

Name: KEY

Part I. Multiple Choice: Clearly circle the best answer. (60 pts)

1. Which of the following cannot be separated into a simpler substance by chemical means?

- A A) Element
B) Compound
C) Homogeneous mixture
D) Heterogeneous mixture

2. Which of the following does not have a uniform composition throughout?

- D A) Element
B) Compound
C) Homogeneous mixture
D) Heterogeneous mixture

3. Isopropyl alcohol, commonly known as rubbing alcohol, boils at 82.4°C. What is the boiling point in Kelvin?

- A A) 355.6 K
B) 323.6 K
C) 190.8 K
D) -190.8 K

$$82.4^{\circ}\text{C} + 273.15\text{K} = 355.6\text{K}$$

4. Which of the following is a chemical change?

- B A) Melting wax
B) Broiling a steak on a grill
C) Condensing water vapor into rainfall
D) Carving a piece of wood

5. Which one of these represents a *physical* change?

- A A) Water, when heated, forms steam
B) Bleach turns hair yellow
C) Milk turns sour
D) Apples, when exposed to air, turn brown

6. The result of $(3.8621 \times 1.5630) - 5.98$ is properly written as

- A A) 0.06
B) 0.056
C) 0.0565
D) 0.05646

7. Select the answer that expresses the result of this calculation with the correct number of significant figures.

$$\frac{13.602 \times 1.90 \times 3.06}{4.2 \times 1.4097} =$$

- D A) 13.357
B) 13.36
C) 13.4
D) 13

8. Millikan's oil-drop experiment

- A
- A) established the charge on an electron.
 - B) showed that all oil drops carried the same charge.
 - C) provided support for the nuclear model of the atom.
 - D) suggested the presence of a neutral particle in the atom.

9. What is the name used to represent the total number of neutrons and protons in the nucleus of each atom of an element?

- B
- A) Isotope number
 - B) Mass number
 - C) Atomic number
 - D) Atomic mass units

10. Atoms X, Y, Z, and R have the following nuclear compositions. Which two are isotopes?



- D
- A) X & Y
 - B) X & R
 - C) Y & R
 - D) X & Z

11. An atom of the isotope sulfur-31 consists of how many protons, neutrons, and electrons?

- B
- A) 15 p, 16 n, 15 e
 - B) 16 p, 15 n, 16 e
 - C) 16 p, 31 n, 16 e
 - D) 16 p, 16 n, 15 e

12. Which of these elements is most likely to be a good conductor of electricity?

- D
- A) N
 - B) He
 - C) Cl
 - D) Fe

13. Which of these elements is most chemically similar to magnesium, Mg?

- B
- A) sulfur, S
 - B) calcium, Ca
 - C) iron, Fe
 - D) potassium, K

14. What is the name of the energy that results from the interaction of charged particles?

- D
- A) thermal energy.
 - B) kinetic energy.
 - C) chemical energy.
 - D) electrostatic energy.

15. The size of an atomic orbital is associated with

- A
- A) the principal quantum number (n).
 - B) the angular momentum quantum number (l).
 - C) the magnetic quantum number (m_l).
 - D) the spin quantum number (m_s).

16. The shape of an atomic orbital is associated with

- B A) the principal quantum number (n).
 B) the angular momentum quantum number (l).
 C) the magnetic quantum number (m_l).
 D) the spin quantum number (m_s).

17. The orientation in space of an atomic orbital is associated with

- C A) the principal quantum number (n).
 B) the angular momentum quantum number (l).
 C) the magnetic quantum number (m_l).
 D) the spin quantum number (m_s).

18. Which one of the following sets of quantum numbers is not possible?

- B

	n	l	m_l	m_s
A)	4	3	-2	+1/2
<input checked="" type="radio"/> B)	3	0	1	-1/2
C)	3	0	0	+1/2
D)	2	1	1	-1/2

19. What is the maximum number of electrons in an atom that can have the following set of quantum numbers: $n = 4$, $l = 3$, $m_l = -2$, $m_s = +1/2$?

- A A) 1
 B) 2
 C) 6
 D) 10

20. A possible set of quantum numbers for the last electron added to complete an atom of gallium Ga in its ground state is

- B

	n	l	m_l	m_s
A)	3	1	0	-1/2
<input checked="" type="radio"/> B)	4	1	0	+1/2
C)	3	1	1	+1/2
D)	4	2	1	+1/2

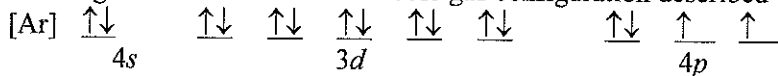
21. The Pauli Exclusion Principle states that no ___ electrons within an atom can have the same ___ quantum numbers.

- B A) 4, 4
 B) 2, 4
 C) 4, 6
 D) 2, 6

22. Atomic orbitals that have the same amount of energy are _____.

- C A) Regenerative
 B) Negatively Charged
 C) Degenerate
 D) Positively Charged

23. Which ground-state atom has a noble gas configuration described by the following *orbital diagram*?



- A) phosphorus, P
 B) germanium, Ge
 C) selenium, Se
 D) tellurium, Te

24. How many unpaired electrons does a ground-state atom of sulfur have?

- A) 0
 B) 2
 C) 3
 D) 4

25. Which element has the following ground-state electron configuration: $1s^2 2s^2 2p^6 3s^2$?

- A) Na
 B) Mg
 C) Al
 D) Si

26. Which element has the following noble gas configuration: $[\text{Kr}] 5s^2 4d^{10} 5p^2$?

- A) Sn
 B) Sb
 C) Pb
 D) Ge

27. The noble gas configuration of a ground-state chromium, Cr, atom is

- A) $[\text{Ar}] 4s^1 4d^5$
 B) $[\text{Ar}] 4s^2 4p^6$
 C) $[\text{Ar}] 4s^1 3d^5$
 D) $[\text{Ar}] 3d^5$

28. What is the electron configuration for bromine, Br?

- A) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 4d^{10} 4p^6$
 B) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^1 3d^{10} 4p^6$
 C) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^4$
 D) $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^{10} 4p^5$

29. The electronic structure $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^8$ refers to the ground state of

- A) Kr
 B) Ni
 C) Fe
 D) Pd

30. The noble gas configuration of a ground-state Co atom is

- A) $[\text{Ar}] 4s^2 3d^7$
 B) $[\text{Ar}] 3s^2 3d^7$
 C) $[\text{Ar}] 4s^1 3d^6$
 D) $[\text{Ar}] 4s^2 4d^7$

Part II. Calculations: Clearly show all work for full credit. (40 pts)

1. (5 pts) What is the volume (in cm^3) of piece of lead that weighs 2.54 kg if the density of lead is 11.342 g/cm^3 ?

$$2.54 \text{ kg} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ cm}^3}{11.342 \text{ g}} = 2.24 \times 10^2 \text{ cm}^3$$

2. (10 pts) Lithium forms compounds which are used in dry cells and storage batteries and in high-temperature lubricants. It has two naturally occurring isotopes, ${}^6\text{Li}$ (isotopic mass = 6.015121 amu, percent abundance = 7.504%) and ${}^7\text{Li}$ (isotopic mass = 7.016003 amu, percent abundance = 92.496%). What is the average atomic mass of lithium-6?

$$\begin{aligned} (6.015121 \text{ amu})(0.07504) &= 0.4514 \text{ amu} \\ (7.016003 \text{ amu})(0.92496) &= 6.490 \text{ amu} \\ \hline &6.9414 \text{ amu} \end{aligned}$$

6.941 amu

3. (5 pts) How many moles are present in 17.4 g of lead, Pb?

$$17.4 \text{ g Pb} \times \frac{1 \text{ mol Pb}}{207.2 \text{ g Pb}} = \boxed{0.0840 \text{ mol Pb}}$$

4. (10 pts) What is the mass of 5.35×10^{25} atoms of manganese, Mn?

$$5.35 \times 10^{25} \text{ atoms Mn} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{54.94 \text{ g Mn}}{1 \text{ mol Mn}} = \boxed{4.88 \times 10^3 \text{ g Mn}}$$

5. (10pts) A photon associated with red light has a wavelength 699 nm ($c = 3.0 \times 10^8$ m/s; $h = 6.63 \times 10^{-34}$ J·s)?

a. What is the frequency (in s^{-1}) of this photon?

$$\lambda \cdot \nu = c$$

$$\nu = \frac{c}{\lambda} = \frac{3.00 \times 10^8 \frac{m}{s}}{699 \text{ nm}} \times \frac{1 \text{ nm}}{1 \times 10^{-9} \text{ m}} = \boxed{4.29 \times 10^{14} \text{ s}^{-1}}$$

b. What is the energy (in J) of this photon?

$$E = h \cdot \nu = (6.63 \times 10^{-34} \text{ J}\cdot\text{s}) (4.29 \times 10^{14} \text{ s}^{-1})$$

$$= \boxed{2.84 \times 10^{-19} \text{ J}}$$

	IA																										VIII A	
1	1																											2
	H																											He
	1.008																											4.00
2	3	4																	5	6	7	8	9	10				
	Li	Be																	B	C	N	O	F	Ne				
	6.94	9.01																	10.81	12.01	14.01	16.00	19.00	20.18				
3	11	12																	13	14	15	16	17	18				
	Na	Mg																	Al	Si	P	S	Cl	Ar				
	22.99	24.31																	26.98	28.09	30.97	32.06	35.45	39.95				
4	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36										
	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr										
	39.10	40.08	44.96	47.90	50.94	52.00	54.94	55.85	58.93	58.71	63.55	65.37	69.72	72.59	74.92	78.96	79.90	83.80										
5	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54										
	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe										
	85.47	87.62	88.91	91.22	92.91	95.94	[98]	101.1	102.9	106.4	107.9	112.40	114.8	118.7	121.8	127.60	126.90	131.30										
6	55	56	71	72	73	74	75	76	77	78	79	80	81	82	83	84	85	86										
	Cs	Ba	Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn										
	132.9	137.3	175	178.5	181	183.9	186.2	190.2	192.2	195.1	197	200.59	204.4	207.2	209	[209]	[210]	[222]										
7	87	88	103	104	105	106	107	108	109	110	111	112	113	114	115	116		118										
	Fr	Ra	Lr	Rf	Db	Sg	Bh	Hs	Mt	Ds	Rg	Uub	Uut	Uuq	Uup	Uuh		Uuo										
	[223]	[226]	[262]	[267]	[268]	[271]	[272]	[270]	[276]	[281]	[280]	[285]	[284]	[289]	[288]	[293]		[294]										

57	58	59	60	61	62	63	64	65	66	67	68	69	70
La	Ce	Pr	Nd	Pm	Sm	Eu	Gd	Tb	Dy	Ho	Er	Tm	Yb
138.9	140.1	140.9	144.2	[145]	150.4	152	157.3	158.9	162.5	164.93	167.3	168.9	173
89	90	91	92	93	94	95	96	97	98	99	100	101	102
Ac	Th	Pa	U	Np	Pu	Am	Cm	Bk	Cf	Es	Fm	Md	No
[227]	232	[231]	238	[237]	[244]	[243]	[247]	[247]	[251]	[252]	[257]	[258]	[259]