Science Practice Test 13
"More Practice" Answer Key

1. **C**

Change	Example
1.Change in color	metal rusting: $4Fe+3O_2+6H_2O\rightarrow 2Fe_2O_3\bullet nH_2O$
2.Evolution of gas	fizz (carbon dioxide) formed by pouring vinegar to baking soda: $CH_3COOH+NaHCO_3\rightarrow CH_3COONa+H_2O+CO_{2(g)}$
3.Precipitate formation	Redox reaction between silver nitrate and sodium chloride : $AgNO_3+NaCl\rightarrow AgCl_{(s)}+NaNO_3$

2. **B**
Selenium is a nonmetallic element used in copper mining.

3. **B**
Charges: Ca: +2, Cl: -1, Na: +1, CO_3: -2
$CaCl_2 + Na_2CO_3 \rightarrow Ca_{(+2)}CO_{3(-2)}+2Na_{(+1)}Cl_{(-1)}$

4. **D**
A molecule is the smallest physical unit of a given substance which can exist independently. Thus, a glucose molecule is the smallest unit of glucose. It also still retains the physical properties possessed by glucose.

5. **A**

Molecule	Molecular Formula
Ozone	O_3
Nitrogen	N
Hydrogen	H
Carbon Monoxide	CO

6. **B**
A combination reaction is the union of substances to form a single chemical compound.

7. **B**
Distillation is the process of separation of water to other particles through boiling and condensation. Pure water or H_2O does not have any other particles. Thus, it cannot be distilled.

8. **A**
An atom is the smallest portion of any material which still retains its properties. Despite this, it can still be dissociated into protons, neutrons and electrons through nuclear fission.

9. **B**
Carbon-12 and Carbon-14 are isotopes. Isotopes are forms of a chemical element that differ in the number of neutrons. All carbon isotopes still have an atomic number of 6. However, the mass number of Carbon-12 is 12 while that of Carbon-14 is 14. Thus, the number of neutrons in Carbon-12 is 12 – 6 or 6 while the number of neutrons in Carbon-14 is 14 – 6 or 8.

10. **D**
The basic feature of quantum mechanics that is incorporated in the Bohr Model is that the energy of the particles in the Bohr atom is restricted to certain discrete values. One says that the energy is quantized. This means that only certain orbits with certain radii are allowed; orbits in between simply don't exist.

Source:http://csep10.phys.utk.edu/astr162/lect/light/bohr.html

11. **B**
Antacids contain sodium bicarbonate. Another important ingredient is citric acid. Both of these chemicals react with each other producing carbonic acid. In its liquid form this carbonic acid decomposes producing water and carbon dioxide. What this means is that the glass of water is very much like your favorite soda that also contains carbon dioxide in it. The fizz that you see is the carbon dioxide bubbles bubbling to the surface.

Source:http://humantouchofchemistry.com/how-antacids-work.htm

12. **C**
The number of electrons of a neutral atom is the same as the atomic number, thus, 11.

13. **C**
Losing 2 electrons means losing 2 negative charges, leaving 2 protons unbalanced.

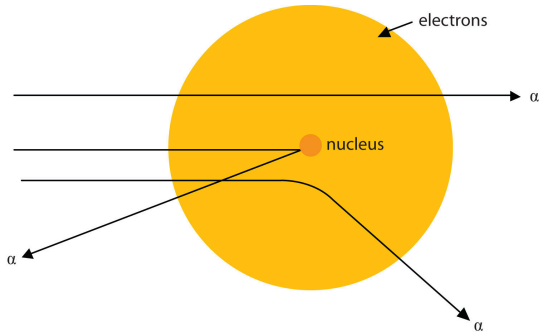
14. **D**
$2HCl + Ca(OH)_2 \rightarrow CaCl_2 + 2H_2O$

15. **D**
General Characteristics of Acids:
- pH < 7
- Sour taste (though you should never use this characteristic to identify an acid in the lab)
- Reacts with a metal to form hydrogen gas
- Increases the H+ concentration in water
- Donates H+ ions
- Turns blue litmus indicator red

General Characteristics of Bases:
- pH > 7
- Bitter taste
- Slippery feel
- Increases the OH- concentration in water
- Accepts OH- ions
- Turns red litmus indicator blue

Source:https://sites.google.com/site/acidbasechemistry/characteristics-of-acids-and-bases

16. **D**



Source:https://www.atulranatutors.co.uk/physics/rutherfords-gold-scattering-experiment-for-gcse-science/

In the golden foil experiment, Rutherford bombarded thin gold foils with alpha particles. Most alpha particles were not deflected while some bounced back from the foil at large angles. Rutherford concluded that atoms are mostly empty spaces, with the

17. **A**
When Blue litmus paper becomes Red ⇒ Acid
When Red litmus paper becomes Blue => Base

18. **C**
Small molecules like water can pass through the semi-permeable membrane while larger ions cannot pass through.

19. **B**
$_{17}Cl^{1-}$= 18 electrons
$_{8}O^{2-}$= 10 electrons
$_{20}Ca^{2+}$= 18 electrons
$_{31}Ga^{3+}$= 28 electrons

20. **D**
Same element but different in mass number.

21. **C**
In the energy diagram, the product has a higher energy level than the reactants which means the system absorbed energy from the system. This is characteristic of endothermic reaction.

22. **C**
When two objects are at thermal equilibrium, they are of the same temperature. Therefore, there is no driving force for heat to transfer.

23. **A**
Isotopes have the same proton number, hence the same element but have different mass numbers.

24. **C**
An exothermic reaction occurs when heat is released while an endothermic reaction occurs when heat is absorbed. When ice melts, it absorbs heat so the reaction is endothermic.

25. **C**
Melting, evaporation, and sublimation are all

endothermic since the reaction absorbs heat.

Freezing, condensation, and deposition are exothermic since the reaction releases heat.

26. **D**

As seen in the equation, 65.2 kJ is released which is found in the product side.

27. **C**

Gallium (III) Oxide is an ionic compound which is composed of a metal and a non-metal. The charge of Gallium is 3+ while the charge of oxygen is -2. To get the answer, the criss-cross method is used.

$$[Ga^{3-}]_2\ [O^{2-}]_3$$

28. **B**

"Like dissolves like". Water is polar. Thus, substance A describes **non-polar covalent** compounds since they are insoluble in water.

Substance B describes **polar covalent compounds** which are soluble in water.

Covalent compounds are poor conductors of electricity because their electrons are shared between atoms and are not free to move. Thus, covalent compounds do not have mobile charged particles (such as ions or delocalized electrons) needed to conduct electricity.

29. **D**

Substance C is an **ionic compound** which is soluble in water due to its polarity. Once it dissolves, the ionic compound is separated into positive and negative ions which disperse in the solution.

These charges move freely in the solution which allows electric current to flow. Thus, ionic compounds are good conductors of electricity.

30. **C**

Mentos candy has a rough and porous surface while Halls have smooth coating. The surface of the coke geyser allows more sites for CO_2 bubbles to form causing them to escape rapidly compared to smooth coating of halls.

31. **D**

The three processes involve chemical reactions that change the materials into new substances with different properties.

32. **C**

Mass number equal to 23 is the sum of protons and neutrons. 11 is the atomic number equal to the number of protons. Since the Sodium cation has a charge of +1, it has less one electron compared to the number of protons. Therefore, it has 10 electrons.

33. **A**

Isotopes are variations of an element with a different number of neutrons. The number of protons (and consequently the atomic number) is the same for isotopes of an element. A and B are the only pair with the same number of protons, but different number of electrons as shown by the mass number.

34. **D**

It is not polar since there is no net charge due to equal number of protons and electrons. It is not an anion because the atom has no excess negative charge. **It has 17 amu.**

35. **A**

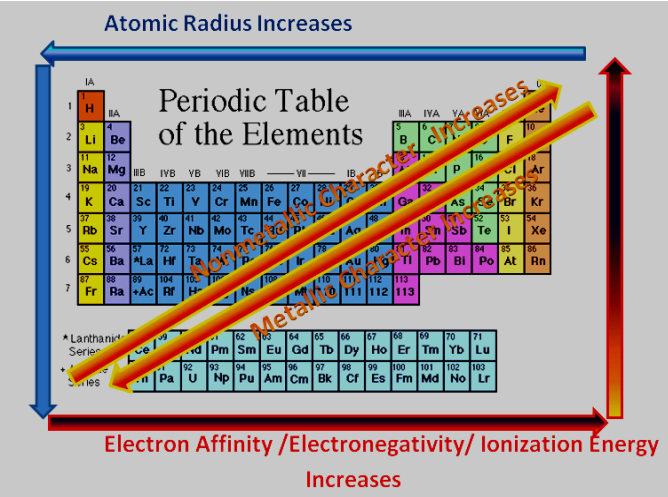
Condensation occurs when gases are cooled down, whereas evaporation occurs when liquids are exposed to higher temperatures. If the dew on the leaf is heated, this will become water vapor due to evaporation.

Science Practice Test 14
"More Practice" Answer Key

1. **D**

Na (sodium) is an alkali metal. F (flourine) is a halogen. Xe (xenon) is a noble gas. No two of these elements are from the same family. Thus, none of these are similar.

2. **A**



Source:http://i150.photobucket.com/albums/s118/hi78953/chemwiki.png

As we move across a period (row) from left to right, the number of electrons increases, thus increasing nuclear charge. This causes the attraction between the nucleus and electrons to increase. Thus, the electrons are being pulled more tightly by the nucleus. As a result, the radius or size of the atom decreases.
Atomic Radius: Li > B > O > F

3. **D**

As we move across a period (row) from left to right, the valence shell of an atom is being filled up and attraction between the nucleus and electrons increases. Thus, more energy is released upon gaining an electron (higher electron affinity).
Electron Affinity: F > N > Be > Li

4. **A**

An orbital is a division of the available space within an atom for an electron to orbit around the nucleus. Each orbital can accommodate up to two electrons.

A nucleus is the central region of an atom. It consists of protons and neutrons and is thus positively charged. Thus, there are no electrons in this region.

A shell is a group of electrons that are associated with the same level of energy. Outer shells have more space than the inner ones and can accommodate more orbitals and thus, more electrons.

An orbit is the path where an electron passes through as it moves around the nucleus of an atom according to Bohr's planetary model. However, since Bohr's planetary model was already disproved by the Quantum model, then this is not a possible answer.

We are left with choices A (orbital) and C (shell). However, among the known elements, only the first seven shells of an atom hold electrons and only the first four shells are ever filled up.

5. **C**

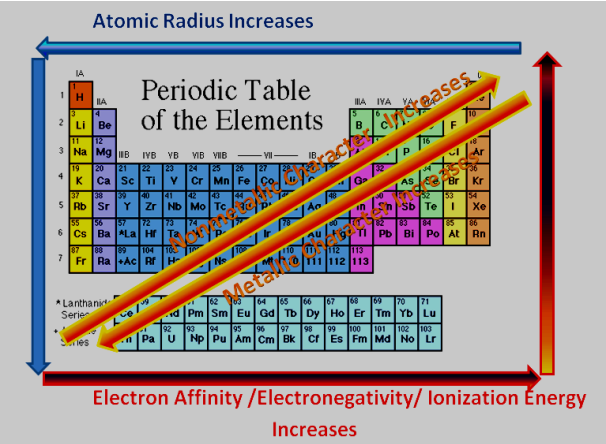
Electronegativity measures the tendency of an atom in a molecule to draw electrons in a chemical bond.

6. **C**

A noble gas is a chemically inert gas. This is due to its full outer shell of electrons. Thus, they possess an ns^2np^6 configuration.

7. **B**

Usually, metals tend to lose electrons to form cations while non-metals tend to gain electrons to form anions. This is due to the fact that elements follow the Octet Rule, which states that elements lose or gain electrons so that they will have the same number as that of the nearest noble gas. Thus, the ability of an element to form anions increases with decreasing metallic property (or increasing nonmetallic property). Among these elements, fluorine is the least metallic and thus has the highest tendency to form anions.



Source:http://i150.photobucket.com/albums/s118/hi78953/chemwiki.png

8. **D**

Electron affinity is the tendency of an atom to gain an electron. Metals typically form cations by losing negatively charged electrons, resulting in positively charged ions. Therefore, an element with a high electron affinity has a low tendency to form a cation.

In general, elements with high electron affinity also have high electronegativity, high ionization energy, and small atomic size.

9. **A**

The letter symbol for Fluorine is F.

10. **A**

The electron configuration of an atom is the representation of the arrangement of electrons that are distributed among the orbital shells and subshells. Commonly, the electron configuration is used to describe the orbitals of an atom in its ground state, but it can also be used to represent an atom that has ionized into a cation or anion by compensating with the loss of or gain of electrons in their subsequent orbitals.

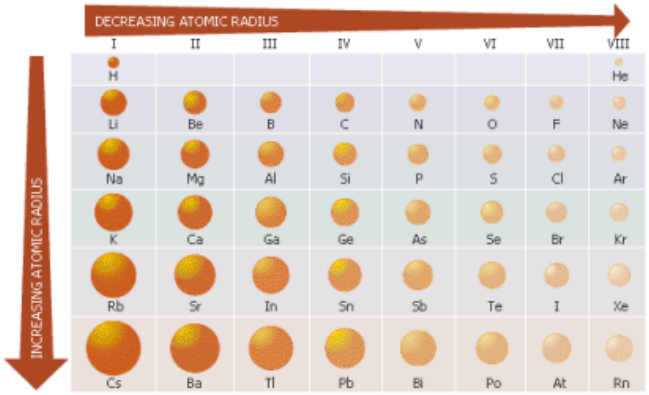
The sequence of the orbitals is 1s, 2s, 2p, 3s, 3p, 4s, 3d, 4p, 5s, 4d, 5p, 6s, 4f, 5d, 6p, 7s, 5f, 6d, and 7p where s holds 2 electrons, p holds 6 electrons, d holds 10 electrons and f holds 14 electrons.

Hund's Rule states that electrons will fill all the empty orbitals first before filling orbitals with electrons in them.

Source:http://chemwiki.ucdavis.edu/Inorganic_Chemistry/Electronic_Configurations

11. **B**

The atomic radius decreases as you go up the period and as you go to the right of the group.



Source:http://ckjh.cksd.wednet.edu/staff/erics/advanced%20physical%20science/Unit%203%20the%20periodic%20table/unit%20notes/ionization%20energy%20note_files/image007.gif

12. **D**

There are seven elements that form diatomic molecules.

This is a list of the seven diatomic elements.

- Hydrogen (H_2)
- Nitrogen (N_2)
- Oxygen (O_2)
- Fluorine (F_2)
- Chlorine (Cl_2)
- Iodine (I_2)
- Bromine (Br_2)

13. **D**

Covalent molecular results from the sharing of electrons between two atoms, like the bonding between two nonmetals.

14. **D**

The elements in the periodic table are arranged based on increasing proton number or atomic number.

15. **C**

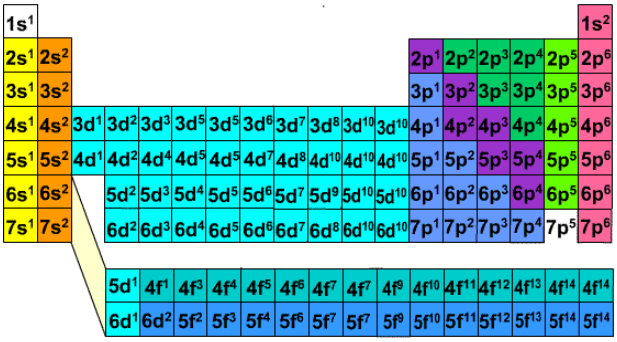
Silicon (Si) and Germanium (Ge) are metalloids found in the carbon group (group IV-A). Metalloids are used in making computer chips since metalloids are semi-conductors allowing them to function either as conductors or insulators depending on the condition.

16. **A**

These metals represent a group –elements found in the same column. They are found in Group 1 which are also known as alkali metal. Elements from the same group have the same properties due to the same number of valence electrons.

17. **D**

The element with the given electron configuration is found in group 2, which belongs to the alkaline earth metals.



source:https://www.livescience.com/28507-element-groups.html

18. **B**

Principal (n): 1 to 7

Angular momentum (L): 0 to n-1

Magnetic (m_l): - l to +l

Spin (m_s): $-\frac{1}{2}\ to\ +\frac{1}{2}$

If n=4, then, l will be from 0 to 3, Therefore, l =2 is possible. If l is 2, then, m_l = -2 to +2, therefore, m_l = -1 is possible, while m_s is either $-\frac{1}{2}\ to\ +\frac{1}{2}$

19. **C**

The oxidation number of oxygen is -2 and there are 7 oxygen atoms.

Let x= oxidation no of chromium

2x + 7 (-2) = -2

2x + -14 = -2

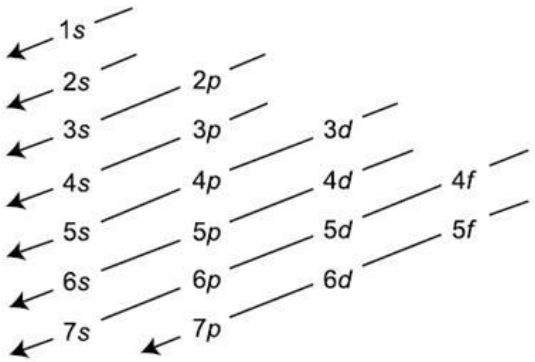
2x= 12

x= +6

20. **C**

The noble gas **argon (Ar)** has an electron configuration ending in $3p^6$ and an atomic number of 18. Since manganese has 25 electrons, **7 more electrons** must be added after argon. The 4s orbital can hold a maximum of 2 electrons, while the 3d orbital can hold a maximum of 10 electrons.

According to the **Aufbau principle**, after filling the 3p orbital, electrons fill the 4s orbital first, followed by the 3d orbital. Therefore, the electron configuration of manganese is **[Ar] $4s^2$ $3d^5$**.



Source:https://edu.rsc.org/feature/the-trouble-with-the-aufbau-principle/2000133.article

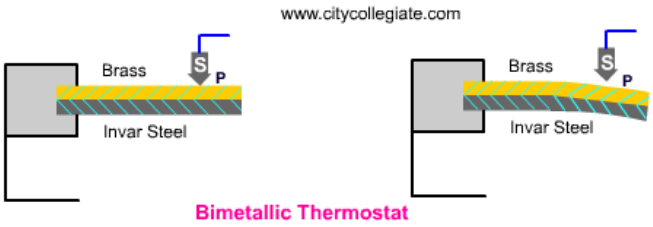
21. **D**

Element X is Neon (Ne), a noble gas. Noble gases have full valence electrons since they already have eight valence electrons. Thus, these elements already have a stable configuration and have little tendency to lose or gain their electrons.

22. **A**

A thermostat is a device which is used to maintain a desired temperature in a system like refrigerator, air-conditioner, iron and in a number of devices. Thermostat works on the principle of thermal expansion of solid materials. A bimetallic thermostat device consists of a strip of two different metals having

different coefficients of linear expansion. The bimetallic strip works as an electric contact breaker in an electric heating circuit. The circuit is broken when the desired temperature is reached Due to difference in the coefficients of linear expansion of two metals, The bimetallic strip bends in the form of a downward curve and the circuit is broken. The metallic strip is in contact with a screw 'S'. When it becomes hot, bends downward and contact at 'P' is broken. Thus the current stops flowing through the heating coil. When the temperature falls, the strip contracts and the contact at 'P' is restored.



Source:http://www.citycollegiate.com/thermostat.html

23. C

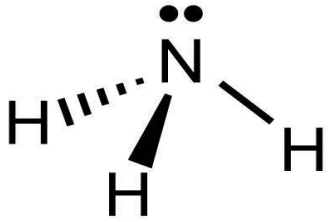
A covalent bond occurs when there is sharing of electrons between atoms. It can form covalent network structures or covalent molecular structures.

Covalent network structures have atoms covalently bonded to several other atoms forming just one giant molecule.

Meanwhile, **covalent molecular structures** have discrete separate molecules that are covalently bonded to each other.

Science Practice Test 15
"More Practice" Answer Key

1. **A**



AX_3E = trigonal pyramidal

2. **A**

Having a **strong intermolecular forces attraction (IMF)** means that a substance typically has a **high boiling point, high melting point, and high surface tension**. Substances with a strong IMFA also have **low volatility**. Volatility is the tendency of a substance to **evaporate**, which involves breaking of hydrogen bonds holding water molecules together.

A stronger IMFA means there is a **greater attraction between molecules**, making it more difficult for them to overcome these forces and transition from liquid to gas. Therefore, the stronger the IMF, the lower the volatility of the substance.

3. **A**

When water freezes, the hydrogen forms bonds between water molecules. The hydrogen bonds form a pattern called *lattice.* The fixed geometry prevents water molecules from packing close together. Therefore, hydrogen bonds create spaces between molecules.

4. **C**

Melting point arranged from highest to lowest:
Diamond > gold> sodium chloride > water

5. **D**

Colligative properties are properties of a solution that depend mainly on the relative numbers of particles of solvent and solute molecules and not on the detailed properties of the molecules themselves.

The colligative properties are:

1. Vapor pressure depression
2. Boiling point elevation
3. Melting point depression
4. Osmotic pressure

The freezing point of pure water is 0°C, but that melting point can be depressed by the adding of a solvent such as a salt. The use of ordinary salt (sodium chloride, NaCl) on icy roads in the winter helps to melt the ice from the roads by lowering the melting point of the ice. A solution typically has a measurably lower melting point than the pure solvent.

Source:http://hyperphysics.phy-astr.gsu.edu/hbase/chemical/meltpt.html#c.

6. **A**

An object will float if it is less dense than the liquid it is placed in. An object will sink if it is denser than the liquid it is placed in.

7. **D**

Organic compounds contain carbon, hydrogen and oxygen atoms. CH_3COOH or acetic acid is the main component in vinegar.

8. **A**

Alkenes are hydrocarbons with at least one double bond.

9. **C**

The hydroxyl group (-OH) is a functional group found in alcohols.

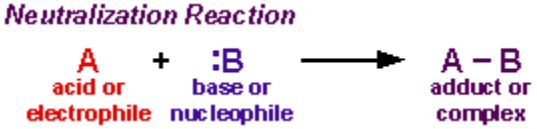
10. **C**

Isomers have the same molecular formula but different structures.

Science Practice Test 16
"More Practice" Answer Key

1. **C**
Gas constant (R), as its name implies, is a constant which defines the relation of the gas's pressure and volume to its absolute temperature (in Kelvin). Its value is $8.314\ \frac{joules}{Kelvin}$

2. **D**
If A is represented by , then 0.6 of the particles (in a container with a pressure of 0.6 atm) are . In choice D, 6 out of 10 or 0.6 of the particles are A.

3. **D**


According to the Lewis theory of acid-base reactions, an acid is an electrophile (accepts electrons) while a base is a nucleophile (electron donors).

4. **C**
If you treat an acidic solution with excess base, then the solution will be less acidic or more basic. This means that its pH level will increase.

5. **D**
According to the Charles's Law, $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, so

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{(10\ L)(27+273)}{(2+273)} = 10.91$$

6. **D**
$Ideal\ Gas\ Law: PV = nRT$

$$n = \frac{PV}{RT} = \frac{(1.00\ atm)(25\ L)}{\left(8.134 \frac{J}{mol\ K}\right)(25+273)} = 0.010313821\ M$$

$$V = \frac{nRT}{P} = \frac{(0.010313821\ M)\left(8.134\ \frac{J}{mol\ K}\right)(596\ K)}{0.5\ atm}$$

$$V = 100\ L$$

7. **D**
Since HCl is a monoprotic acid and NaOH is a monoprotic base, then one mole of HCl can be neutralized with one mole of NaOH.

$$(0.1\ M\ HCL)\ (x\ L) = (0.350\ M\ NaOH)\ (25\ x\ 10^{-3}\ L)$$

$$x\ L = \frac{(0.350\ M\ NaOH)\left(25\ x\ 10^{-3}\right)}{0.1\ M\ HCl}$$

$$= 87.5\ x\ 10^{-3}\ L = 87.5\ mL$$

8. **A**

Property	Definition
heat capacity	quantity of heat required to increase the temperature of one mole of a substance by 1°C.
heat of fusion	quantity of heat required to be absorbed by a substance to undergo state change from solid to liquid
heat of formation	quantity of heat evolved or absorbed in the formation of one mole of a substance
heat of vaporization	quantity of heat required to be absorbed by a substance to undergo state change from liquid to gas

9. **C**
Using Boyle's Law, P_1V_1

$= P_2V_2$ $P_2 = P_1V_1/V_2 =$

$=(5atm)(50L)/(20L)$

$=12.5$ atm

10. **D**
The boiling point in celsius is 100 C which is equivalent to 212 F or 373.15 K.

$^oF = (9/5)(1OO^oC) + 32 = 180 + 32 = 212^oF$

11. **B**

Chemical reactions proceed at different rates. The factors that affect reaction rates are:

- surface area of a solid reactant
- concentration or pressure of a reactant
- temperature
- nature of the reactants
- presence/absence of a catalyst.

12. **C**

If we overlap the graphs of Pressure vs. Volume and Temperature vs. Volume, we can see that as Pressure decreases, Temperature increases at constant volume. Thus, as pressure increases, temperature decreases.

13. **D**

Charles' Law states temperature is proportional to the volume. Boyle's Law states that the product of the pressure and volume for a gas is a constant for a fixed amount of gas at a fixed temperature. Avogadro's gas law states the volume of a gas is proportional to the number of moles of gas present when temperature and pressure are held constant. Gay -Lussac's law is an ideal gas law where at constant volume, the pressure of an ideal gas is directly proportional to its absolute temperature.

14. **B**

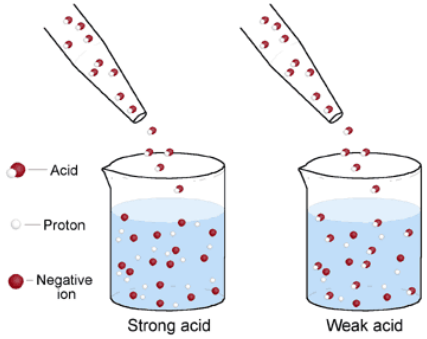
Buffers prevent drastic changes in pH of a system. Buffers neutralize added acid or base inside the body because too much acidity or alkalinity may cause various complications to our body organs, especially to the kidney.

15. **C**

Sodium hydroxide (NaOH) is a strong base, and hydrochloric acid (HCl) is a strong acid. When equal amounts of NaOH and HCl are mixed, a neutralization reaction occurs, forming water and salt (NaCl). Since both the acid and base are strong and completely dissociate in water, the resulting solution is neutral with a pH of 7.

16. **B**

HCl is a strong acid because the ions of HCl can completely dissociate into hydrogen ions and chloride ions when it is dissolved in water (see picture below). In contrast, acetic acid is a weak acid since not all hydrogen ions are dissociated when it is dissolved in water.



Source:https://www.pathwayz.org/Tree/Plain/STRENGTH+VS+CONCENTRATION

Water is neutral with a pH equal to 7 while ammonia is a base with pH greater than 7.

17. **D**

a. According to Graham's law of diffusion, the rate of diffusion is inversely proportional to the square root of its molar mass given that the temperature and pressure are constant. Helium (He) has a lower molar mass than oxygen (O_2), so helium molecules **diffuse faster** than oxygen molecules under the same conditions.

b. According to Boyle's law, increasing the pressure will decrease the volume of a gas if temperature is constant.

c. A gas behaves like an ideal gas under the conditions of a high temperature and low pressure.

18. **C**

The boiling point is the temperature at which the vapor pressure equals the atmospheric pressure.

The normal boiling point of water at sea-level is 100°C or 212°F. Above sea level, the atmospheric pressure is lower so the boiling point of water is also lower. Thus, the answer is 178°F.

19. **C**
Concentration of alcohol 1: 5%
Concentration of alcohol 2: 5%
Assume that each has 1L volume.

The total volume of the solution is 2L and the total concentration is still 5%.

$C_1 \quad V1_1 = C_2 \quad V_2$
(5%) (1L) = (5%) (1L)

After adding the same volume of water (2L), the total volume (V_2) will be 4L.

C_1 V_1 (first sol'n) = C_2 V_2 (second sol'n)

C_1 = 5% C_2 = unknown
V_1 = 2L V_2 = 4L

(5%) (2L) = (C_2) (4L)
C_2 = 2.5%

20. **C**
Density is a key factor in determining whether a liquid will float or sink.

Density = $\frac{mass}{volume}$

Liquid X and Y = 1L
Density of liquid x = $\frac{10\% \; of \; 3 \; kg}{40\% \; of \; 1L} = \frac{3}{4} \; \frac{kg}{L}$

Mass of Y: 100% - 10% = 90%
Volume of liquid Y: 100% - 40% = 60%
Density of liquid Y = $\frac{90\% \; of \; 3 \; kg}{60\% \; of \; 1L} = \frac{9}{2} \; \frac{kg}{L}$

The density of water is 1kg/L.

Liquid Y has the highest density followed by water, and liquid X has the lowest density. The higher the density, the more it will sink, the lower the density, the more it will float and water will stay in the middle.

21. **D**
It can be observed that when the temperature is increased, substance V has the highest rate of expansion with the volume increasing from 1.1 cm^3 to 1.6 cm^3.

22. **D**
As the temperature of substance Y increases, the volume decreases. Thus, substance Y has a negative rate of expansion. It can also be observed that at 0°C to 4°C, W is compressed since the volume is decreased.

23. **A**

$$Rate \; of \; Effusion = \frac{1}{\sqrt{MM}}$$

$$\frac{Rate_A}{Rate_B} = \frac{\sqrt{MM_B}}{\sqrt{MM_A}} = \sqrt{\frac{MM_B}{MM_A}}$$

$$\frac{Rate_x}{Rate_{CO_2}} = \sqrt{\frac{MM_{CO_2}}{MM_x}} = 2$$

$$\frac{MM_{CO_2}}{MM_x} = 4$$

$$MM_{CO_2} = 4MM_x$$

$$44 \; \frac{g}{mol} = 4MM_x$$

$$MM_x = 11 \; \frac{g}{mol}$$

24. **D**
When a substance changes from one state to another, it occurs with a change of heat. Although the heat content of the material changes, the temperature remains the same. Therefore, when a substance melts, heat is absorbed and temperature stays constant.

25. **A**
Q = mCΔT
Q(heat) = unknown
m(mass) = 1L of water is 1kg
C(specific heat) = 4.19 kJ/kg.K
ΔT(change in temperature) = 50 - 30 =20K

Q = (1kg) (4.19 kJ/kg.K) (20K)
Q = 83.8 kJ

26. **B**
Q = mCΔT

$$Q = (10 \; g)(24°C - 20°C)\left(0.2 \; \frac{cal}{g-°C}\right)$$
$$= (10 \; g)(4°C)\left(0.2 \; \frac{cal}{g-°C}\right) = 8 \text{ calories}$$

27. **B**
The molecules of gases are far apart from each other. Thus, the molecules can be easily compressed when there is an increase in pressure or when transferred into a smaller container.

28. **D**
According to Boyle's Law, volume and pressure have an inverse relationship given that the temperature is constant. As the volume increases, the pressure decreases.

Science Practice Test 17
"More Practice" Answer Key

1. **C**

Oxidation-reduction (Redox) reactions combine compounds wanting to gain electrons (reduce) and compounds willing to give electrons (oxidize).

2. **C**

$N_t = N_0\left(\frac{1}{2^t}\right)$

where *N(t)* is the amount remaining after N_0 radioactive particles underwent decomposition *t* times

$\frac{1}{16}N_0 = N_0\left(\frac{1}{2^t}\right)$

$\frac{1}{2^t} = \frac{1}{16}$

$2^t = 16$

t = 4

Thus, in four days, the sample underwent four decompositions. Thus, its half-life is one day.

3. **B**

sugar = 0.82(150 g) = 123g

4. **B**

Use the equation $C_1V_1 = C_2V_2$.
Since C_2 = twice of original = $2C_1$
=2*(0.05 g/mL) =0.10 g/mL

Therefore,

$C_1V_1 = C_2V_2$

(0.05 g/mL)*(100 mL) = (0.10 g/mL)*V_2

V_2 = 50 mL

5. **D**

$Concentration = \frac{solute}{solvent} = \frac{5g}{100\,mL}$

$\frac{5g}{100mL} \times \frac{1}{4} = \frac{5}{V_{unknown}}$

$V_{unknown}$ = 400 mL

6. **B**

Assume 4g/100 ml.
Add 4g / 100ml + 4g / 100ml = 8 g / 200 ml.
Add an equal volume of water = 8g / 400 ml.

(8g / 400 ml) x 100 = **2%**

7. **A**

Redox reactions, or oxidation -reduction reactions, primarily involve the transfer of electrons between two chemical species. The compound that loses an electron is said to be oxidized, the one that gains an electron is said to be reduced. There are also specific terms that describe the specific chemical species. A compound that is oxidized is referred to as a reducing agent, while a compound that is reduced is referred to as the oxidizing agent.

8. **B**

Only substance II has the positive slope, thus, its solubility will increase with increasing temperature.

9. **D**

A catalyst is a substance that increases the rate of a chemical reaction without itself undergoing any permanent chemical change.

10. **B**

Since Mg has the Mg^{2+} ion while the Cl has the Cl^- ion, this will proceed in a reaction as:

$Mg^{2+} + 2Cl^- \rightarrow MgCl_2$

11. **D**

45 g in 200mL. Thus, 225 g in 1000 mL
= **225 g/L**

12. **B**

$\frac{70\ g}{200\ mL} = 0.35\ g/mL$

Since the amount of solute is equal to the solubility of the solute in water, the solution is saturated.

Kinds of Saturation	Definition
Saturated Solution	A solution with solute that dissolves until it is unable to dissolve anymore, leaving the undissolved substances at the bottom
Unsaturated Solution	A solution (*with less solute than the saturated solution*) that completely dissolves, leaving no remaining substances
Supersaturated Solution	A solution (*with more solute than the saturated solution*) that contains more undissolved solute than the saturated solution because of its tendency to crystallize and precipitate.

Source:http://chemwiki.ucdavis.edu/Physical_Chemistry/Equilibria/Solubilty/Types_of_Saturation

13. **A**

Molarity of NaF:

$100\ g\ NaF\left(\frac{1\ mole}{42\ g}\right) = 2.38\ moles\ NaF$

M = 2.38 moles / 5L = 0.48 M

Molarity of KCl:

$300\ g\ KCl\left(\frac{1\ mole}{75\ g}\right) = 4\ moles\ KCl$

M = 4 moles / 5L = 0.8 M

This means, A is less concentrated than B.

14. **A**

If two solutions of different concentration are separated by a semi-permeable membrane which is permeable to the smaller solvent molecules but not to the larger solute molecules, then the solvent will tend to diffuse across the membrane from the less concentrated to the more concentrated solution. This process is called osmosis.The water will, thus, move from A to B.

15. **C**

Henry's Law states: "At a constant temperature, the amount of a given gas that dissolves in a given type and volume of liquid is directly proportional to the partial pressure of that gas in equilibrium with that liquid."

Dalton's Law of Partial Pressures, or Dalton's Law, states that the total pressure of a gas in a container is the sum of the partial pressures of the individual gases in the container.

Hess's Law states: The enthalpy change accompanying a chemical change is independent of the route by which the chemical change occurs.

Raoult's law states that the vapor pressure of a solvent above a solution is equal to the vapor pressure of the pure solvent at the same temperature scaled by the mole fraction of the solvent present.

16. **A**

Catalyst increases the rate by lowering activation energy.

Temperature affects the kinetic energy of particles, increasing the chance of effective collisions.

Concentration affects the number of reactant particles, thereby increasing or decreasing the role of reaction.

Buffer helps maintain pH in solution. It does not directly affect the rate of a reaction.

17. **B**

Half-life is the time it takes for half of the nuclei in a sample of a radioactive substance to decay.

The half-life of ^{14}C is 5730 years. The total time given is 17,190 years which is equivalent to 3 half-lives. Thus, the original amount of ^{14}C will be halved 3 times.

5730 yrs 5730 yrs 5730 yrs
1000 g —> 500 g —> 250 g —> **125 g**
(1st half-life) (2nd half-life) (3rd half life)

18. **B**
Since the solution can still dissolve more solute, it has not reached its saturation point yet, thus, it is unsaturated.

19. **B**
If the half-life of Iodine-131 is equivalent to 8 days, then 24 days is equivalent to 3 half-lives.

8 yrs 8 yrs 8 yrs
64 g —> 32 g —> 16 g —> **8 g**
(1st half-life) (2nd half-life) (3rd half life)

20. **D**
Cl_2O_7 is a **covalent** compound containing 2 non-metal elements. In covalent compounds, the element with lower electronegativity is written first. When naming a covalent compound, write the prefix followed by the name of the first element. Then write the prefix, the root of the second element, and the suffix –ide.

Thus, Cl_2O_7 has the prefix of **dichlorine heptoxide.**

21. **C**
Let x= oxidation no of chromium
There are 2 chromium atoms.

The oxidation number of oxygen is -2 and there are 7 oxygen atoms.

The overall charge of the ion is -2.

$2x + 7(-2) = -2$
$2x + -14 = -2$
$2x = 12$
$x = +\mathbf{6}$

22. **C**
The solubility of gases generally increases as the temperature decreases.

23. **C**
Permanganate ion is represented by the chemical formula MnO_4^-

Science Practice Test 18
"More Practice" Answer Key

1. **C**

mass=$\left(9.1\ x\ 10^{-28}\frac{grams}{atom}\right)(6.02\ x\ 10^{23} atoms)$

$= 5.4782\ x\ 10^{-4}\ grams \approx 5.78\ x\ 10^{-4} grams$

2. **B**

$CaCl_2+Na_2CO_3 \rightarrow CaCO_3+2NaCl$

$2\ moles\ CaCl_2\left(\frac{1\ mole\ CaCO_3}{1\ mole\ CaCl_2}\right) = 2\ moles\ CaCO_3$

$3\ moles\ Na_2CO_3\left(\frac{1\ mole\ CaCO_3}{1\ mole\ CaCl_2}\right) = 3\ moles\ CaCO_3$

Since calcium chloride produces fewer moles of product than sodium carbonate, then calcium chloride is the limiting reactant.

3. **D**

$pH = -\log log\ [H_3O^+]$

$[H_3O^+] = 10^{-pH}$

$\left[H_3O^+\right] = 10^{-6} M = 1\ x\ 10^{-6}\ M$

4. **C**

$= 29\ x\ 10^{-3} g\ Mg(OH)_2\ x\left(\frac{mol\ Mg(OH)_2}{58\ g\ Mg(OH)_2}\right)$

$x\left(\frac{2\ mol\ HCl}{1\ mol\ Mg(OH)_2}\right)x\left(\frac{36\ g\ HCl}{mol\ HCl}\right)$

$= 36\ x\ 10^{-3} g\ HCl = 36$ mg HCl

5. **C**

The empirical formula is a chemical formula that shows the relative proportion of elements in the compound rather than specifying the number of atoms in a given molecule of a compound.

6. **C**

Mass ratio (C:H): 3:1
Molecular mass of Carbon: 12 g/mol
Molecular mass of Hydrogen: 1 g/mol
Ratio of molecular mass (C:H): 12:1

Since (molecular mass)(number of atoms) = total mass, then we can determine the ratio between the number of atoms in each compound through proportion.

$\frac{3x}{1y} = \frac{12}{1}; 3x = 12y; x = 4y$

For every one carbon atom, there are four hydrogen atoms.

7. **B**

$pH = -\log log\left[H^+\right]$

pH $= -\log log\left[1.0\ x\ 10^{-8}\right] = 8$

$pOH = 14 - pH = 14 - 8 = 6$

8. **B**

According to The Law of Conservation of Mass, in any chemical reaction, the mass of reactants must be equal to the mass of products. Thus, the mass of KNO_3 must be equal to the sum of the masses of KNO_2 and O_2 which is 65.

9. **B**

$12\ g\ glucose\left(\frac{1\ mol}{180.16\ g}\right)\left(6.022\ x\ 10^{23}\ molecules\right)$

$\approx 12\ g\ glucose\left(\frac{1\ mol}{180\ g}\right)\left(6\ x\ 10^{23}\ molecules\right)$

$\approx 4\ x\ 10^{22}\ molecules$

10. **B**

After 250mL of water dissolve 20g of NaCl, 40g of NaCl remain undissolved.
20g : 250mL :: 40g : x
(20g)x = (40)(250)

$x = \frac{(40g)(250\ mL)}{(20g)} = 500\ mL\ of\ water$

11. **B**

Matter moves from an area of higher concentration to an area of lower concentration. In the given setup, water concentration in solution A is $1 - \frac{10\ g}{50\ g/mol} = 1 - 0.2 = 0.8$ while that in solution B is $1 - \frac{10\ g}{100\ g/mol} = 1 - 0.1 = 0.9$. Thus, water will move from solutions B to A.

12. **B**
Molarity = (n_{solute}) / ($L_{solution}$)
[(g / MM)solute] / (Lsolution)
[5.9 g / (23+36) g/mol] / (0.5 L)
0.2 mol/L = 0.2 M

13. **C**
25:50 = 1:2 = C:O
CO_2

14. **B**
$m_{molecule}$ = (44 g / 1 mol)*(1 mol / $6.0x10^{23}$ molecules) = 7.3×10^{-23} g

15. **C**
$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

16. **D**
a. Near the equivalence point, the equivalence point drastically decreases as the acid-base solution becomes more acidic.
b. Notice that there isn't any steep bit on this graph. Instead, there is just what is known as a "point of inflection". That lack of a steep bit means that it is difficult to do a titration of a weak acid against a weak base.
c. As the base gets stronger, its pH value gets higher.
d. You can see that the pH only falls a very small amount until quite near the equivalence point. Then there is a really steep plunge.
Source:
https://sites.google.com/site/acidbasechemistry/characteristics-of-acids-and-bases

17. **B**
$N_2 + 3H_2 \rightarrow 2NH_3$
Using stoichiometry,

$$6\ moles\ H_2 \left(\frac{1\ mole\ H_2}{3\ moles\ H_2}\right) = 2\ mole\ H_2$$

18. **B**
Since only 2 moles of N is needed to react with 6 moles of H, while

$$6\ moles\ N_2 \left(\frac{3\ mole\ H_2}{1\ mole\ N_2}\right) = 18\ mole\ H_2$$

18 moles H is needed to react with 6 moles N, the limiting reactant is hydrogen.

19. **B**
We need to base calculation to the limiting reactant

$$6\ moles\ H_2 \left(\frac{2\ mole\ NH_3}{3\ moles\ H_2}\right) = 4\ mole\ NH_3$$

20. **B**
The molecular mass of acetic acid is:
=4 x 12.01 + 4 x 1 + 2 x 16 = 60.05 g/mol.

To get the number of moles:

$$4g\left(\frac{1\ mol}{60.05\ g}\right) = 0.067\ mol$$

To gel molarity:

$$M = \frac{moles\ of\ solute}{volume\ of\ solution} = \frac{0.067mol}{0.1L} = 0.67M$$

21. **A**
2 moles N_2 x (28 g / mol) = 56 g N_2
2 moles O_2 x (32 g / mol) = 64 g O_2

$$\%N_2 = \frac{56}{64+56}\ x\ 100 = \frac{56}{120}\ x\ 100 = 46.67\% = 47\%$$

22. **A**
Mass of $CaCo_3$ = 10g
Molar mass of $CaCo_3$ = 100g/mole

$$Moles = \frac{Mass}{Molar\ Mass}$$
$$= \frac{10g}{100g/mole}$$
$$= \frac{1}{10}\ mole\ or\ 0.1\ mole$$

23. **B**
Mass = moles x MM
Mass = 1.5 moles x 100 g/mole
Mass = 150g

24. **B**
Solids are not part of the equilibrium constant expressions. Concentration of the products are written on the numerator while concentration of reactants will be written on the denominator. The stoichiometric coefficients will be written as exponents of the contained substance.

25. **A**

The given molecular formula is $C_2H_4O_2$. To obtain the empirical formula, simplify the ratio to the lowest whole numbers. Thus, the empirical formula becomes CH_2O.

26. **C**

In Le Chateliers Principle, if the system experiences stress, the system will adjust to relieve the stress. If volume decreases, the side of lower moles will be favored.

27. **B**

The molecular formula of caffeine is $C_8H_{10}N_4O_2$ and it contains 8 carbon atoms.

28. **A**

The empirical formula shows the proportion of the elements but not the actual number of atoms in a compound. Lime water is an example of a common name. Benzoyl peroxide is an example of a chemical name. Option B gives the actual number of atoms of the compound. Option A gives the simplest positive ratio of the elements involved.

29. **C**

The number of atoms is the number of moles multiplied by Avogadro's number. The higher the number of moles of a substance, the higher the number of atoms will be. 4 moles of NaOH will have more atoms than the 1 mole of water, 1 mole of carbon dioxide, and 1 mole of Ammonium carbonate

30. **D**

Osmosis is a process where the solvent molecules transfer through a semi-permeable membrane from a diluted solution to a more concentrated one to achieve equilibrium in concentration.

Therefore, pure water from B will move to A and C solutions.