PERIODIC TABLE OF THE ELEMENTS

	1A												3A	4A	5A	6A	7A	8A
	1												13	14	15	16	17	18
1	1 H 1.008	2A 2																2 He 4.003
2	3 Li 6.941	4 Be 9.012											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	11 Na 22.99	12 Mg 24.31	3B 3	4B 4	5B 5	6B 6	7B 7	<--- 8	8B 9	---> 10	1B 11	2B 12	13 Al 26.98	14 Si 28.09	15 P 30.97	16 S 32.07	17 Cl 35.45	18 Ar 39.95
4	19 K 39.10	20 Ca 40.08	21 Sc 44.96	22 Ti 47.88	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 65.39	31 Ga 69.72	32 Ge 72.59	33 As 74.92	34 Se 78.96	35 Br 79.90	36 Kr 83.80
5	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 (99)	44 Ru 101.1	45 Rh 102.9	46 Pd 106.4	47 Ag 107.9	48 Cd 112.4	49 In 114.8	50 Sn 118.7	51 Sb 121.8	52 Te 127.6	53 I 126.9	54 Xe 131.3
6	55 Cs 132.9	56 Ba 137.3	57 La 138.9	72 Hf 178.5	73 Ta 180.9	74 W 183.9	75 Re 186.2	76 Os 190.2	77 Ir 192.2	78 Pt 195.1	79 Au 197.0	80 Hg 200.6	81 Tl 204.4	82 Pb 207.2	83 Bi 209.0	84 Po (209)	85 At (210)	86 Rn (222)
7	87 Fr (223)	88 Ra 226.0	89 Ac 227.0	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (281)	111 Rg (272)	112 Cn (285)	113 Nh (284)	114 Fl (289)	115 Mc (288)	116 Lv (291)	117 Ts (294)	118 Og (294)

Lanthanides	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 157.2	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
Actinides	90 Th 232.0	91 Pa 231.0	92 U 238.0	93 Np 237.0	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 (260)

Fundamental Physical Constants

Avogadro's Number	$N_a = 6.02214 \times 10^{23}$ /mol
Atomic Mass Unit	amu = 1.66054×10^{-27} kg
Charge of the Electron	e = 1.60218×10^{-19} C
Faraday Constant	F = 9.64853×10^{4} C/mol
Mass of the Electron	$m_e = 9.10939 \times 10^{-31}$ kg
Mass of the Neutron	$m_n = 1.67493 \times 10^{-27}$ kg
Mass of the Proton	$m_p = 1.67262 \times 10^{-27}$ kg
Planck's Constant	h = 6.62607×10^{-34} J·s
Speed of Light	c = 2.99792×10^{8} m/s
Acceleration of Gravity	g = 9.80665 m/s^2
Rydberg Constant	$R_H = 1.09677 \times 10^{7}$ m^{-1}
Universal Gas Constant	R = 8.31447 J/mol·K
	R = 0.082058 L·atm/mol·K

Conversions and Relationships

Length	1 km = 1×10^{3} m = 0.621 mile
	1 inch = 2.54 cm 1 ft = 12 in
	1 pm = 1×10^{-12} m = 0.01 Å
Mass	1 kg = 1×10^{3} g = 2.205 lb
	1 metric ton = 1×10^{3} kg
Volume	1 dm^3 = 1×10^{-3} m^3 = 1 liter
	1 cm^3 = 1 mL 1 m^3 = 35.3 ft^3
	1 gallon = 3.785 liters
Energy	1 J = 1 kg·m^2/s^2 = 1 C·V
	1 calorie = 4.184 J
Temperature	T(K) = T(°C) + 273.15
	T(°C) = (T(°F) – 32)(5/9)
	H_2O: mp = 0°C and bp = 100°C
Pressure	1 Pa = 1 N/m^2 = 1 kg/m·s^2
	1 atm = 1.01325×10^{5} Pa
	1 atm = 760 torr = 760 mmHg
Math	$\pi = 3.1416$ e = 2.7183

Equations

$\Delta E = \Delta U = q + w \qquad \Delta H = \Delta E + \Delta(PV) \qquad q = mc\Delta T \qquad w = -P_{ext}\Delta V$

$\Delta H^\circ_{rxn} = \sum mol \cdot \Delta H^\circ_f\,(products) - \sum mol \cdot \Delta H^\circ_f\,(reactants)$

$\Delta H^\circ_{rxn} = \sum mol \cdot BE\,(bonds\ broken) - \sum mol \cdot BE\,(bonds\ formed)$

$c = \lambda\nu \qquad \Delta E = h\nu \qquad \Delta E = \frac{hc}{\lambda} \qquad \Delta E = -2.18 \times 10^{-18}\,J\left(\frac{1}{n_f^2} - \frac{1}{n_i^2}\right)$

M = molar mass $d = MP/RT$ $M = mRT/PV$

$PV = nRT \qquad \frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2} \qquad KE = \frac{3}{2}RT = \frac{1}{2}mv^2$

$F_e = \frac{kQ_1Q_2}{d^2} \qquad v_{rms} = \sqrt{\frac{3RT}{M}} \qquad \frac{Rate_A}{Rate_B} = \frac{\sqrt{M_B}}{\sqrt{M_A}}$

$P_A = X_A \cdot P_{total} \qquad (P + n^2a/V^2)(V - nb) = nRT$

$\ln\left(\frac{P_2}{P_1}\right) = \frac{-\Delta H_{vap}}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad \ln\left(\frac{k_2}{k_1}\right) = \frac{-E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right) \qquad k = Ae^{-E_a/RT}$

$P_{solvent} = X_{solvent}P^\circ_{solvent} \qquad \Delta P = (X_{solute}P^\circ_{solvent})i \qquad \Pi = (MRT)i$

$\Delta T_{bp} = (k_{bp} \cdot m)i \qquad \Delta T_{fp} = (k_{fp} \cdot m)i \qquad S_{gas} = k_H \cdot P_{gas}$

$[A]_t = -kt + [A]_0 \qquad \ln[A]_t = -kt + \ln[A]_0 \qquad \frac{1}{[A]_t} = kt + \frac{1}{[A]_0}$

$t_{1/2} = \frac{[A]_0}{2k} \qquad t_{1/2} = \frac{ln2}{k} \qquad t_{1/2} = \frac{1}{k[A]_0}$

Solubility Rules

1. All common compounds of Group 1A ions and NH_4^+ are soluble
2. All common nitrates, acetates, and most perchlorates are soluble
3. All common chlorides, bromides, and iodides are soluble, except those of Ag^+, Pb^{2+}, Cu^+, and Hg_2^{2+}. All common fluorides are soluble, except those of Pb^{2+} and Group 2A
4. All common sulfates are soluble, except those of Ca^{2+}, Sr^{2+}, Ba^{2+}, Ag^+, and Pb^{2+}
5. All common metal hydroxides are insoluble, except those of Group 1A and the larger members of Group 2A (starting with Ca^{2+})
6. All common carbonates and phosphates are insoluble, except those of Group 1A and NH_4^+
7. All common sulfides are insoluble, except those of Groups 1A, 2A, and NH_4^+

Exam 2 – CHM 2045 – Fall 2020 – Study Review, Questions Only

Question 1 — 10 pts

A sample of an ideal gas occupies 11.64 L at 464.6°C. Assuming that the pressure remains constant, what temperature (in °C) is needed to reduce the volume to 1.78 L?

Enter a number in degrees Celsius to 1 decimal places.

Question 2 — 10 pts

Not all pollution is due to human activity. Natural sources, including volcanoes, also contribute to air pollution. A scientist tries to generate a mixture of gases similar to those found in a volcano by introducing 15 g of water vapor, 5.4 g of SO_2, and 1.1 g of CO_2 into a 53 L vessel held at 136 °C.

Calculate the total pressure (in atm) of the mixture of gases. Enter a number to 4 decimal places.

Question 3 — 10 pts

An unknown liquid is vaporized in a 263 mL flask by immersion in a water bath at 104 °C. The barometric pressure is 753 torr. If the mass of the vapor retained in the flask is 1.618 g, what is its molar mass of the unknown liquid? The volume of the unknown liquid is negligible.

Enter your answer numerically (without units) to two decimal places.

Question 4 — 5 pts

Assuming ideal gas behavior, which of the following gases would have the lowest density at standard temperature and pressure?

- ○ Kr
- ○ CO_2
- ○ SF_6
- ○ CF_2Cl_2
- ○ OF_2

Question 5 — 10 pts

Hydrogen gas (a potential future fuel) can be formed by the reaction of methane with water according to the equation:

$$CH_{4(g)} + H_2O_{(g)} \rightarrow CO_{(g)} + 3\ H_{2(g)}$$

In a particular reaction, 27.4 L of methane gas (measured at a pressure of 659 torr and a temperature of 24.2 °C) mixes with 25.9 L of water vapor (measured at a pressure of 686 torr and a temperature of 26.8 °C). The reaction produces 16.2 L of hydrogen gas at STP.

What is the percent yield of the reaction?
(round your answer up to one decimal place)

Question 6 — 5 pts

At which pressure would H_2 be expected to behave more ideally?

- ○ 100 atm
- ○ 500 atm
- ○ 1000 atm
- ○ 1 atm
- ○ 300 atm

Question 7 — 10 pts

A system suffers an increase in internal energy of 115.2 J and at the same time the gas in the system is compressed from 352 mL to 294 mL by a constant external pressure of 4.8 atm. What is the heat change of the system?

101.3 J = 1 L/atm.

Report your answer with the correct sign (+/—) to 1 decimal place.

Question 8 — 10 pts

When 12.1 g KBr is dissolved in enough water to give 191 g of the solution in a coffee-cup calorimeter, the temperature drops from 53.1 °C to 22.9 °C. If the solution has a specific heat capacity which is essentially the same as water, 4.184 J/g· °C, calculate the enthalpy change in **J per gram** of KBr dissolved.

round your answer up to an integer number (to 0 decimal places)

Question 9 — 10 pts

Nitromethane (CH_3NO_2) burns in air to produce significant amounts of heat.

$2\ CH_3NO_2(l) + 3/2\ O_2(g) \longrightarrow 2\ CO_2(g) + 3\ H_2O(l) + N_2(g) \quad \Delta H°_{rxn} = -1418\ kJ$

How much heat is produced by the complete reaction of 0.313 kg of nitromethane?

Enter your answer numerically up to 2 decimal places and in terms of kJ (do not use scientific notation). Enter a positive number.

Question 10 — 10 pts

Given the series of reactions with known changes of enthalpy:

$3A + 3B \rightarrow C + 2D$	$\Delta H_1 = 9$ kJ/mol
$C + 3E \rightarrow 3A + F$	$\Delta H_2 = -242$ kJ/mol
$3G \rightarrow 2D + F$	$\Delta H_3 = 24$ kJ/mol

Figure out change of enthalpy (ΔH) of the reaction:

$$B + E \rightarrow G$$

Write your answer in term of kJ/mol (number only) to 1 decimal place.

Question 11

10 pts

Find the standard enthalpy of the schematic reaction (ΔH^{o}_{rxn}) described by the equation:

$$4\ A_2 + 4\ B \rightarrow 5\ C + 12\ D_4$$

Standard enthalpies of formation of reactants and products are (in kJ/mol)

$\Delta H_f^{o}(A_2)$	$\Delta H_f^{o}(B)$	$\Delta H_f^{o}(C)$	$\Delta H_f^{o}(D_4)$
164	91	357	-72

Write your answer in terms of kJ (number only) to 0 decimal places.

Question 12

10 pts

In a bomb calorimeter compartment surrounded by 1.047 kg of water, the combustion of 1.41 g of benzene, C_6H_6 (l), raised the temperature of the water from 23.640 °C to 32.692 °C. Find the heat capacity of the calorimeter in kJ/°C. ΔE for the reaction is −2,680.3328 kJ/mol of C_6H_6 (l). The specific heat of water is 4.184 J/g·°C.

- ○ 965 kJ/°C
- ○ 0.874 kJ/°C
- ○ 1.056 kJ/°C
- ○ 652 kJ/°C
- ○ 0.965 kJ/°C

Question 13

8 pts

Express the rate of this reaction in terms of the change in concentration of F (assume all are gases):

$$3\,A + 8\,B + 7\,C \longrightarrow 5\,D + 3\,F$$

When C is decreasing at 1.984 M/s, how fast is F increasing?

Enter your answer without units to 3 decimal places.

Question 14

7 pts

Consider the reaction: $3\,A + 5\,B \longrightarrow 3\,C$

If the rate of consumption of A is 0.924 M/s, what is the rate of reaction?

Enter a positive number without units to 3 decimal places.

Question 15

10 pts

Given the individual reaction orders for all substances and the overall reaction order from the following rate law: rate = k [A] [B]^2

By what factor does the rate change if each of the following changes occur?

[Select 0.5, 2, 0.25, 1, 4, 0.125, 8] is doubled;

[Select 0.5, 2, 0.25, 1, 4, 0.125, 8] is halved;

[Select 0.5, 2, 0.25, 1, 4, 0.125, 8] is doubled and [B] is halved?

Question 16

10 pts

For the reaction $2\ NO + O_2 \rightarrow 2\ NO_2$, initial rate data are:

Experiment	[NO], M	$[O_2]$, M	Initial Rate, M/s
1	0.030	0.060	2.5×10^{-5}
2	0.030	0.020	2.5×10^{-5}
3	0.060	0.060	10.0×10^{-5}

The rate law is Rate = $k[NO]^x[O_2]^y$. What are the values of x and y respectively?

- ○ x = 2, y = 2
- ○ x = 0, y = 2
- ○ x = 2, y = 1
- ○ x = 2, y = 0
- ○ x = 1, y = 1

Question 17

10 pts

A decomposition reaction has a rate constant of 1.458×10^{-3} 1/yr. How long does it take for reactant concentration to reach 39.8% of its original value.

Enter how many years (number only) to 0 decimal places.

Question 18

10 pts

For the reaction: $A(g) \rightarrow B(g) + C(g)$, the rate law is: rate = $k[A]$

At 300 K, the half-life is 345 seconds and the activation energy is 103.3 kJ/mol. What is the rate constant at 442 K?

Report your answer without units to 0 decimal places.

Question 19

5 pts

According to the Bohr model, an electron transition from n = 5 to n = 3 in a hydrogen atom represents emission of a longer wavelength than that of a transition from n= 3 to n = 1

- ○ True
- ○ False

Question 20

8 pts

The frequency of a certain light is 5.2×10^{14} Hz, what is the wavelength in nm?

Enter a number only, in nm to 1 decimal place.

Question 21

10 pts

A laser emits at a wavelength of 473 nm. All of its output energy is absorbed in a detector that measures a total energy of 1.32×10^{-16} J. How many photons are being emitted by the laser?

Enter the number of photons to 0 decimal places.

Question 22

10 pts

How many orbitals in an atom can have the following quantum number designations. Enter a numerical value only (e.g. 0, 1, 2, 3 ...)

Designation	Number of Orbitals
n = 3	
n = 4, *l* = 3	

Question 23

2 pts

Scratch paper: I am in the process of making very small pieces out of my scratch paper (aka confetti) and showing that process to the camera.

On my honor, I have neither given nor received unauthorized aid in doing this assignment.

- ○ True
- ○ False