MOCK UPCAT 7: ANSWER KEY WITH EXPLANATIONS

1. **C**

Fungi are **eukaryotic** protista that differs from bacteria and other prokaryotes. They have **cell walls** that contain chitin, mannan and other polysachharides. They could be unicellular or multicellular. **Molds and yeasts** are examples of fungi.

2. **C**

Since both parent rats had brown eyes, but produces baby rats with red eyes, this means that the allele for the red eyes is a recessive trait and both parents had the Bb genotype. The babies with red eyes have the bb genotype. Thus, brown eyes are dominant while red eyes are recessive.

3. **C**

The soil, sand and small rocks occupy small spaces and sink in the bottom of the lake. Since big rocks occupy more space, they will lessen the space for water of the lake.

4. **B**

When the first sperm membrane fuses with the egg membrane, it separates the fertilization membrane and forms a barrier to other sperm. Then, both the egg and the sperm form a nucleus within the egg. They each contain half of the chromosomes that the embryo will have.

Source: http://www.austinivf.com/embryology/egg-oocyte-fertilization.php

5. **D**

Amoeba does not have cell walls, only cell membranes. Green Alga have chloroplasts. Molds have no flagellum. This leaves Lactobacillus. Lactobacilli are rod-shaped, Gram-positive, fermentative, organotrophs. They are usually straight, although they can form spiral or coccobacillary forms under certain conditions. They are often found in pairs or chains of varying length. Lactobacilli are classified as lactic acid bacteria, and derive almost all of their energy from the conversion of glucose to lactate during homolactic fermentation. In this process 85 -90% of the sugar utilized is converted to lactic acid. They generate ATP by nonoxidative substrate-level phosphorylation.

6. **D**

Molds and amoeba do not have chloroplasts. Euglena does not have cell walls. This leaves Green Alga. Green algae have chloroplasts that contain chlorophyll a and chlorophyll b, giving them a bright green color, as well as the accessory pigments beta carotene and xanthophylls, in stacked thylakoids. The cell walls of green algae usually contain cellulose and they store carbohydrate in the form of starch. All green algae have mitochondria with flat cristae. When present, paired flagella are used to move the cell. They are anchored by a cross-shaped system of microtubules and fibrous strands. Flagella are only present in the motile male gametes of charophytes and are absent from the gametes of Pinophyta and flowering plants.

7. **B**

Planet	Radius (km)
Mercury	2440
Venus	6052
Earth	6378
Mars	3397
Jupiter	71492
Saturn	60268
Uranus	25559
Neptune	24766
Pluto	1150

8. **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

9. **A**

The letter symbol for Flourine is F.

10. **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

11. **B**

sugar = 0.82(150 g) = 123g

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. **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,

$$C_1V_1 = C_2V_2$$

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

$$V_2 = 50\ mL$$

16. **D**

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

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

$$V_{unknown} = 400\ mL$$

17. **B**

Molarity = $(n_{solute}) / (L_{solution})$

10. $[(g / MM)_{solute}] / (L_{solution})$
11. $[5.9\ g / (23+36)\ g/mol] / (0.5\ L)$
12. $0.2\ mol/L = 0.2\ M$

18. **C**

$$25:50 = 1:2 = C:O$$

$$CO_2$$

19. **B**

$m_{molecule} = (44\ g / 1\ mol)*(1\ mol / 6.0x10^{23}$ molecules) $= 7.3 \times 10^{-23}$ g

20. **B**

Assume 4g/100 ml.

Add 4g / 100ml + 4g / 100ml = 8 g / 200 ml.

Add an equal volume of water = 8g / 400 ml.

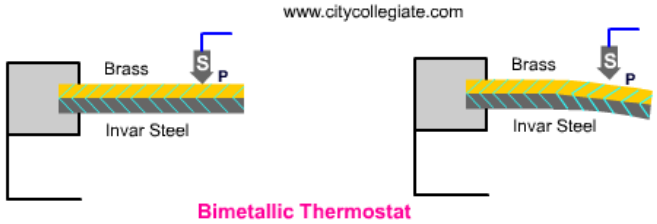
(8g / 400 ml) x 100 = **2%**

21. **C**

$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

22. **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.htm

23. **C**

Using Boyle's Law, $P_1V_1 = P_2V_2$

$P_2 = P_1V_1/V_2 = (5atm)(50L)/(20L)$

$= 12.5\ atm$

24. **D**

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

25. **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.

26. **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.

27. **B**

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

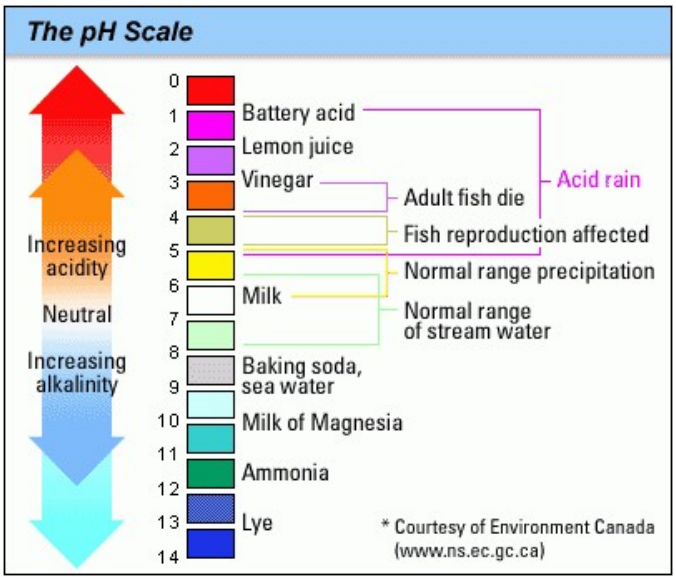
28. **D**

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

29. **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.

30. **A**



	Red litmus	Blue litmus
ACIDIC SOLUTION	Stays red	Turns red
NEUTRAL SOLUTION	Stays red	Stays blue
ALKALINE SOLUTION	Turns blue	Stays blue

Source: https://qph.fs.quoracdn.net/main-qimg-0ae0532abed1a3489733bbe8cbc4e417

The red litmus paper stays red when it is tested on acids and turns blue when it is tested on bases while blue litmus paper stays blue when it is tested on bases and turns red when it is tested on acids.

	red litmus	blue litmus
A	red	red
B	red	red
C	blue	blue
D	blue	blue

Liquid A and B are acids while liquid C and D are bases therefore the *ph* of AB is less than the *ph* of CD.

31. **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.

32. **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

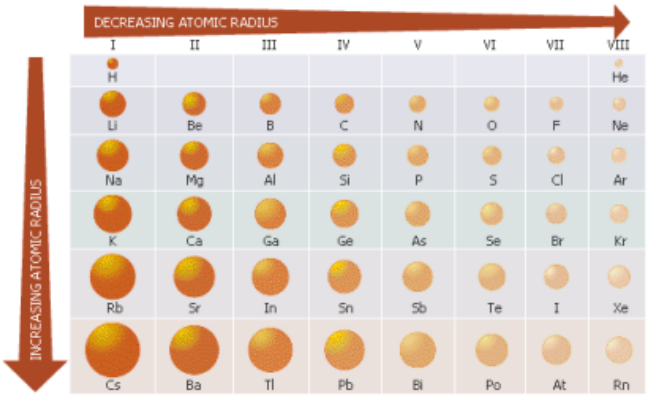
33. **B**

Since Mg has the Mg^{2+} ion while the Cl has the Cl^- ion, this will proceed in a reaction as:
$Mg^{2+} + 2Cl^- \rightarrow MgCl_2$

34. **C**

a. True, the total value of the "exponents" of the orbitals is 14.
b. True, the s orbital can hold up to 2 electrons.
c. False, the s orbital in the 3rd level is not filled, thus, the atom is not in the ground state.
d. True, the atom has 3 electrons in its highest level, the 3rd energy level.

35. **B**



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

36. **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)

37. **B**

$N_2 + 3H_2 \rightarrow 2NH_3$
Using stoichiometry,

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

38. **B**

Since only 2 moles of N is needed to react with 6 moles of H, while

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

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

39. **B**

We need to base calculation to the limiting reactant

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

40. **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

41. **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

42. **D**

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

43. **B**

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

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

44. **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,

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

to gel molarity,

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

45. **A**

Molarity of NaF:

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

M = 2.38 moles / 5L = 0.48 M

Molarity of KCl:

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

M = 4 moles / 5L = 0.8 M

This means, A is less concentrated than B.

46. **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.

47. **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#c1

48. **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.

49. **D**

The 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.

50. **D**

2 moles N_2 x (28 g / mol) = 56 g N_2
2 moles O_2 x (32 g / mol) = 64 g O_2
$\%N_2 = \frac{56}{64+56} \times 100 = \frac{56}{120} \times 100 = 46.67\% = 47\%$

51. **D**

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

52. **C**

A Covalent network solid is a chemical compound in which the atoms are bonded by covalent bonds in a continuous network, like diamond or graphite.

53. **B**

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

54. **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.

55. **B**

He had a total travel time of 1 ½ hours.
So, 1.5 hours x 35 kph = 52.5 km

56. **D**

There are a lot of forces acting on the box like the normal force and weight. But these forces are cancelling each other out, that is why the box is not moving.

57. **A**

Pressure depends upon the height of the liquid. Since water in glass A has the highest height, this exerts the greatest pressure.

58. **C**

A falling object is losing height, thus, losing potential energy, while gaining acceleration. As it gains acceleration, its velocity also increases. So the kinetic energy also increases.

59. **C**

At point C, all of the potential energy of the system has been converted to its kinetic energy. Since kinetic energy is dependent on velocity, point C has the highest velocity. Thus, this is the point with the fastest flow.

60. **D**

A body that moves in a circular path at constant speed has an acceleration directed towards the center of the circle, called as centripetal acceleration.