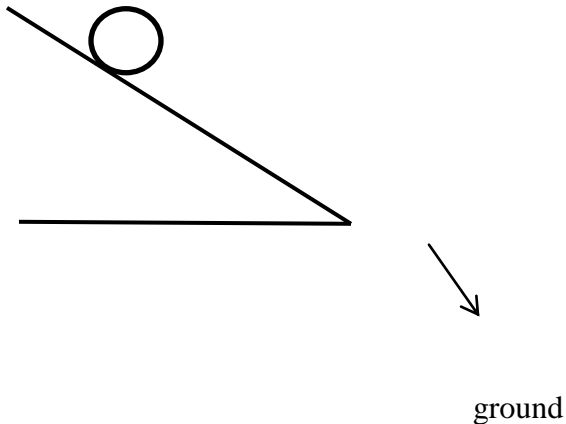


- P10. The frequency of a police car siren at rest is 1800 Hz. The police car is traveling at a speed of 36.2 m/s due north as Kunal is driving his Honda Civic away from the police car at a speed of 41.5 m/s due south. What is the frequency of the sound detected by Kunal if the air temperature is 20.0°C?
- A) 1670 Hz  
B) 1610 Hz  
C) 1550 Hz  
D) 1490 Hz  
E) 1430 Hz
- P11. Nicholas was hunting for wild pigs near Lampasas when an errant shot hit a cylindrically shaped water tank, near the bottom of the tank. If the bullet made a hole 8.66 m below the top surface of the water in the tank, how fast will the water initially flow out of the hole?
- A) 12.1 m/s  
B) 13.0 m/s  
C) 13.9 m/s  
D) 14.8 m/s  
E) 15.7 m/s
- P12. Jack has a circuit with three resistors connected in series. Their respective resistances are 6.00  $\Omega$ , 9.00  $\Omega$  and 15.0  $\Omega$ . If he connects this arrangement to a 12.0-V battery, what is the voltage drop across the 9.00- $\Omega$  resistor?
- A) 7.20 V  
B) 6.00 V  
C) 4.80 V  
D) 3.60 V  
E) 2.40 V
- P13. A particle with a charge of 12.0  $\mu\text{C}$  is located on the x-axis at  $x = 24.4$  cm. A second particle with a charge of 3.66  $\mu\text{C}$  is located on the x-axis at  $x = 58.8$  cm. What is the magnitude of the electric field at a point on the x-axis where  $x = 40.0$  cm?
- A) 3,500,000 N/C  
B) 3,710,000 N/C  
C) 3,920,000 N/C  
D) 4,130,000 N/C  
E) 4,340,000 N/C
- P14. An electron is traveling horizontally at a speed of 7,250,000 m/s when it enters a region in which there is a 2.47-T magnetic field that is oriented vertically upward. The electron begins to travel in a circle with a radius of \_\_\_\_\_.
- A) 16.7  $\mu\text{m}$   
B) 288  $\mu\text{m}$   
C) 3.44 mm  
D) 49.5 mm  
E) 612 mm
- P15. A circular conducting loop has a radius of 3.22 cm and the plane of the loop is fixed perpendicular to a magnetic field that changed from 0.225 T to 3.69 T in 0.00345 s. Find the magnitude of the induced emf.
- A) 2.11 V  
B) 2.40 V  
C) 2.69 V  
D) 2.98 V  
E) 3.27 V
- P16. A 2.00-in-tall candle is positioned 32.0 cm from a concave mirror. The radius of curvature of the mirror is 24.0 cm. Find the magnitude of the height of the image.
- A) 2.40 in  
B) 2.00 in  
C) 1.60 in  
D) 1.20 in  
E) 0.800 in
- P17. A space ship is launched from the surface of Planet X and it travels directly away from the planet at a speed of 0.600c relative to the planet. The ship fires a missile that also travels directly away from the planet at a speed of 0.500c relative to the ship. What is the speed of the missile relative to an observer at the launch site on Planet X? ( $c$  = speed of light)
- A) 0.846c  
B) 0.888c  
C) 0.942c  
D) 1.00c  
E) 1.10c

P18. Complete the beta decay reaction.



- A)  $e^-$
- B)  ${}^4_2\text{He}$
- C)  $e^+$
- D)  $\gamma$
- E)  ${}^1_1\text{H}$



P19. A solid ball with a radius of 15.6 cm and a mass of 1.22 kg is released from rest and rolls without slipping down the roof of a house as shown. It reaches the end of the roof and falls to the ground below. The roof makes an angle of  $28.8^\circ$  with the horizontal and the ball travels 4.32 m down the roof before flying off the end. What is the speed of the ball just as it reaches the end of the roof?

- A) 5.10 m/s
- B) 5.25 m/s
- C) 5.40 m/s
- D) 5.55 m/s
- E) 5.70 m/s

P20. An object is placed at the origin. A converging lens, with a focal length of 24.0 cm, is placed at  $x = 36.0$  cm. A second converging lens, with a focal length of 16.0 cm, is placed at  $x = 126$  cm. Find the location of the final image.

- A)  $x = 320$  cm
- B)  $x = 270$  cm
- C)  $x = 220$  cm
- D)  $x = 170$  cm
- E)  $x = 120$  cm

# 17-18 TMSA HSSC Test #2

Chemistry

										8A 18									
1A 1											3A 13	4A 14	5A 15	6A 16	7A 17	2			
1 H 1.01											5 B 10.81	6 C 12.01	7 N 14.01	8 O 16.00	9 F 19.00	10 Ne 20.18			
3 Li 6.94	4 Be 9.01											13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95		
11 Na 22.99	12 Mg 24.31	3B 3	4B 4	5B 5	6B 6	7B 7	8B 8 9 10		1B 11	2B 12	31 Ga 69.72	32 Ge 72.64	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80			
19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.87	23 V 50.94	24 Cr 52.00	25 Mn 54.94	26 Fe 55.85	27 Co 58.93	28 Ni 58.69	29 Cu 63.55	30 Zn 65.38	49 In 114.82	50 Sn 118.71	51 Sb 121.76	52 Te 127.60	53 I 126.90	54 Xe 131.29		
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 101.07	45 Rh 102.91	46 Pd 106.42	47 Ag 107.87	48 Cd 112.41	81 Tl 204.38	82 Pb 207.20	83 Bi 208.98	84 Po (209)	85 At (210)	86 Rn (222)		
55 Cs 132.91	56 Ba 137.33	57 La 138.9	72 Hf 178.49	73 Ta 180.95	74 W 183.84	75 Re 186.21	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.97	80 Hg 200.59	113 Nh (286)	114 Fl (289)	115 Mc (289)	116 Lv (293)	117 Ts (293)	118 Og (294)		
87 Fr (223)	88 Ra (226)	89 Ac (227)	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (281)	112 Cn (285)								

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
90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np (237)	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 (262)

## Constants

$R = 0.08206 \text{ L}\cdot\text{atm}/\text{mol}\cdot\text{K}$   
 $R = 8.314 \text{ J}/\text{mol}\cdot\text{K}$   
 $R = 62.36 \text{ L}\cdot\text{torr}/\text{mol}\cdot\text{K}$   
 $e = 1.602 \times 10^{-19} \text{ C}$   
 $N_A = 6.022 \times 10^{23} \text{ mol}^{-1}$   
 $k = 1.38 \times 10^{-23} \text{ J/K}$   
 $h = 6.626 \times 10^{-34} \text{ J}\cdot\text{s}$   
 $c = 3.00 \times 10^8 \text{ m/s}$   
 $\mathcal{R} = 2.178 \times 10^{-18} \text{ J}$   
 $m_e = 9.11 \times 10^{-31} \text{ kg}$

## Water data

$T_{\text{mp}} = 0^\circ\text{C}$   
 $T_{\text{bp}} = 100^\circ\text{C}$   
 $C_{\text{ice}} = 2.09 \text{ J/g K}$   
 $C_{\text{water}} = 4.184 \text{ J/g K}$   
 $C_{\text{steam}} = 2.03 \text{ J/g K}$   
 $\Delta H_{\text{fus}} = 334 \text{ J/g}$   
 $\Delta H_{\text{vap}} = 2260 \text{ J/g}$   
 $K_f = 1.86 \text{ }^\circ\text{C/m}$   
 $K_b = 0.512 \text{ }^\circ\text{C/m}$

## Conversions

$1 \text{ atm} = 760 \text{ torr}$   
 $= 101325 \text{ Pa}$   
 $= 14.7 \text{ psi}$   
 $1 \text{ bar} = 105 \text{ Pa}$   
 $1 \text{ cal} = 4.184 \text{ J}$   
 $1 \text{ L}\cdot\text{atm} = 101.325 \text{ J}$   
 $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$   
 $1 \text{ lb} = 453.6 \text{ g}$   
 $1 \text{ ton} = 2000 \text{ lbs}$   
 $1 \text{ tonne} = 1000 \text{ kg}$   
 $1 \text{ in} = 2.54 \text{ cm}$

## Some Average Bond Energies (kJ/mol)

C-H	413	C-C	346
O-H	463	C-O	358
H-H	436	C=C	602
O=O	498	C=O	799

## Some equilibrium constants

$\text{water} \quad K_w = 1.0 \times 10^{-14}$   
 $\text{CH}_3\text{NH}_2 \quad K_b = 4.4 \times 10^{-4}$   
 $\text{CH}_3\text{CO}_2\text{H} \quad K_a = 1.8 \times 10^{-5}$   
 $\text{NH}_3 \quad K_b = 1.8 \times 10^{-5}$

## PHYSICS

## Useful Constants

quantity	symbol	value
Free-fall acceleration	$g$	$9.80 \text{ m/s}^2$
Coulomb constant	$k$	$8.99 \times 10^9 \text{ N}\cdot\text{m}^2/\text{C}^2$
Electron mass	$m_e$	$9.11 \times 10^{-31} \text{ kg}$
Fundamental charge	$e$	$1.602 \times 10^{-19} \text{ C}$
Speed of light in a vacuum	$c$	$3.00 \times 10^8 \text{ m/s}$
Density of water	$\rho$	$1000 \text{ kg/m}^3$
Permeability of free space	$\mu_0$	$4\pi \times 10^{-7} \text{ T}\cdot\text{m/A}$
Planck's constant	$h$	$6.626 \times 10^{-34} \text{ J}\cdot\text{s}$
Gravitational constant	$G$	$6.67 \times 10^{-11} \text{ N}\cdot\text{m}^2/\text{kg}^2$

2017-2018 TMSCA HSSC TEST #2 KEY

**Biology**

B01. A  
B02. D  
B03. A  
B04. B  
B05. E  
B06. C  
B07. D  
B08. B  
B09. E  
B10. E  
B11. E  
B12. C  
B13. A  
B14. E  
B15. D  
B16. B  
B17. C  
B18. C  
B19. D  
B20. B

**Chemistry**

C01. A  
C02. D  
C03. B  
C04. B  
C05. C  
C06. A  
C07. A  
C08. D  
C09. E  
C10. E  
C11. D  
C12. B  
C13. C  
C14. C  
C15. C  
C16. A  
C17. B  
C18. C  
C19. E  
C20. E

**Physics**

P01. C  
P02. D  
P03. A  
P04. E  
P05. B  
P06. C  
P07. E  
P08. B  
P09. D  
P10. E  
P11. B  
P12. D  
P13. A  
P14. A  
P15. E  
P16. D  
P17. A  
P18. C  
P19. C  
P20. B

## TMSAC Science Test #2

- C01. (A) At the same temperature and pressure, 1 mole of each gas occupies the same volume. Since  $\text{CO}_2$  has the greatest molar mass, it has the greatest density.
- C03. (B) Balanced equation:  $2 \text{C}_6\text{H}_{14} + 19 \text{O}_2 \rightarrow 12 \text{CO}_2 + 14 \text{H}_2\text{O}$
- C04. (B) Solutions of ionic salts are conductive. Non-polar molecular, metals and network covalent are typically not soluble in water.
- C05. (C)  $10.8 \text{ g CaCl}_2 \times \frac{1 \text{ mole}}{111.1 \text{ g}} \times \frac{2 \text{ mol Cl}^-}{1 \text{ mol CaCl}_2} = 0.194 \text{ mol Cl}^- \quad M = \frac{0.194 \text{ mol}}{0.355 \text{ L}} = 0.548 \text{ M}$
- C06. (A) There is no difference of electronegativity between Cl and Cl so it is the most covalent.
- C08. (D) The reaction is exothermic so lowering the temperature will shift the position of equilibrium to the right. Adding solid carbon or an inert gas does not affect equilibrium.
- C09. (E) F.C. = #valence  $e^-$  - #assigned  $e^-$  =  $6 - 5 = +1$
- C10. (E)  $[\text{H}_3\text{O}^+] = 10^{-6.63} = 2.3 \times 10^{-7} \text{ M} = [\text{OH}^-]$  since this is pure water  
 $K_w = [\text{H}_3\text{O}^+][\text{OH}^-] = (2.3 \times 10^{-7})^2 = 5.5 \times 10^{-14}$
- C11. (D) For concentration vs time graph, the slope of tangent represents the instantaneous rate.
- C12. (B)  $40.9 \text{ g CO}_2 \times \frac{1 \text{ mole}}{44 \text{ g}} = 0.930 \text{ mol CO}_2 = 0.930 \text{ mol C} \times \frac{12 \text{ g}}{1 \text{ mol}} = 11.1 \text{ g C}$   
 $12.6 \text{ g H}_2\text{O} \times \frac{1 \text{ mole}}{18 \text{ g}} = 0.700 \text{ mol H}_2\text{O} = 1.4 \text{ mol H} \times \frac{1.01 \text{ g}}{1 \text{ mol}} = 1.4 \text{ g H}$   
 $20.0 \text{ g} - (11.1 \text{ g C} + 1.4 \text{ g H}) = 7.5 \text{ g O} \times \frac{1 \text{ mole}}{16 \text{ g}} = 0.469 \text{ mol O}$   
 $\frac{0.469 \text{ mol O}}{0.460} = 1$   
 $\frac{0.930 \text{ mol C}}{0.460} = 2$   
 $\frac{1.4 \text{ mol H}}{0.460} = 3$   
 Empirical formula is  $\text{C}_2\text{H}_3\text{O}$
- C13. (C) Adding a nonvolatile solute lowers the vapor pressure of the solvent and raises the boiling point.
- C14. (C)  $25.0 \text{ g Al} \times \frac{1 \text{ mol Al}}{27.0 \text{ g}} \times \frac{3 \text{ mol } e^-}{1 \text{ mol Al}} \times \frac{96500 \text{ C}}{1 \text{ mol } e^-} \times \frac{1 \text{ sec}}{3.5 \text{ C}} \times \frac{1 \text{ min}}{60 \text{ sec}} \times \frac{1 \text{ hr}}{60 \text{ min}} = 21.3 \text{ hrs}$
- C15. (C)  $0.250 \text{ L} \times 0.50 \frac{\text{mol}}{\text{L}} = 0.125 \text{ mol Pb}^{2+} \quad 0.150 \text{ L} \times \frac{1.0 \text{ mol}}{1 \text{ L}} = 0.150 \text{ mol I}^-$   
 $\text{Pb}^{2+} + 2\text{I}^- \rightarrow \text{PbI}_2 \quad \text{so I}^- \text{ is limiting reactant}$   
 $0.150 \text{ mol I}^- \times \frac{1 \text{ mol PbI}_2}{2 \text{ mol I}^-} \times \frac{461 \text{ g PbI}_2}{1 \text{ mol}} = 346 \text{ g PbI}_2$

## TMSAC Science Test #2

C16. (A)  $3.71 \times 10^{22} \text{ Ag atoms} \times \frac{1 \text{ mole Ag}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{1 \text{ mol AgNO}_3}{1 \text{ mol Ag}} \times \frac{169.9 \text{ g}}{1 \text{ mol AgNO}_3} = 10.5 \text{ g}$

C18. (C) Change of state (sublimation and vaporization) are physical, not chemical changes.

C19. (E)  $\text{CH}_4 + 2 \text{ O}_2 \rightarrow \text{CO}_2 + 2 \text{ H}_2\text{O}$  in this reaction, break 4 C – H & 2 O = O bonds  
Form: 2 C = O and 4 H – O bonds.

$$\Delta H = 4 \times \left( +413 \frac{\text{kJ}}{\text{mol}} \right) + 2 \times \left( +498 \frac{\text{kJ}}{\text{mol}} \right) + 2 \times \left( -799 \frac{\text{kJ}}{\text{mol}} \right) + 4 \times \left( -464 \frac{\text{kJ}}{\text{mol}} \right)$$

$$= -806 \frac{\text{kJ}}{\text{mol}}$$

C20. (E)  $n_{\text{tot}} = \left( 3.10 \text{ g N}_2 \times \frac{1 \text{ mol}}{28 \text{ g N}_2} \right) + \left( 4.95 \text{ g He} \times \frac{1 \text{ mol}}{4.0 \text{ g He}} \right) = 1.35 \text{ mol}$

$$T = \frac{PV}{nR} = \frac{10.5 \text{ atm} \times 2.50 \text{ L}}{1.35 \text{ mol} \times 0.08206 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}}} = 237 \text{ K} = -36 \text{ }^\circ\text{C}$$

## SELECTED SOLUTIONS

P1-P3 Astrophysics for People in a Hurry; Neil deGrasse Tyson; W. W. Norton & Company; 2017

P1. page 36    P2. page 52    P3. page 63

P4. 21<sup>st</sup> Century Astronomy; Kay, Palen, Smith, Blumenthal; W.W. Norton & Company; 2013; pages 325-336

$$\sum F = ma$$

$$F_p - F_f = ma$$

$$mg \sin \theta - \mu mg \cos \theta = ma$$

$$a = 9.8 \sin 30^\circ - .315(9.8) \cos 30^\circ$$

$$a = 2.2266$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$v = \sqrt{0 + 2(2.2266)(3.2)}$$

$$v = 3.77 \text{ m/s}$$

$$y = y_0 + v_0 t + .5at^2$$

$$\text{P6. } 0 = 28.4 + (33.5 \sin 52.4^\circ)t + .5(-9.8)t^2$$

$$t = 6.33 \text{ s}$$

$$m_1 v_1 + m_2 v_2 = m_1 v_3 + m_2 v_4$$

$$\text{P8. } 0 + 0 = 5.25v_3 + .055(150)$$

$$v_3 = -1.57 \text{ m/s}$$

$$v = 331 + .6T$$

$$v = 331 + .6(20)$$

$$v = 343$$

$$\frac{6000(2\pi)}{60} = 200\pi$$

$$\text{P9. } v = \omega r$$

$$v = 200\pi(.04)$$

$$v = 25.1 \text{ m/s}$$

$$\text{P10. } f' = f \left( \frac{v - v_o}{v + v_s} \right)$$

$$f' = 1800 \left( \frac{343 - 41.5}{343 + 36.2} \right)$$

$$f' = 1430 \text{ Hz}$$

$$v = \sqrt{2g(y_2 - y_1)}$$

$$\text{P11. } v = \sqrt{2(9.8)(8.66)}$$

$$v = 13.0 \text{ m/s}$$

$$R = 6 + 9 + 15 = 30$$

$$V = IR$$

$$\text{P12. } I = \frac{V}{R} = \frac{12}{30} = .4$$

$$V = (.4)9 = 3.60 \text{ V}$$

$$E = \frac{kQ}{r^2}$$

$$E_1 = \frac{(8.99 \times 10^9)(12 \times 10^{-6})}{(.156)^2}$$

$$\text{P13. } E_1 = 4,432,938 \text{ right}$$

$$E_2 = \frac{(8.99 \times 10^9)(3.66 \times 10^{-6})}{(.188)^2}$$

$$E_2 = 930,747 \text{ left}$$

$$E_1 - E_2 = 3,500,000 \text{ N/C, right}$$

$$F_m = F_c$$

$$qvB = \frac{mv^2}{r}$$

$$\text{P14. } r = \frac{(9.11 \times 10^{-31})(7.25 \times 10^6)}{(1.602 \times 10^{-19})(2.47)}$$

$$r = .0000167 \text{ m}$$

$$\xi = -NA \frac{dB}{dt}$$

$$\text{P15. } \xi = -1(\pi(.0322)^2) \frac{3.69 - .225}{.00345}$$

$$\xi = -3.27 \text{ V}$$



$$\sum \tau = I\alpha$$

$$F_f r = I\alpha$$

$$I = \frac{2}{5}mr^2, a = \alpha r$$

$$F_f = \frac{\frac{2}{5}mr^2 \left(\frac{a}{r}\right)}{r}$$

$$F_f = \frac{2}{5}ma$$

$$\sum F = ma$$

$$F_p - F_f = ma$$

$$mg \sin \theta - \frac{2}{5}ma = ma$$

$$a = \frac{5}{7}g \sin \theta$$

$$v^2 = v_0^2 + 2a(x - x_0)$$

$$\text{P19. } v = \sqrt{0 + \frac{10}{7}(9.8)\sin 28.8^\circ(4.32)}$$

$$v = 5.40 \text{ m/s}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{24} = \frac{1}{36} + \frac{1}{d_i}$$

$$d_i = 72$$

$$\text{P20. } d_o = 90 - 72$$

$$\frac{1}{16} = \frac{1}{18} + \frac{1}{d_i}$$

$$d_i = 144$$

$$x = 144 + 126$$

$$x = 270 \text{ cm}$$

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{12} = \frac{1}{32} + \frac{1}{d_i}$$

$$\text{P16. } d_i = 19.2$$

$$M = -\frac{d_i}{d_o} = \frac{h_i}{h_o}$$

$$\frac{h_i}{2} = -\frac{19.2}{32}$$

$$h_i = -1.20 \text{ in}$$

$$u = \frac{u' + v}{1 + \frac{vu'}{c^2}}$$

$$\text{P17. } u = \frac{.6 + .5}{1 + .5(.6)}c$$

$$u = 0.846c$$

P19.

$$v = \sqrt{0 + \frac{10}{7}(9.8)\sin 28.8^\circ(4.32)}$$

$$v = 5.40 \text{ m/s}$$

P20.

$$d_o = 90 - 72$$

$$\frac{1}{16} = \frac{1}{18} + \frac{1}{d_i}$$

$$d_i = 144$$

$$x = 144 + 126$$

$$x = 270 \text{ cm}$$