General Chemistry 1 *(CHEM 1141)*

Shawnee State University – Fall 2019

November 14, 2019

Exam # 3 A

Name KEY

Please write your full name, and the exam version (3 A) that you have on the scantron sheet !
(Bubble in the best answer choice for each question on the green & white scantron sheet in pencil !)

Please ☑ check the box next to your correct section number.

Section Number

❒ 1. (Monday Lab, 11:10 AM – 1:55 PM)

❒ 2. (Wednesday Lab, 11:10 AM – 1:55 PM)

❒ 3. (Monday Lab, 2:30 PM – 5:20 PM)

❒ 4. (Wednesday Lab, 2:30 PM – 5:20 PM)

❒ 5. (Thursday Lab, 12:30 PM – 3:20 PM)

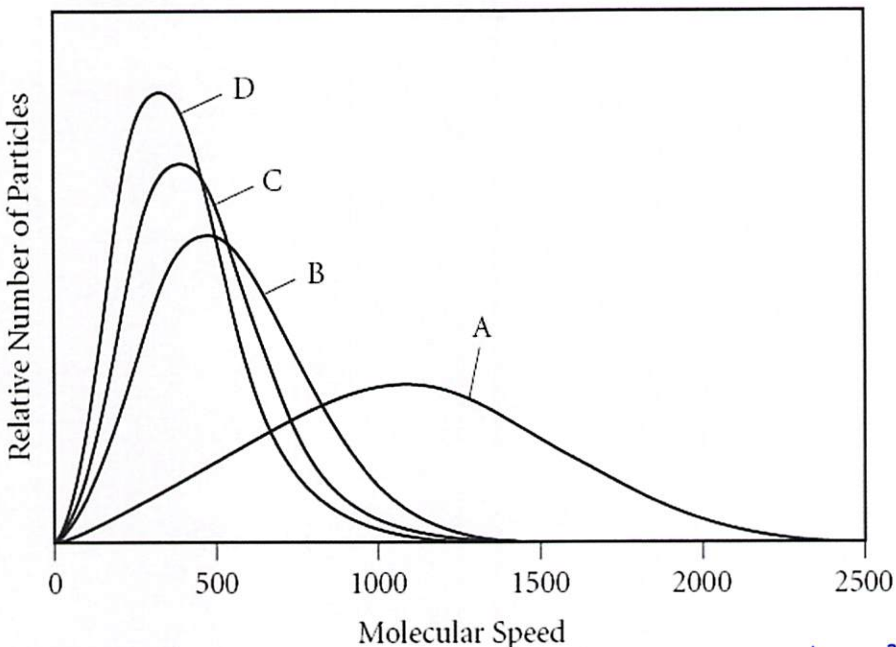
❒ 6. (Tuesday Lab, 12:30 PM – 3:20 PM)

Multiple Choice:	________	**/ 50**
Q21:	________	**/ 10**
Q22:	________	**/ 10**
Q23:	________	**/ 10**
Q24:	________	**/ 10**
Q25:	________	**/ 10**
BONUS:	________	**/ 3**
TOTAL:	________	**/ 100**

You are only allowed to use a TI30–XIIS or equivalent non–programmable calculator on this exam !
(This means no cell phones, no smart phones, no smart watches, no ipads, or any other such devices will be allowed !)

Each problem in this section (multiple choice) is worth 2.5 points !

Q1. Which of the gases in the graph below has the **smallest** molar mass?



A) A

@ given temp, avg KE ∝ T, $KE = \frac{1}{2}mv^2$
so if m↓, v↑

B) B

C) C

D) D

V ∝ T
→ double T, double V

Q2. If a sample of gas is warmed up from 75 K to 150 K, while also increasing its pressure from 2.0 atm to 4.0 atm, by what factor will its volume change?

P ∝ 1/V, double P, halve V

VOL
↳ Temp: ×2
Press: ×1/2
×1 ~ no change!

A) It will be four times larger than before

B) It will be the same size

C) It will be twice as small as before

D) It will be eight time smaller than before

Q3. A mixture of He and Ne at a total pressure of 0.95 atm is found to contain 0.32 mol of He and 0.56 mol of Ne. The partial pressure of Ne is _______ atm.

A) 1.83 atm

B) 0.60 atm

C) 0.53 atm

D) 0.64 atm

$P_{Ne} = X_{Ne} \cdot P_{TOT}$

$X_{Ne} = \frac{n_{Ne}}{n_{TOT}} = \frac{0.56 mol}{0.32 mol + 0.56 mol} = 0.636$

$\rightarrow P_{Ne} = 0.636 \times 0.95 atm = 0.60 atm.$

Q4. The pressure of a sample of CH_4 gas (6.022 g) in a 30.0 L vessel at 402 K is _____ atm.

A) 2.42 atm

B) 6.62 atm

C) 0.413 atm

D) 22.4 atm

$pV = nRT \rightarrow p = \frac{nRT}{V}$

$n = 6.022 g\ CH_4 \times \frac{1 mol\ CH_4}{16.04 g\ CH_4} = 0.37544 mol$

$p = \frac{nRT}{V} = \frac{0.37544 mol \times 0.08206 \frac{atm \cdot L}{mol \cdot K} \times 402 K}{30.0 L}$

$= 0.413 atm.$

Q5. Which of the following is used to calculate the properties of a nonideal gas?

A) Charles's Law

B) Dalton's Law of partial pressures

C) van der Waals equation

D) Avogadro's Law

$\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT$

a: intermolecular forces

b: molecular volumes (excluded volumes)

Q6. What must be held constant for the change in enthalpy to be equal to the heat?

A) volume $\Delta H = q_p$

B) number of moles $\Delta E = q_v$

C) temperature

D) pressure

Q7. It takes 11.2 kJ of energy to raise the temperature of 145 g of benzene from 22.0°C to 67.0°C. What is the specific heat of benzene?

$1\ kJ = 1{,}000\ J$

A) 1.72 J/g·°C

$q = m \cdot C_s \cdot \Delta t$

B) 1.14 J/g·°C

$\rightarrow C_s = \frac{q}{m \cdot \Delta t} = \frac{11{,}200\ J}{145g \times (67.0°C - 22.0°C)}$

C) 3.50 J/g·°C

$= 1.72\ J/g \cdot °C$

D) 5.25 J/g·°C

form 1 mol of substance from its elements in their most stable form!

Q8. Choose the reaction that illustrates $\Delta H°_f$ for $Mg(NO_2)_2(s)$.

A) $Mg(s) + N_2(g) + 2\ O_2(g) \rightarrow Mg(NO_2)_2(s)$

B) $Mg^{2+}(aq) + 2\ NO_2^-(aq) \rightarrow Mg(NO_2)_2(s)$

C) $Mg(s) + 2\ N(g) + 4\ O(g) \rightarrow Mg(NO_2)_2(s)$

D) $Mg(NO_2)_2(s) \rightarrow Mg(s) + N_2(g) + 4\ O_2(g)$

most stable form of element has $\Delta H_f^\circ = 0$

Q9. Identify the substance that has a $\Delta H^\circ_f = 0$ at 25°C.

A) $O_3(g)$ — Oxygen: $O_2(g)$ is most stable form!

B) C(s, diamond) — carbon: C(s, graphite) " ——— "

C) Hg(s) — mercury: Hg(l) " ——— " (one of two liquid elements! Bromine is other)

D) Ne(g)

Q10. Calculate the energy of orange light emitted by a neon sign with a frequency of 4.89×10^{14} Hz? (s^{-1})

$E = h\nu = 6.626\times10^{-34}\ J{\cdot}s \times 4.89\times10^{14}\ s^{-1}$
$= 3.24\times10^{-19}\ J$

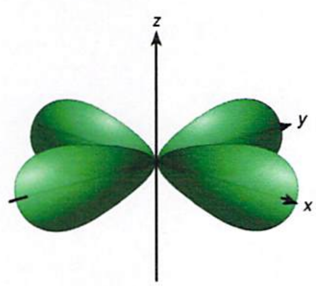
A) 3.09×10^{-19} J

B) 6.14×10^{-19} J

C) 3.24×10^{-19} J

D) 5.11×10^{-19}J

Q11. The following best represents what kind of orbital?



$d_{x^2-y^2}$

A) s

B) p

C) d

D) f

Q12. Identify a correct set of quantum numbers for a 4d orbital.

A) $n = 3, l = 2, m_l = -1$

B) $n = 4, l = 2, m_l = 0$

C) $n = 2, l = 1, m_l = 0$

D) $n = 4, l = 3, m_l = 1$

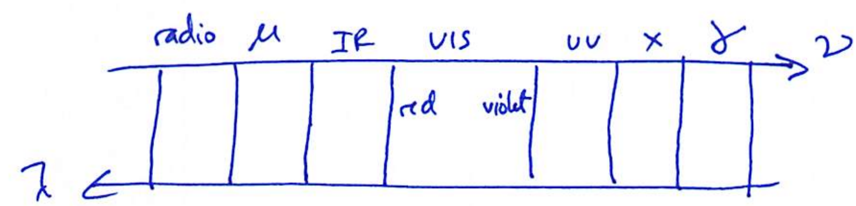
Q13. Which of the following visible colors of light has the **longest** wavelength?

A) red

B) green

C) yellow

D) violet



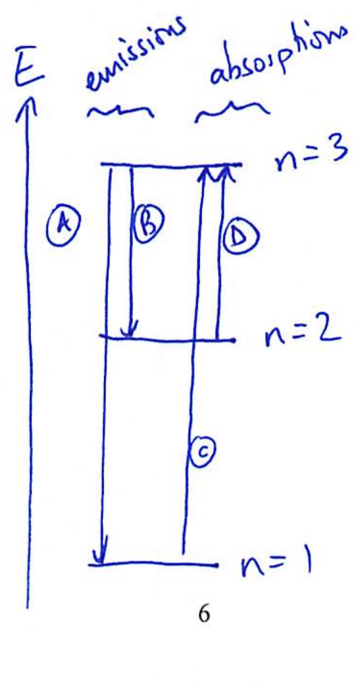
Q14. Which electronic transition in a hydrogen atom would result in **absorption** of the **longest wavelength** of light?

A) $n = 3 \longrightarrow n = 1$

B) $n = 3 \longrightarrow n = 2$

C) $n = 1 \longrightarrow n = 3$

D) $n = 2 \longrightarrow n = 3$



Q15. A __________ ΔH corresponds to an __________ process.

A) negative, exothermic

B) negative, endothermic

C) positive, exothermic

D) zero, endothermic

Q16. An example of an intensive property is :

extensive : depends on amount

intensive : doesn't depend on amount!

A) number of moles

B) specific heat capacity

heat capacity per gram per degree celcius — so intensive!

C) heat

D) enthalpy change

Q17. How many significant figures does the measurement 0.040 L contain?

trailing zeros: ✓ if decimal point!
non-zero digit ✓
leading zeros: ✗

A) one

B) two

C) three

D) four

metal + non-metal → IONIC

transition metal: usually has variable charge!

Q18. The correct name for VO_3 is:

? (2-) (2-) (2-)
V O O O
must be 6+

→ vanadium(VI) oxide

A) vanadium trioxide

B) vanadium(III) oxide

C) vanadium oxide

D) vanadium(VI) oxide

1 mol H_2O → 2 mol H

Q19. How many hydrogen atoms are contained in 18.02 g of H_2O?

$18.02\,g\,H_2O \times \frac{1\,mol\,H_2O}{18.02\,g\,H_2O} \times \frac{2\,mol\,H}{1\,mol\,H_2O} \times \frac{6.022\times10^{23}}{1\,mol}$

$= 12.044\times10^{23}$ atoms H

or 1.204×10^{24} atoms H

A) 2.011×10^{23} atoms

B) 6.022×10^{23} atoms

C) 1.204×10^{24} atoms

D) 1.806×10^{24} atoms

caused red (was itself ox.)

Q20. Which substance is the reducing agent in the following chemical equation:

$$\overset{(0)}{Zn(s)} + 2\,\overset{(+1)(-1)}{HCl(aq)} \rightarrow \overset{(0)}{H_2(g)} + \overset{(+2)(-1)}{ZnCl_2(aq)}$$

RED (H: +1 → 0); OX (Zn: 0 → +2)

A) Zn(s)

"caused" H in HCl to be reduced!

B) HCl(aq)

C) $H_2(g)$

D) $ZnCl_2(aq)$

Each problem in this section (short answer) is worth 10 points !

All work must be shown in order to receive full credit !

You must use the factor–label (conversion–factor) method for all conversions !

Be sure to include units where applicable !

All numeric answers must be rounded to the correct number of significant figures !

Q21. 34.4 mL of 1.42 M HBr(aq) is added to an excess of Zn. What volume of gas would be produced at a temperature of 37°C and a pressure of 248 mmHg?

$H_2(g)$

Zn(s) + 2HBr(aq) ⟶ $ZnBr_2$(aq) + H_2(g)

$PV = nRT$

$\rightarrow V = \frac{nRT}{P}$

n = #mol GAS (H_2)

#mol H_2

$34.4\,mL \times \frac{1\,L}{1000\,mL} \times \frac{1.42\,mol\,HBr}{1\,L} \times \frac{1\,mol\,H_2(g)}{2\,mol\,HBr} = 0.0244\,mol\,H_2(g)$

$P = 248\,mmHg \times \frac{1\,atm}{760\,mmHg} = 0.3263\,atm$

$t = 37°C$, $T = 37 + 273.15 = 310.\,K$

(0dp) (2dp) (0dp)

$\rightarrow V = \frac{nRT}{P} = \frac{0.0244\,mol \times 0.08206\,\frac{atm \cdot L}{mol \cdot K} \times 310.\,K}{0.3263\,atm}$

$= \boxed{1.90\,L}$ 3s.f.

Q22. **(a)** Calculate ΔH for the reaction:

$$CH_4(g) + 4\ Cl_2(g) \longrightarrow CCl_4(g) + 4\ HCl(g)$$

Use the following reactions and given ΔH's:

(1) $C(s) + 2\ H_2(g) \longrightarrow CH_4(g)$ ΔH = -74.6 kJ

(2) $C(s) + 2\ Cl_2(g) \longrightarrow CCl_4(g)$ ΔH = -95.7 kJ

(3) $H_2(g) + Cl_2(g) \longrightarrow 2\ HCl(g)$ ΔH = -92.3 kJ

Show your work clearly!

reverse (1): $CH_4(g) \longrightarrow C(s) + 2H_2(g)$; ΔH = +74.6 kJ (reverse ΔH)

no change (2): $C(s) + 2Cl_2(g) \longrightarrow CCl_4(g)$; ΔH = -95.7 kJ

double (3): $2H_2(g) + 2Cl_2(g) \longrightarrow 4HCl(g)$; ΔH = -184.6 kJ (double ΔH)

$CH_4(g) + 4Cl_2(g) \longrightarrow CCl_4(g) + 4HCl(g)$; ΔH = -205.7 kJ.

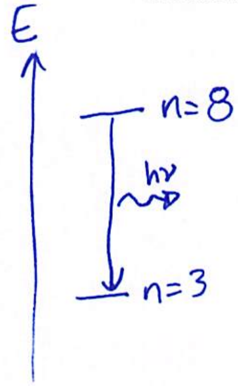
(b) Calculate the amount of heat absorbed or released when 25.0 g of HCl is produced according to the ΔH found for your answer in part (a).

$$q = 25.0\,g\ HCl \times \frac{1\,mol\ HCl}{36.46\,g\ HCl} \times \frac{-205.7\,kJ}{4\,mol\ HCl} = -35.3\,kJ.$$

(c) State whether heat is **absorbed or released** for part (b).

released

Q23. **(a)** The Paschen lines in a hydrogen atom result from transitions from/to the n=3 level. Calculate the wavelength of light emitted or absorbed when the transition n=8 → n=3 occurs.



$E_n = -\frac{R_H}{n^2}$, $R_H = 2.18\times10^{-18}$ J

$\Delta E = -\frac{R_H}{3^2} \ominus -\frac{R_H}{8^2} = R_H\left(\frac{1}{8^2}-\frac{1}{3^2}\right) = 2.18\times10^{-18}\text{J}\times\left(\frac{1}{64}-\frac{1}{9}\right) = -2.08\times10^{-19}$ J

$E_3 - E_8$ (f, i)

atom loses E! (-ve)

$E_{photon} = -E_{atom} = +2.08\times10^{-19}$ J

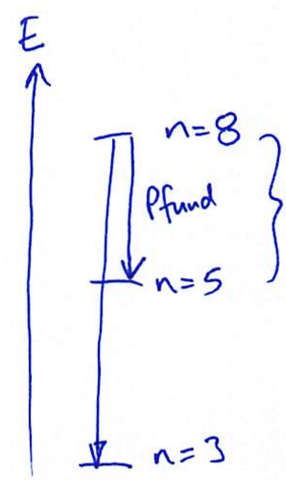
$E = \frac{hc}{\lambda} \rightarrow \lambda = \frac{hc}{E} = \frac{6.626\times10^{-34}\text{ J}\cdot\text{s} \times 3.00\times10^{8}\text{ m}\cdot\text{s}^{-1}}{2.08\times10^{-19}\text{ J}}$

$= 9.56\times10^{-7}$ m

(957 nm)

(b) The transition n=8 → n=3 represents an ___emission___. (emission or absorption)

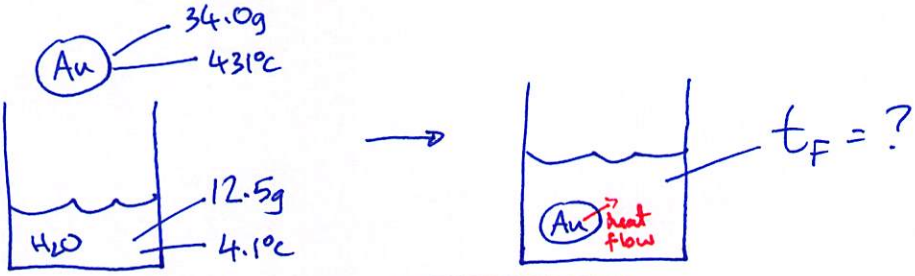
(c) The Pfund lines result from a transition from/to the n=5 level. When comparing the n=8 → n=3 transition to the n=8 → n=5 transition, the n=8 → n=5 transition has a ___smaller___ (smaller, higher) energy with a photon that has a ___longer___ (shorter, longer) wavelength.



} smaller ΔE → longer λ, since $E = \frac{hc}{\lambda}$

or $E \propto 1/\lambda$

Q24. A gold coin that weighs 34.0g is heated up to a temperature of 431°C. It is then immediately dropped into an insulated beaker of water that contains 12.5 grams of water at a temperature of 4.1°C. Calculate the final temperature of the gold/water system. Note: the specific heat capacity of water is 4.184 J/g·°C, and that of gold is 0.129 J/g·°C. Assume that the system is perfectly isolated.



$$\boxed{q_{H_2O} = -q_{Au}}$$

– heat lost (–) by Au is gained (+) by H_2O

$$q_{H_2O} = -q_{Au}$$

$$\Rightarrow m_{H_2O} \times C_{s,H_2O} \times \Delta t_{H_2O} = -m_{Au} \times C_{s,Au} \times \Delta t_{Au}$$

$$\rightarrow 12.5g \times 4.184\ J/g\cdot°C \times (t_F - 4.1°C) = -34.0g \times 0.129\ J/g\cdot°C \times (t_F - 431°C)$$

$$\rightarrow 52.3\ \tfrac{J}{°C} \times t_F - 214.43J = -4.386\ \tfrac{J}{°C} \times t_F + 1890.4J$$

$$\rightarrow 2104.8J = 56.686\ J/°C \times t_F$$

$$\rightarrow t_F = \frac{2104.8J}{56.686\ J/°C} = \boxed{37.1°C}$$

Q25. Place the correct number next to the letter of the definition or phrase that best matches.

8 A. number of wave cycles that pass through a stationary point	1. n
3 B. the vertical height of a wave	2. radio
5 C. the distance between adjacent crests of a wave	3. amplitude
10 D. quantum number that describes the shape of an orbital	4. gamma rays
6 E. quantum number that describes the orientation in space of the orbital	5. wavelength
1 F. quantum number that describes the size and energy of an orbital	6. m_l
9 G. quantum number with possible values of +1/2 and -1/2	7. Ψ^2
7 H. represents the probability of finding an electron at a point in space	8. frequency
2 I. type of electromagnetic radiation with the lowest energy	9. m_s
4 J. type of electromagnetic radiation with the highest energy	10. l

3 Point Bonus Question

Determine the molar mass of a gas that has a density of 6.70 g/L at STP. Show all work!

$\mathcal{M} = \frac{dRT}{P}$ (given)

STP: 1 atm, 273.15 K, 0°C } exact

$$= \frac{6.70\,g/L\ (3sf) \times 0.08206\,\frac{atm \cdot L}{mol \cdot K}\ (4s.f.) \times 273.15\,K\ (exact)}{1\,atm\ (exact)}$$

= 150. g/mol (3s.f.)

OR

= 1.50×10^2 g/mol (3s.f.)

Exam checklist

(Check the boxes to certify the following:)

❒ My full name is written legibly on the front page

❒ My correct lab section has been indicated on the front page

❒ My full name is written legibly on the scantron sheet

❒ My exam version *(3A, 3B, 3C, or 3D)* is written on the scantron sheet

❒ I have shown work for all problems *(where appropriate)*, paying attention to

- Significant figures / decimal places
- Units

❒ I have used the conversion–factor method for all conversions

❒ If I have torn off the back page *(periodic table)*, I will not turn it in with my exam!

Thank–you from the Chemistry Professors and Good Luck!

Useful Information

1 atm = 760 mmHg = 101,325 Pa

$PV = nRT$

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

$P_i = X_iP_T$

$P_T = P_A + P_B + \ldots$

$d = P\mathcal{M} / RT$ $\quad \mathcal{M} = dRT/P$ $\quad u_{rms} = \sqrt{3RT/M}$ $\quad r_1/r_2 = \sqrt{M_2/M_1}$

$q = m \cdot C_s \cdot \Delta t$ $\quad q = C \cdot \Delta t$

$$\Delta E = R_H\left(\frac{1}{n_i^2} - \frac{1}{n_f^2}\right) \qquad E_n = -R_H\left(\frac{1}{n^2}\right)$$

$R_H = 2.18 \times 10^{-18}$ J

$$R = 0.08206 \frac{\text{atm} \cdot \text{L}}{\text{mol} \cdot \text{K}}$$

$c = \nu \cdot \lambda$ $\quad E = h \cdot c / \lambda = h \cdot \nu$

$c = 3.00 \times 10^8$ m/s $\quad h = 6.626 \times 10^{-34}$ J·s $\quad N_A = 6.022 \times 10^{23}$

Periodic Table of the Elements

IA *1*	IIA *2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	IIIA *13*	IVA *14*	VA *15*	VIA *16*	VIIA *17*	VIIIA *18*
1 **H** 1.008																	2 **He** 4.003
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
11 **Na** 22.99	12 **Mg** 24.31											13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.07	17 **Cl** 35.45	18 **Ar** 39.95
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** 65.39	31 **Ga** 69.72	32 **Ge** 72.61	33 **As** 74.92160	34 **Se** 78.96	35 **Br** 79.90	36 **Kr** 83.80
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** 101.1	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** 127.60	53 **I** 126.9	54 **Xe** 131.3
55 **Cs** 132.9	56 **Ba*** 137.3	71 **Lu** 175.0	72 **Hf** 178.5	73 **Ta** 180.9	74 **W** 183.8	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** [210]	85 **At** [210]	86 **Rn** [222]
87 **Fr** [223]	88 **Ra**** [226]	103 **Lr** [262]	104 **Rf** [261]	105 **Db** [262]	106 **Sg** [266]	107 **Bh** [264]	108 **Hs** [265]	109 **Mt** [268]	110 [269]	111 [272]	112 [277]	113	114 [285]	115	116 [289]	117	118 [293]

*	57 **La** 138.9	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** 162.50	67 **Ho** 164.9	68 **Er** 167.3	69 **Tm** 168.9	70 **Yb** 173.0
**	89 **Ac** [227]	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]