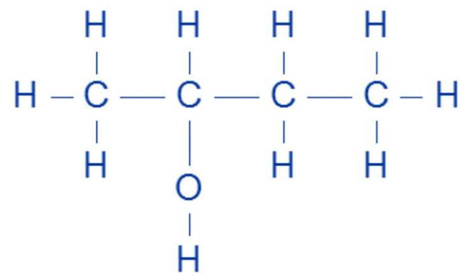
JUNE 2018 CHEM REGENTS ANSWERS PART 2-3

51 State the general trend in first ionization energy as the elements in Period 3 are considered from left to right. The period trend for 1st Ionization Energy is increasing. How do you KNOW??? Pick the first several elements of period 3, which are Na, Mg, Al, Si, and P. Write down the 1st Ionization Energy values in a row: 496, 738, 578, 787, and 1012 kJ/mole. That aluminum does a twist, sort of like wearing LONG PANTS to school once a year. That's an exception, not a break in the general trend.

52 Identify a type of strong intermolecular force that exists between water molecules, but does not exist between carbon dioxide molecules. [1] Hydrogen bonds. Water molecules have hydrogen in polar bonds with oxygen, causing the polar molecules to be hydrogen bonded to each other. Carbon dioxide molecules are nonpolar because they are straight line shaped, they have radial symmetry, so they are NOT attracted together very much at all.

53 Draw a structural formula for 2-butanol. [1]
An example is at right. The "OH" group must be connected to the 2nd carbon atom. Left here, but it could be on the other central carbon instead. Here the "O" is bonded to the "H", but you could write it as —OH if you prefer.



Silver compounds	
Name	Chemical formula
silver carbonate	Ag_2CO_3
silver chlorate	$AgClO_3$
silver chloride	AgCl
silver sulfate	Ag_2SO_4

54 Explain, in terms of element classification, why silver chloride is an ionic compound. [1]

An ionic compound has a metal cation and a nonmetal anion bonded together. Silver and chlorine make ions to bond.

55 Show a numerical setup for calculating the percent composition by mass of silver in silver carbonate (gram-formula mass = 276 g/mol). [1]

Ag_2CO_3
Ag 2 x 108 = 216 grams
C 1 x 12 = 12 grams
O 3 x 16 = 48 grams
276 grams/mole

% comp by mass (for silver only)

$$\frac{216}{276} \times 100\% = 78\%$$

56 Identify the silver compound in the table that is most soluble in water. [1]
Only silver chlorate is soluble according to table E, which is where you HAVE to LOOK.

When a cobalt-59 atom is bombarded by a subatomic particle, a radioactive cobalt-60 atom is produced. After 21.084 years, 1.20 grams of an original sample of cobalt-60 produced remains unchanged. This is nuclear decay, but this isotope is NOT on table N. So what, the info is right here, relax.

57 Complete the nuclear equation by writing a notation for the missing particle. [1]

$${}^{59}_{27}\text{Co} + {}^{1}_{0}\text{n} \rightarrow {}^{60}_{27}\text{Co}$$

your answer is just the blue part, and it has to be a neutron to make the math work.

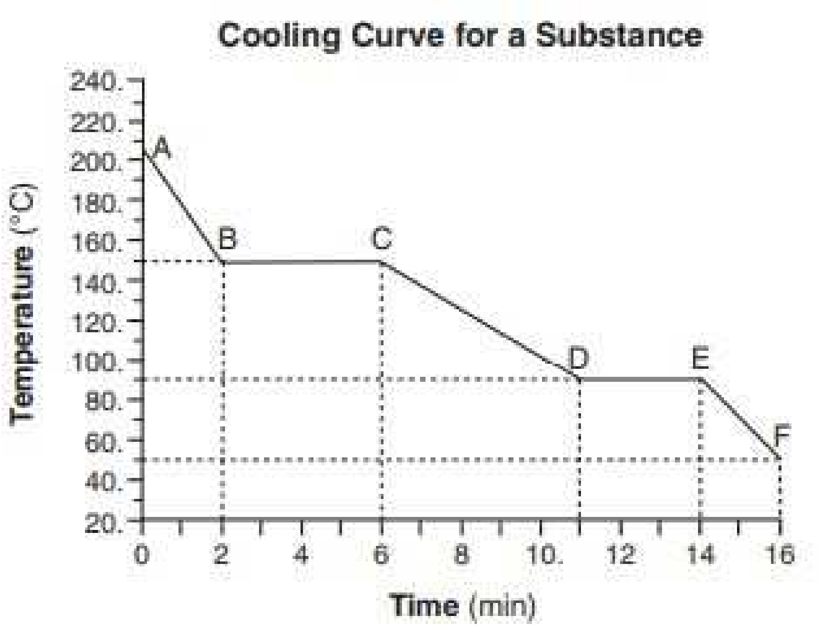
58 Based on Table N, identify the decay mode of cobalt-60. [1] Table N now. BETA PARTICLE or β^{-}

59 Determine the mass of the original sample of cobalt-60 produced. [1] 19.20 grams Honestly, this is worded confusingly. The Co-60 started out 21.084 years ago, and only 1.20 grams is left, the rest of it underwent beta decay. Make the reverse "T" chart, and do the work AFTER you look at table N to find out that this stuff has a half life of 5.271 years. The math will ALWAYS work out perfectly on the regents, always.

19.20 grams	9.60 grams	4.80 grams	2.40 grams	1.20 grams

4 half lives ago 21.084 years ago	3 half lives ago 15.813 years ago	2 half lives ago 10.542 years ago	1 half life ago 5.271 years ago	now

Base your answers to questions 60 through 62 on the information below and on your knowledge of chemistry. A sample of a molecular substance starting as a gas at 206°C and 1 atm is allowed to cool for 16 minutes. This process is represented by the cooling curve below.

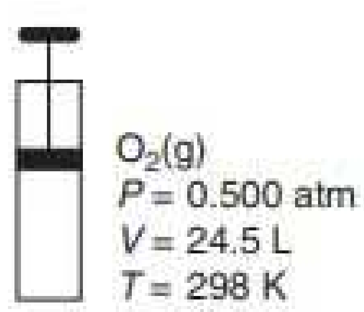


60 Determine the number of minutes that the substance was in the liquid phase, only. [1] 5 MINUTES
On a heating curve, AB is when the gas is cooling. BC is when the gas condenses into a liquid. It's ALL liquid at C. CD is the liquid cooling. DE is liquid freezing into a solid. It's only liquid from B to D, which is from minute "6" to minute "11". 11 - 6 = 5 minutes.

61 Compare the strength of the intermolecular forces within this substance at 180.°C to the strength of the intermolecular forces within this substance at 120.°C. [1]
At 180°C this substance is a gas, the particles are far apart, and not very attracted (compared to their kinetic energy). At 120°C, they are liquid, which means the particles are "sticky, but not stuck" together, clearly the interparticle attractions are stronger in the liquid phase at 120°C.

62 Describe what happens to the potential energy and the average kinetic energy of the molecules in the sample during interval DE. [1]
DE is when the liquid phase is freezing into the solid phase, the kinetic energy is steady because there is NO CHANGE IN TEMPERATURE. Since energy is being removed at a constant rate, it's the POTENTIAL ENERGY that is DECREASING.

Base your answers to questions 63 through 65 on the information below and on your knowledge of chemistry.
The diagram below represents a cylinder with a moveable piston containing 16.0 g of $O_{2(g)}$. At 298 K and 0.500 atm, the $O_{2(g)}$ has a volume of 24.5 liters.



63 Determine the number of moles of $O_{2(g)}$ in the cylinder. The gram-formula mass of $O_{2(g)}$ is 32.0 g/mol. [1]

$$\frac{16.0 \text{ g oxygen}}{1} \times \frac{1 \text{ mole oxygen}}{32.0 \text{ g oxygen}} = 0.500 \text{ moles}$$ (3 SF, but SF don't matter here)

There are LOTS of ways to do this, but the simple way is to convert grams into moles using molar mass.

64 State the changes in both pressure and temperature of the gas in the cylinder that would increase the frequency of collisions between the $O_{2(g)}$ molecules. [1] This question has 2 PARTS, answer BOTH.
Increasing to higher pressure would cause more collisions
Heating to a higher temperature would cause more collisions

65 Show a numerical setup for calculating the volume of $O_{2(g)}$ in the cylinder at 265 K and 1.00 atm. [1]
You have starting conditions and two new conditions, with the V_2 as your unknown. Use the combined gas law, go slowly and put all numbers, with all units, in the right place.

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$\frac{(0.500 \text{ atm})(24.5 \text{ L})}{298 \text{ Kelvin}} = \frac{(1.00 \text{ atm})(V_2)}{265 \text{ Kelvin}}$$

Becomes →

$$(0.500 \text{ atm})(24.5 \text{ L})(265 \text{ Kelvin}) = (298 \text{ Kelvin})(1.00 \text{ atm})(V_2)$$

$$\frac{(0.500 \text{ atm})(24.5 \text{ L})(265 \text{ Kelvin})}{(298 \text{ Kelvin})(1.00 \text{ atm})} = V_2 = 10.89345638 \text{ Liters} = 10.9 \text{ Liters with 3 SF}$$

In the late 1800s, Dmitri Mendeleev developed a periodic table of the elements known at that time. Based on the pattern in his periodic table, he was able to predict properties of some elements that had not yet been discovered. Information about two of these elements is shown in the table below.

Some Element Properties Predicted by Mendeleev			
Predicted Elements	Property	Predicted Value	Actual Value
Eka-Aluminum (Ea)	density at STP	5.9 g/cm^3	5.91 g/cm^3
	melting point	low	30.°C
	oxide formula	Ea_2O_3	
	approximate molar mass	68 g/mol	
Eka-silicon (Es)	density at STP	5.5 g/cm^3	5.3234 g/cm^3
	melting point	high	938°C
	oxide formula	EsO_2	
	approximate molar mass	72 g/mol	

66 Identify the phase of Ea at 310. K. This is data manipulation.
The MELTING POINT (solid becomes liquid) is 30°C. Convert this Kelvin temp to centigrade and decide if it's hotter than the melting point (a liquid) or colder than the melting point (a solid).
K = C + 273 → 310 K = C + 273 → C = 37°C, so it's melting into a LIQUID.

67 Write a chemical formula for the compound formed between Ea and Cl.
Clearly Ea makes a +3 cation, so it would be $EaCl_3$ only.

68 Identify the element that Mendeleev called eka-silicon, Es.
In the same group with silicon (14) with mass about 72 g/mole (or 72 AMU) it has to be GERMANIUM

69 Show a numerical setup for calculating the percent error of Mendeleev's predicted density of Es.
For the very last time in your whole life (probably), write out the % error formula so you get this right. Paper is cheap.

$$\%\ \text{error} = \frac{\text{measured value} - \text{accepted value}}{\text{accepted value}} \times 100$$

BECOMES….

$$\%\ \text{Errror} = \frac{5.5\ \text{g/cm}^3 - 5.3234\ \text{g/cm}^3}{5.3234\ \text{g/cm}^3} \times 100\% = +3.31742\ldots \rightarrow \text{or } +3.3\% \text{ with 2 SF}$$

Methanol can be manufactured by a reaction that is reversible. In the reaction, carbon monoxide gas and hydrogen gas react using a catalyst. The equation below represents this system at equilibrium.

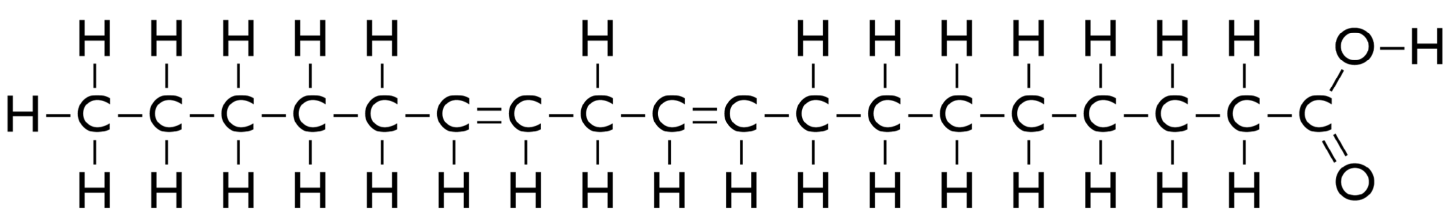
$$CO_{(g)} + 2H_{2(g)} \leftrightarrows CH_3OH_{(g)} + \text{energy}$$

70 State the class of organic compounds to which the product of the forward reaction belongs. [1]
The PRODUCT is the methanol, so you say ALCOHOL.

71 Compare the rate of the forward reaction to the rate of the reverse reaction in this equilibrium system. [1]
Systems in dynamic equilibrium are always changing and always staying the same, so the RATE OF THE FORWARD REACTION EQUALS THE RATE OF THE REVERSE REACTION.

72 Explain, in terms of collision theory, why increasing the concentration of $H_{2(g)}$ in this system will increase the concentration of $CH_3OH_{(g)}$. [1] With more hydrogen gas concentration (either more hydrogen or just increased pressure) there will be MORE COLLLISIONS between the hydrogen gas and the CO_2, so there will be an increase in the forward reaction (making more methanol).

73 State the effect on the rates of both the forward and reverse reactions if no catalyst is used in the system. [1]
Catalysts do NOT change the reaction, just the speed of it. With no catalyst this reaction would slow both rates, forward and reverse, down.



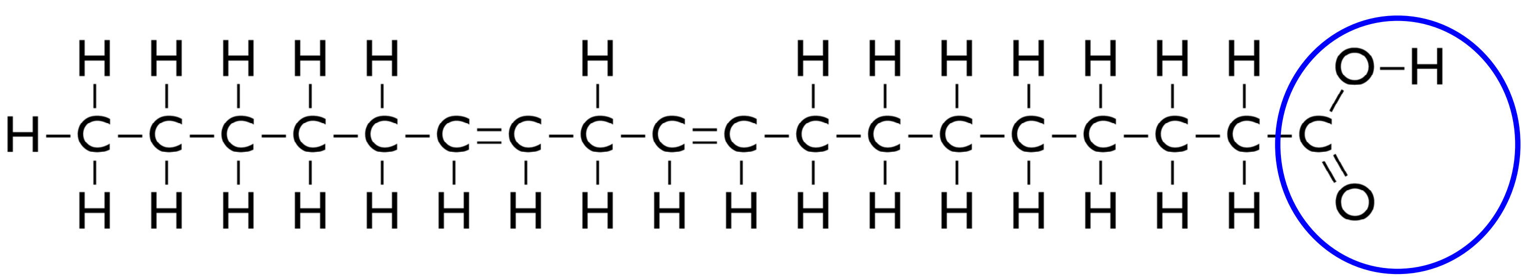
Fatty acids, a class of compounds found in living things, are organic acids with long hydrocarbon chains. Linoleic acid, an unsaturated fatty acid, is essential for human skin flexibility and smoothness.
The formula below represents a molecule of linoleic acid.

74 Write the molecular formula of linoleic acid. [1] JUST COUNT SLOWLY. There are 18 carbon atoms, 32 hydrogen atoms, and 2 oxygens, so $C_{18}H_{32}O_2$ is sufficient. This does not ask for a structural formula, just a simple molecular one. Nothing fancy.

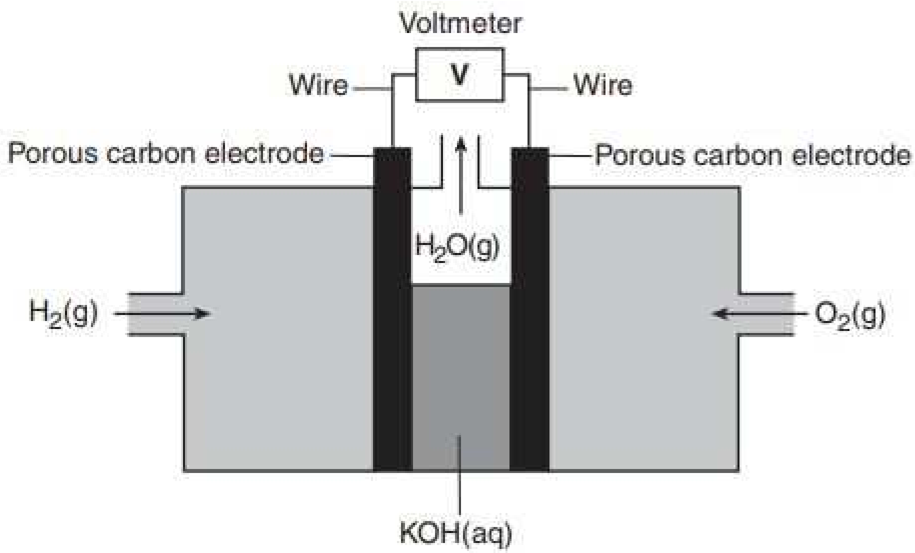
75 Identify the type of chemical bond between the oxygen atom and the hydrogen atom in the linoleic acid molecule. [1] Hydrogen and oxygen make a SINGLE POLAR COVALENT BOND.

76 On the diagram in your answer booklet, circle the organic acid functional group. [1]

circle the —COOH group



Fuel cells are voltaic cells. In one type of fuel cell, oxygen gas, $O_{2(g)}$, reacts with hydrogen gas, $H_{2(g)}$, producing water vapor, $H_2O_{(g)}$, and electrical energy. The unbalanced equation for this redox reaction is shown below. $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(g)}$ energy A diagram of the fuel cell is shown below. During operation of the fuel cell, hydrogen gas is pumped into one compartment and oxygen gas is pumped into the other compartment. Each compartment has an inner wall that is a porous carbon electrode through which ions flow. Aqueous potassium hydroxide, $KOH_{(aq)}$, and the porous electrodes serve as the salt bridge.



77 Balance the equation in your answer booklet for the reaction in this fuel cell, using the smallest whole-number coefficients.

$2H_{2(g)}$ + ______ $O_{2(g)} \rightarrow$ $2H_2O_{(g)}$ + energy

(leave the oxygen as a "1", which we don't write in)

78 Determine the change in oxidation number for oxygen in this operating fuel cell.

This is the reaction to think about: $H_{2(g)} + O_{2(g)} \rightarrow H_2O_{(g)}$

Oxygen starts as a diatomic molecule with a ZERO oxidation number (neutral). It changes to a –2 in H_2O

Your answer is 0 → -2 (or zero to negative two)

79 State the number of moles of electrons that are gained when 5.0 moles of electrons are lost in this reaction.

The number of electrons that are oxidized (LOST) must equal the number reduced (GAINED), so 5.0 moles.

In a laboratory investigation, a student compares the concentration and pH value of each of four different solutions of hydrochloric acid, $HCl_{(aq)}$, as shown in the table below.

Data for $HCl_{(aq)}$ Solutions		
Solution	Concentration of $HCl_{(aq)}$ (M)	pH Value
W	1.0	0
X	0.10	1
Y	0.010	2
Z	0.0010	3

80 State the number of significant figures used to express the concentration of solution Z. 2 SF 0.0010 M

81 Determine the concentration of an HCl(aq) solution that has a pH value of 4.

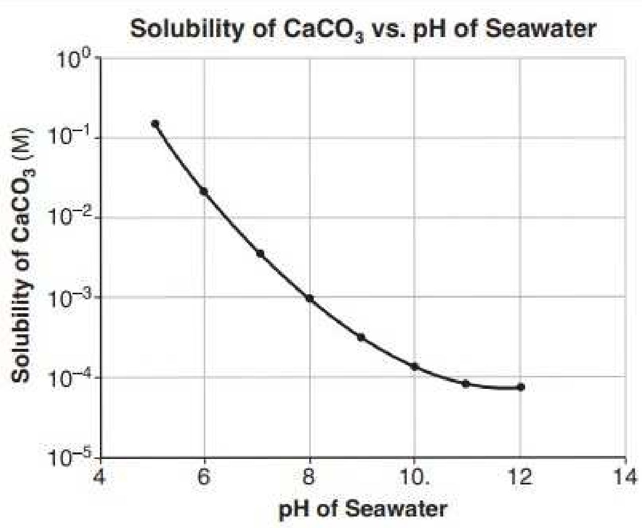
You're supposed to see that with each whole number change in pH increase, there is a 10X drop in the number of hydrogen ions in solution. So a pH of 4 has just 0.00010 M (or 1×10^{-4} M)

82 Determine the volume of 0.25 M NaOH(aq) that would exactly neutralize 75.0 milliliters of solution X.

Use the titration formula from table T: $(M_A)(V_A) = (M_B)(V_B)$ Since the acid is the MONOPROTIC HCl, it has just one H+1 cation per particle, and the base is also a single hydroxide base (NaOH), we can cancel out the modifiers for the ions per particle in this problem.

$(M_A)(V_A) = (M_B)(V_B)$ becomes → $(0.10\text{ M})(75.0\text{ mL}) = (0.25\text{ M})(V_B)$ → $V_B =$ 30 mL of NaOH

Carbon dioxide is slightly soluble in seawater. As carbon dioxide levels in the atmosphere increase, more CO_2 dissolves in seawater, making the seawater more acidic because carbonic acid, $H_2CO_{3(aq)}$, is formed. Seawater also contains aqueous calcium carbonate, $CaCO_{3(aq)}$, which is used by some marine organisms to make their hard exoskeletons. As the acidity of the sea water changes, the solubility of $CaCO_3$ also changes, as shown in the graph below.



83 State the trend in the solubility of $CaCO_3$ as seawater becomes more acidic.

(great question, be careful) This graph shows increasing pH, or more basic. The question is about getting MORE ACIDIC—going to the left side of the graph. The more acidic, the more soluble the calcium carbonate becomes. This in real life means as the oceans get more acidic, the shells and exoskeletons of marine animals (think coral reefs and clams) dissolve more, which is bad.

84 State the color of bromcresol green in a sample of seawater in which the $CaCO_3$ solubility is 10^{-2} M.

A 10^{-2} M calcium carbonate solubility equates with a pH of about 6.4, LOOK at table M now.

SAY BLUE

85 A sample of seawater has a pH of 8. Determine the new pH of the sample if the hydrogen ion concentration is increased by a factor of 100.

A pH of 8.0 is basic. If you increase the H+1 concentration 100X that means you make a 2 whole number change to the more acidic (pH drops), so the answer is pH of 6.0 (or six)