

Matter Atoms and Elements Practice Problems

KEY

- 1) Classify the following using the classification scheme of matter. Be as specific as possible. 1) _____
- A) oxygen gas
ELEMENT - MOLECULAR
 - B) stainless steel
HOMOGENEOUS MIXTURE
 - C) zinc metal
ELEMENT - ATOMIC
 - D) HCl gas
COMPOUND - MOLECULAR
 - E) sodium bicarbonate
COMPOUND - IONIC
 - F) ammonia
COMPOUND - MOLECULAR
 - G) a solution of water, sodium bicarbonate, and sodium chloride
HOMOGENEOUS MIXTURE
 - H) seawater
UNFILTERED - HETERO. MIX. FILTERED - HOMOGENEOUS MIX
- 2) The decomposition of an unknown gas produces two different gases, each of which is a pure substance. Using only this information, it can be said with certainty that: 2) _____
- A) one of the products is an element
 - B) neither of the products are elements
 - C) both products are elements
 - D) the gas did not produce a solid
 - E) the gas cannot be an element
- 3) Conversion of a gas to a solid is known as 3) _____
- A) condensation
 - B) sublimation.
 - C) deposition.
 - D) evaporation
 - E) gasmosis
- 4) Which of the following is a chemical change? 4) _____
- A) hammering gold into a thin film
 - B) copper being submersed in hot water
 - C) evaporation of isopropyl alcohol from the skin
 - D) water vapor depositing as frost in the freezer
 - E) chlorine gas and sodium metal reacting to form sodium chloride salt
- 5) "In a chemical reaction, matter is neither created nor destroyed", is another way to state: 5) _____
- A) The Scientific Method
 - B) The Law of Conservation of Mass
 - C) The Law of Definite Proportions
 - D) The Law of Multiple Proportions
 - E) Dalton's Atomic Theory

6) When a match burns it becomes lighter, but when magnesium burns it becomes heavier. Are these observations violations of the law of conservation of mass? If not, how can these observations be rationalized?

NOT VIOLATIONS. MASS IS LOST AS GAS FROM BURNING MATCH, WHILE MASS IS GAINED FROM AIR (OXYGEN) BY BURNING Mg.

7) Which of the following statements is not part of the scientific method?

7) _____

- A) an observation is made
- B) a hypothesis is developed
- C) the hypothesis is test by a carefully designed experiment
- D) a theory is developed based on experimental evidence that is continually tested and modified if necessary

E) once a theory is tested for 5 years or 500 experiments (whichever comes first) the theory becomes a law

8) The scientific method

8) _____

- A) is a way to prove things that most people disagree with.
- B) is a way to prove what you strongly believe in.
- C) is a set of rules and procedures that lead to scientific proof.
- D) is the best way to sound smart.

E) is based on continual observation and experimentation.

9) Isotopes of an element always have _____.

9) _____

- A) harmful radioactive properties
- B) the same mass (in amu) but different numbers of neutrons
- C) the same atomic number (Z) but different numbers of electrons
- D) the same mass number (A) but different atomic number (Z)

E) the same atomic number (Z) but different mass numbers (A)

10) An element's atomic number, Z, is equal to the number of PROTONS the element has.

10) _____

11) An element's mass number, A, is equal to the number of PROTONS + NEUTRONS

11) _____

12) The number of neutrons in an atom is equal to the MASS # - ATOMIC #

12) _____

13) Which of the following is NOT true for ^{13}N , ^{14}N , and ^{15}N ?

13) _____

- A) They all have 7 electrons.
- B) They are all isotopes of nitrogen.
- C) They all have 7 protons.
- D) They all have the same atomic number.

E) They all have the same mass number.

14) Which of the following represents the mass number for an oxygen atom that has a mass of 15.9949 amu?

14) _____

- A) 15.9949
- B) 32
- C) 15.9994
- D) 16
- E) 8

15) Chlorine in nature is found to be approximately 75% chlorine-35 and 25% chlorine-37. What is the mass number of chlorine in nature? 15) _____

- A) 36
 B) 35
 C) 35.5
 D) 37
 E) chlorine contains a mixture two isotopes with mass numbers 35 and 37.

16) The correct symbol for the isotope of carbon with 8 neutrons is _____ 16) _____

- A) ${}^{14}_6\text{C}$ B) ${}^7_6\text{C}$ C) ${}^{14}_{12}\text{C}$ D) ${}^8_6\text{C}$ E) ${}^{12}_8\text{C}$

17) What is the correct symbol for the radioactive isotope, phosphorus-32? 17) _____

- A) ${}^{15}_{32}\text{Ge}$ B) ${}^{17}_{15}\text{P}$ C) ${}^{15}_{15}\text{P}$ D) ${}^{32}_{15}\text{P}$ E) ${}^{32}_{16}\text{S}$

18) Which of the following isotopes is least likely to exist in nature? 18) _____

- A) ${}^{55}_{\text{Fe}}$ B) ${}^{90}_{\text{Nb}}$ C) ${}^{65}_{\text{Cu}}$ D) ${}^{120}_{\text{Sn}}$ E) ${}^{14}_{\text{Mg}}$

19) Which of these isotopes has 31 neutrons? 19) _____

- A) ${}^{56}_{\text{Mn}}$ B) ${}^{55}_{\text{Fe}}$ C) ${}^{28}_{\text{Si}}$ D) ${}^{57}_{\text{Co}}$ E) ${}^{56}_{\text{Ni}}$

20) Identify the correct number of protons, neutrons, and electrons in the following species: 20) _____

| | PROTONS | NEUTRONS | e^- |
|----------------------------------|---------|----------|-------|
| A) ${}^{239}\text{U}$ | 92 | 147 | 92 |
| B) ${}^{118}_{50}\text{Sn}^{2+}$ | 50 | 68 | 48 |
| C) ${}^{31}_{15}\text{P}^{3-}$ | 15 | 16 | 18 |
| D) ${}^{138}\text{Ba}^{2+}$ | 56 | 82 | 54 |
| E) ${}^{192}\text{Ir}^{2+}$ | 77 | 115 | 75 |

21) An atom has 13 neutrons and 10 electrons. If it is a cation with a charge of +1, what is its correct symbol? 21) _____

- A) ${}^{24}_{11}\text{Na}^+$ B) ${}^{23}_{10}\text{Ne}^+$ C) ${}^{13}_{11}\text{Na}^+$ D) ${}^{26}_{13}\text{Al}^+$ E) ${}^{13}_{11}\text{Na}^+$

11 PROTONS, 30 SODIUM

24 PROTONS, SO CR

22) An atom has 28 neutrons and 21 electrons. If it is a cation with a +3 charge, what is its correct symbol? 22) _____

- A) ${}_{28}^{24}\text{Ni}^{3+}$ B) ${}_{21}^{28}\text{Sc}^{3+}$ C) ${}_{24}^{52}\text{Cr}^{3+}$ D) ${}_{24}^{28}\text{Cr}^{3+}$ E) ${}_{21}^{49}\text{Sc}^{3+}$

23) A hypothetical element has two stable isotopes: 23) _____

isotope 1 = 46.046 amu; 64.08% abundance
isotope 2 = 50.826 amu; 35.92% abundance

What is the atomic mass of this element?

- A) 48.50 amu B) 47.76 amu C) 47.44 amu D) 49.11 amu

$$\begin{aligned} \text{ATOMIC MASS} &= (0.6408 \times 46.046 \text{ amu}) + (0.3592 \times 50.826 \text{ amu}) \\ &= 29.5063 \text{ amu} + 18.2567 \text{ amu} = 47.76 \text{ amu} \end{aligned}$$

24) An element has 5 stable isotopes. The mass and percent abundance of each are: 24) _____

| | |
|---------|--------|
| 69.9243 | 20.52% |
| 71.9217 | 27.43% |
| 72.9234 | 7.76% |
| 73.9219 | 36.54% |
| 75.9214 | 7.76% |

What is this element?

$$\begin{aligned} \text{MASS} &= (0.2052 \times 69.9243 \text{ amu}) + (0.2743 \times 71.9217 \text{ amu}) + (0.0776 \times 72.9234 \text{ amu}) + (0.3654 \times 73.9219 \text{ amu}) + \\ &\quad (0.0776 \times 75.9214 \text{ amu}) \\ \text{MASS} &= 14.3485 \text{ amu} + 19.7281 \text{ amu} + 5.6589 \text{ amu} + 27.0111 \text{ amu} + 5.8915 \text{ amu} = 72.64 \text{ amu} \end{aligned}$$

25) The three naturally occurring isotopes of magnesium are ${}^{24}\text{Mg}$, ${}^{25}\text{Mg}$ and ${}^{26}\text{Mg}$. If magnesium-24 has a mass of 23.985042 amu with a relative abundance of 78.99%, and magnesium-25 has a mass of 24.985837 amu with a relative abundance of 10.00%, what is the mass of magnesium-26? (atomic mass of magnesium is 24.3050 amu) 25) _____

- A) 23.94 amu B) 26.43 amu C) 25.98 amu D) 24.31 amu

ATOMIC MASS

↓

$$1 \times 24.3050 \text{ amu} = (0.7899 \times 23.985042 \text{ amu}) + (0.1000 \times 24.985837 \text{ amu}) + (0.1101 \times \text{MASS } {}^{26}\text{Mg})$$

↑

100%

$$\text{MASS } {}^{26}\text{Mg} = 25.98 \text{ amu}$$

↑

% ABUNDANCE HAS TO BE 11.01%
SOLVE FOR MASS

26) How many atoms are in 5.21 g of arsenic?

26) _____

$$5.21 \text{ g} \times \frac{\text{mol As}}{74.92 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ ATOMS}}{\text{mol As}} = 4.19 \times 10^{22}$$

27) What is the mass of a sample containing 1.20 moles of nickel?

27) _____

$$1.20 \text{ mol Ni} \times \frac{58.69 \text{ g}}{\text{mol Ni}} = 70.4 \text{ g}$$

28) 24.9 g of manganese is equivalent to how many moles of manganese?

28) _____

$$24.9 \text{ g} \times \frac{\text{mol Mn}}{54.94 \text{ g}} = 0.453 \text{ mol}$$

29) What is the mass in grams of 1 atom of sulfur?

29) _____

$$1 \text{ S ATOM} \times \frac{\text{mol S}}{6.022 \times 10^{23} \text{ ATOMS}} \times \frac{32.07 \text{ g}}{\text{mol S}} = 5.325 \times 10^{-23} \text{ g}$$

30) What is the molar mass of an element if 4.00 grams of it contain 2.98×10^{22} atoms?

30) _____

WANT: $\frac{\text{g}}{\text{mol}}$ so $\rightarrow \frac{4.00 \text{ g}}{2.98 \times 10^{22} \text{ ATOMS}} \times \frac{6.022 \times 10^{23} \text{ ATOMS}}{\text{mol}} = 80.8 \text{ g/mol}$

31) A cubic centimeter of lead weighs 11.35 g. How many atoms are in the block?

31) _____

↑
DON'T NEED

$$11.35 \text{ g} \times \frac{\text{mol Pb}}{207.2 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ ATOMS}}{\text{mol}} = 3.299 \times 10^{22} \text{ ATOMS}$$

32) How many millimoles of nickel are in 1.245 micrograms of nickel?

32) _____

$$1.245 \text{ } \mu\text{g} \times \frac{10^{-6} \text{ g}}{\mu\text{g}} \times \frac{\text{mol Ni}}{58.69 \text{ g}} \times \frac{\text{mmol}}{10^{-3} \text{ mol}} = 2.121 \times 10^{-5} \text{ mmol}$$

33) How many micromoles of sulfur are present in 4.567 milligrams of potassium sulfate (K_2SO_4)? 33) _____

$$4.567 \text{ mg} \times \frac{10^{-3} \text{ g}}{\text{mg}} \times \frac{\text{mol } K_2SO_4}{174.26 \text{ g}} \times \frac{1 \text{ mol S}}{1 \text{ mol } K_2SO_4} \times \frac{\mu\text{mol}}{10^{-6} \text{ mol}} = 26.21 \mu\text{mol}$$

34) There are how many oxygen atoms in 3.9982 mg of cobalt(III) oxide (Co_2O_3)? 34) _____

$$3.9982 \text{ mg} \times \frac{10^{-3} \text{ g}}{\text{mg}} \times \frac{\text{mol } Co_2O_3}{165.8646 \text{ g}} \times \frac{3 \text{ mol O}}{\text{mol } Co_2O_3} \times \frac{6.022 \times 10^{23} \text{ ATOMS}}{\text{mol O}} = 4.3548 \times 10^{19} \text{ ATOMS}$$

35) A sample of magnesium nitrate ($Mg(NO_3)_2$) has a mass of 5.678 lbs. How many grams of oxygen are in this sample. 35) _____

$$5.678 \text{ lbs} \times \frac{453.59 \text{ g}}{\text{lb}} \times \frac{\text{mol } Mg(NO_3)_2}{148.315 \text{ g}} \times \frac{6 \text{ mol O}}{\text{mol } Mg(NO_3)_2} \times \frac{16.00 \text{ g}}{\text{mol O}} = 1.667 \times 10^3 \text{ g}$$

36) What mass in micrograms of molybdenum(VI)oxide (MoO_3) will yield 0.4356 nanomoles of molybdenum? 36) _____

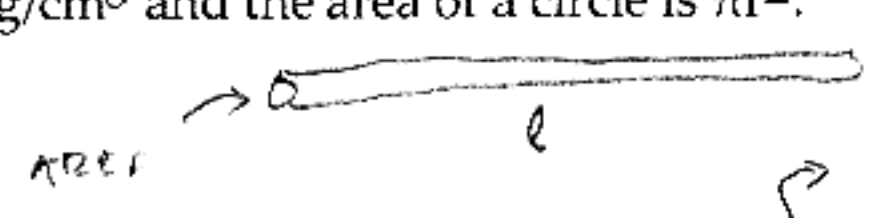
$$0.4356 \text{ nmol} \times \frac{10^{-9} \text{ mol}}{\text{nmol}} \times \frac{1 \text{ mol } MoO_3}{1 \text{ mol Mo}} \times \frac{143.94 \text{ g}}{\text{mol } MoO_3} \times \frac{\mu\text{g}}{10^{-6} \text{ g}} = 6.270 \times 10^{-2} \mu\text{g}$$

37) How many mL of sulfur hexafluoride (SF_6) will yield 3.456 millimoles of this compound? 37) _____
The density of sulfur hexafluoride gas is 6.164 g/L.

$$3.456 \text{ mmol} \times \frac{10^{-3} \text{ mol}}{\text{mmol}} \times \frac{146.056 \text{ g}}{\text{mol } SF_6} \times \frac{\text{L}}{6.164 \text{ g}} \times \frac{\text{mL}}{10^{-3} \text{ L}} = 81.89 \text{ mL}$$

38) A copper wire has a diameter of 1.0304 mm. What length of wire in centimeters will give exactly 1 mole of copper? The density of copper is 8.96 g/cm³ and the area of a circle is πr^2 . 38) _____

$$1 \text{ mol Cu} \times \frac{63.55 \text{ g}}{\text{mol}} \times \frac{\text{cm}^3}{8.96 \text{ g}} = 7.09 \text{ cm}^3$$



$$l = \frac{\text{VOL}}{\text{AREA}} = \frac{7.09 \text{ cm}^3}{\pi \left(\frac{0.10304 \text{ cm}}{2} \right)^2}$$

$$l = 8.50 \times 10^2 \text{ cm}$$

VOL WE WANT → VOL = l × AREA

39) What length of the above wire in meters will provide 2.50 lbs of copper? 39) _____

$$2.50 \text{ lb} \times \frac{453.59 \text{ g}}{\text{lb}} \times \frac{\text{mol}}{63.55 \text{ g}} \times \frac{8.50 \times 10^2 \text{ cm}}{\text{mol}} \times \frac{10^{-2} \text{ m}}{\text{cm}} = 152 \text{ m}$$

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false.

- 40) Michael Faraday invented the cathode ray tube. J.J. Thomson later determined that cathode rays are made up of negatively charged particles. 40) T
- 41) J.J. Thomson determined the mass/charge ratio for electrons. 41) T
- 42) Robert Millikan determined the charge on an electron using ionized oil drops. 42) T
- 43) Even though he subscribed to it, Ernest Rutherford disproved J.J. Thomson's so called "plum-pudding" model of atomic structure, by showing that atoms are mostly empty space containing small, heavy positively charged regions. 43) T
- 44) Atoms always retain their identity during a chemical reaction. 44) T
- 45) Atoms always retain their identity during nuclear reactions such as radioactive decay, fusion and fission. 45) F
- 46) All atoms of a given element are identical. 46) F
- 47) Nuclei are *lighter* than the sum of the masses of the individual protons and neutrons that make it up. This is because some of their mass was converted to energy ($E=mc^2$). 47) T
- 48) 1 amu is equal to the mass of 1 proton. 48) F
- 49) An amu is equal to $\frac{1}{12}$ of the mass of a single carbon-12 atom, so an amu has a mass that is slightly less than the mass of an individual proton or neutron. 49) T