23. (E) (a) cobalt-60 $^{60}_{27}$Co  (b) phosphorus-32 $^{32}_{15}$P  (c) iron-59 $^{59}_{26}$Fe  (d) radium-226 $^{226}_{88}$Ra

28. (E)  
(a) The atomic number of Ra is 88 and equals the number of protons in the nucleus. The ion's charge is 2+ and, thus, there are two more protons than electrons: no. protons = no. electrons + 2 = 88; no. electrons = 88 – 2 = 86. The mass number (228) is the sum of the atomic number and the number of neutrons: 228 = 88 + no. neutrons; Hence, the number of neutrons = 228 – 88 = 140 neutrons.

(b) The mass of $^{16}$O is 15.9994 u. ratio = \( \frac{\text{mass of isotope}}{\text{mass of } ^{16}\text{O}} = \frac{228.030\text{ u}}{15.9994\text{ u}} = 14.2524 \)

44. (E) To determine the average atomic mass, we use the following expression:

average atomic mass = \( \sum (\text{isotopic mass} \times \text{fractional natural abundance}) \)

Each of the three percents given is converted to a fractional abundance by dividing it by 100.

Cr atomic mass = \( (49.9461 \times 0.0435) + (51.9405 \times 0.8379) + (52.9407 \times 0.0950) + (53.9389 \times 0.0236) \)

= 2.17 u + 43.52 u + 5.03 u + 1.27 u = 51.99 u

If all digits are carried and then the answer is rounded at the end, the answer is 52.00 u.

48. (M) We use the expression for determining the weighted-average atomic mass, where \( x \) represents the fractional abundance of $^{10}$B and \( (1-x) \) the fractional abundance of $^{11}$B

\[
10.811\text{ u} = (10.012937\text{ u} \times x) + [11.009305\text{ u} \times (1-x)] = 10.012937x + 11.009305 - 11.009305x
\]

\[
x = \frac{0.198}{0.996368} = 0.199
\]

\[
\therefore 19.9\% \text{ } ^{10}\text{B} \quad \text{and} \quad (100.0 - 19.9) = 80.1\% \text{ } ^{11}\text{B}
\]

55. (E)  
(a) atoms of Fe = 15.8 mol Fe $\times$ \( \frac{6.022 \times 10^{23} \text{ atoms Fe}}{1 \text{ mol Fe}} = 9.51 \times 10^{24} \text{ atoms Fe} \)

(b) atoms of Ag = 0.000467 mol Ag $\times$ \( \frac{6.022 \times 10^{23} \text{ atoms Ag}}{1 \text{ mol Ag}} = 2.81 \times 10^{20} \text{ atoms Ag} \)

(c) atoms of Na = 8.5 $\times$ 10$^{-11}$ mol Na $\times$ \( \frac{6.022 \times 10^{23} \text{ atoms Na}}{1 \text{ mol Na}} = 5.1 \times 10^{13} \text{ atoms Na} \)

57. (E)
(a) moles of Zn = \( \frac{415.0 \text{ g Zn}}{65.39 \text{ g Zn}} \times \frac{1 \text{ mol Zn}}{6.022 \times 10^{23} \text{ atoms Zn}} \times \frac{6.022 \times 10^{23} \text{ atoms Zn}}{1 \text{ mol Zn}} = 6.347 \text{ mol Zn} \)

(b) 
\[ \text{# of Cr atoms} = \frac{147,400 \text{ g Cr}}{51.9961 \text{ g Cr}} \times \frac{1 \text{ mol Cr}}{6.022 \times 10^{23} \text{ atoms Cr}} \times \frac{6.022 \times 10^{23} \text{ atoms Cr}}{1 \text{ mol Cr}} = 1.707 \times 10^{27} \text{ atoms Cr} \]

(c) 
\[ \text{mass Au} = \frac{196.967 \text{ g Au}}{6.022 \times 10^{23} \text{ atoms Au}} \times \frac{1 \text{ mol Au}}{1 \text{ mol Au}} = 3.3 \times 10^{-10} \text{ g Au} \]

(d) 
\[ \text{mass of F atom} = \frac{18.9984 \text{ g F}}{1 \text{ mol F}} \times \frac{1 \text{ mol F}}{6.022 \times 10^{23} \text{ atoms F}} \times \frac{6.022 \times 10^{23} \text{ atoms F}}{1 \text{ atom F}} = 3.15 \times 10^{-20} \text{ g F} \]

For exactly 1 F atom, the number of sig figs in the answer is determined by the least precise number in the calculation, namely the mass of fluorine.

**63.**

We will use the average atomic mass of lead, 207.2 g/mol, to answer this question.

(a) 
\[ \frac{30 \mu \text{g Pb}}{1 \text{ dL}} \times \frac{1 \text{ mL}}{0.1 \text{ L}} \times \frac{1 \text{ g Pb}}{10^6 \mu \text{g Pb}} \times \frac{1 \text{ mol Pb}}{207.2 \text{ g}} = 1.45 \times 10^{-6} \text{ mol Pb/L} \]

(b) 
\[ \frac{1.45 \times 10^{-6} \text{ mol Pb}}{1 \text{ L}} \times \frac{1 \text{ mL}}{1000 \text{ mL}} \times \frac{6.022 \times 10^{23} \text{ atoms Pb}}{1 \text{ mol}} = 8.7 \times 10^{14} \text{ Pb atoms/mL} \]