IB Chemistry 2 Summer Assignment

1. What is the sum of all coefficients when the following equation is balanced using the smallest possible whole numbers? \( \text{C}_2\text{H}_2 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \)

A. 5  B. 7  C. 11  D. 13

2. 1.7 g of NaNO\(_3\) (\(M_r = 85\)) is dissolved in water to prepare 0.20 dm\(^3\) of solution. What is the concentration of the resulting solution in mol dm\(^{-3}\)?

A. 0.01  B. 0.1  C. 0.2  D. 1.0

3. How many molecules are present in a drop of ethanol, C\(_2\)H\(_5\)OH, of mass 2.3 \times 10\(^{-3}\) g?

\(L = 6.0 \times 10^{23} \text{ mol}^{-1}\)

A. 3.0 \times 10^{19}  B. 3.0 \times 10^{20}  C. 6.0 \times 10^{20}  D. 6.0 \times 10^{26}

4. Which sample has the greatest mass?

A. 1 mol of SO\(_2\)  B. 2 mol of N\(_2\)O  C. 2 mol of Ar  D. 4 mol of NH\(_3\)

5. The relative molecular mass of a gas is 56 and its empirical formula is CH\(_2\). What is the molecular formula of the gas?

A. CH\(_2\)  B. C\(_2\)H\(_4\)  C. C\(_3\)H\(_6\)  D. C\(_4\)H\(_8\)

6. What mass, in g, of hydrogen is formed when 3 mol of aluminium react with excess hydrochloric acid according to the following equation?

\[2\text{Al}(s) + 6\text{HCl}(aq) \rightarrow 2\text{AlCl}_3(aq) + 3\text{H}_2(g)\]

A. 3.0  B. 4.5  C. 6.0  D. 9.0

7. What is the total number of hydrogen atoms in 1.0 mol of benzamide, C\(_6\)H\(_5\)CONH\(_2\)?

A. 7  B. 6.0 \times 10^{23}  C. 3.0 \times 10^{24}  D. 4.2 \times 10^{24}

8. What is the sum of the coefficients for the equation when balanced using the smallest possible whole numbers?

\(\text{N}_2\text{H}_4(g) + \text{O}_2(g) \rightarrow \text{NO}_2(g) + \text{H}_2\text{O}(g)\)

A. 5  B. 6  C. 7  D. 8

9. Chloroethene, C\(_2\)H\(_3\)Cl, reacts with oxygen according to the equation below.

\[2\text{C}_2\text{H}_3\text{Cl}(g) + 5\text{O}_2(g) \rightarrow 4\text{CO}_2(g) + 2\text{H}_2\text{O}(g) + 2\text{HCl}(g)\]

What is the amount, in mol, of H\(_2\)O produced when 10.0 mol of C\(_2\)H\(_3\)Cl and 10.0 mol of O\(_2\) are mixed together, and the above reaction goes to completion?

A. 4.00  B. 8.00  C. 10.0  D. 20.0

10. A fixed mass of gas has a certain volume at a temperature of 50 °C. What temperature is required to double its volume while keeping the pressure constant?

A. 100 K  B. 323 K  C. 373 K  D. 646 K
11. What is the concentration of NaCl, in mol dm$^{-3}$, when 10.0 cm$^3$ of 0.200 mol dm$^{-3}$ NaCl solution is added to 30.0 cm$^3$ of 0.600 mol dm$^{-3}$ NaCl solution?
   A. 0.450  B. 0.300  C. 0.500  D. 0.800

12. Which amount of the following compounds contains the least number of ions?
   A. 2 mol of NaOH  B. 1 mol of NH$_4$Cl  C. 2 mol of CaCl$_2$  D. 1 mol of Al$_2$O$_3$

13. What is the approximate molar mass, in g mol$^{-1}$, of MgSO$_4$$\cdot$7H$_2$O?
   A. 120  B. 130  C. 138  D. 246

14. Which is both an empirical and a molecular formula?
   A. C$_5$H$_{12}$  B. C$_5$H$_{10}$  C. C$_4$H$_8$  D. C$_4$H$_{10}$

15. 6.0 mol of aluminium reacts with oxygen to form aluminium oxide. What is the amount of oxygen, in mol, needed for complete reaction?
   $\text{4Al(s) + 3O}_2$(g) $\rightarrow$ $\text{2Al}_2\text{O}_3$(s)
   A. 1.5  B. 3.0  C. 4.5  D. 6.0

16. What is the total number of nitrogen atoms in two mol of NH$_4$NO$_3$?
   A. 4  B. $6.02 \times 10^{23}$  C. $1.20 \times 10^{24}$  D. $2.41 \times 10^{24}$

17. On analysis, a compound with molar mass 60 g mol$^{-1}$ was found to contain 12 g of carbon, 2 g of hydrogen and 16 g of oxygen. What is the molecular formula of the compound?
   A. CH$_2$O  B. CH$_4$O  C. C$_2$H$_4$O  D. C$_2$H$_4$O$_2$

18. The graph below represents the relationship between two variables in a fixed amount of gas. Which variables could be represented by each axis?

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<th>x-axis</th>
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<td>pressure</td>
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<td>temperature</td>
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19. 8.5 g of NH$_3$ are dissolved in H$_2$O to prepare a 500 cm$^3$ solution. Which statements are correct?
   I. NH$_3$ is the solute and H$_2$O is the solution
   II. The concentration of the solution is 17 g dm$^{-3}$
   III. $[\text{NH}_3]$ = 1.0 mol dm$^{-3}$
   A. I and II only  B. I and III only  C. II and III only  D. I, II and III

20. Which non-metal forms an oxide XO$_2$ with a relative molecular mass of 60?
   A. C  B. N  C. Si  D. S
21. The volume of an ideal gas at 27.0 °C is increased from 3.00 dm$^3$ to 6.00 dm$^3$. At what temperature, in °C, will the gas have the original pressure?

A. 13.5   B. 54.0   C. 327   D. 600

22. Which statement about the numbers of protons, electrons and neutrons in an atom is always correct?

A. The number of neutrons minus the number of electrons is zero.
B. The number of protons plus the number of neutrons equals the number of electrons.
C. The number of protons equals the number of electrons.
D. The number of neutrons equals the number of protons.

23. Which statements about the isotopes of chlorine, $^{35}_{17}$Cl and $^{37}_{17}$Cl, are correct?

I. They have the same chemical properties.  II. They have the same atomic number.
III. They have the same physical properties.

A. I and II only   B. I and III only   C. II and III only   D. I, II and III

24. In the emission spectrum of hydrogen, which electronic transition would produce a line in the visible region of the electromagnetic spectrum?

A. $n = 2 \rightarrow n = 1$  B. $n = 3 \rightarrow n = 2$  C. $n = 2 \rightarrow n = 3$  D. $n = \infty \rightarrow n = 1$

25. Consider the relative abundance of the isotopes of element X.

<table>
<thead>
<tr>
<th>Isotope</th>
<th>Relative abundance (%)</th>
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<td>$^{24}$X</td>
<td>80</td>
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<tr>
<td>$^{25}$X</td>
<td>10</td>
</tr>
<tr>
<td>$^{26}$X</td>
<td>10</td>
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</tbody>
</table>

What is the relative atomic mass of X?

A. 24   B. 25   C. Between 24 and 25   D. Between 25 and 26

26. Which of the following is an isotope of $^{24}_{12}$Mg?

A. $^{24}_{12}$Mg$^{2+}$  B. $^{26}_{12}$Mg  C. $^{42}_{13}$Mg  D. $^{26}_{13}$Mg

27. Which describes the visible emission spectrum of hydrogen?

A. A series of lines converging at longer wavelength
B. A series of regularly spaced lines
C. A series of lines converging at lower energy
D. A series of lines converging at higher frequency

28. A sample of element X contains 69 % of $^{63}$X and 31 % of $^{65}$X. What is the relative atomic mass of X in this sample?

A. 63.0   B. 63.6   C. 65.0   D. 69.0
29. How many electrons does the ion $^{31}_{15}P^{3-}$ contain?

A. 12  B. 15  C. 16  D. 18

30. Which is correct for the following regions of the electromagnetic spectrum?

<table>
<thead>
<tr>
<th></th>
<th>Ultraviolet (UV)</th>
<th>Infrared (IR)</th>
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<tbody>
<tr>
<td>A. high energy</td>
<td>high energy</td>
<td>low energy</td>
</tr>
<tr>
<td>B. low frequency</td>
<td>low frequency</td>
<td>low energy</td>
</tr>
<tr>
<td>C. high frequency</td>
<td>short wavelength</td>
<td>low energy</td>
</tr>
<tr>
<td>D. high frequency</td>
<td>long wavelength</td>
<td>low energy</td>
</tr>
</tbody>
</table>

31. What is the relative atomic mass of an element with the following mass spectrum?

A. 24  B. 25  C. 26  D. 27

32. The table below shows the number of protons, neutrons and electrons present in five species.

<table>
<thead>
<tr>
<th>Species</th>
<th>Number of protons</th>
<th>Number of neutrons</th>
<th>Number of electrons</th>
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<td>X</td>
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<td>Y</td>
<td>7</td>
<td>7</td>
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<td>Z</td>
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<td>W</td>
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<td>8</td>
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<tr>
<td>Q</td>
<td>8</td>
<td>10</td>
<td>8</td>
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</tbody>
</table>

Which two species are isotopes of the same element?

A. X and W  B. Y and Z  C. Z and W  D. W and Q

33. Which species have the same number of electrons?

I. $S^{2-}$  II. $Cl^{-}$  III. Ne

A. I and II only  B. I and III only  C. II and III only  D. I, II and III

34. Which property generally decreases across period 3?

A. Atomic number  B. Electronegativity  C. Atomic radius  D. First ionization energy

35. Which property increases down group 1?

A. First ionization energy  B. Melting point  C. Reactivity  D. Electronegativity

36. Which pair of elements has the greatest difference in electronegativity?

A. Cs and F  B. Cs and Cl  C. Cs and Br  D. Cs and I
37. Which statements about the periodic table are correct?
   I. Elements in period 3 have similar chemical properties.
   II. Elements in group 7 show a gradual change in physical properties.
   III. The position of an element in period 3 is related to the number of electrons in the highest occupied energy level.
   A. I and II only  B. I and III only  C. II and III only  D. I, II and III

38. Which property decreases down group 7 in the periodic table?
   A. Melting point  B. Electronegativity  C. Atomic radius  D. Ionic radius

39. Which properties of the alkali metals decrease going down group 1?
   A. First ionization energy and reactivity  B. Melting point and atomic radius
   C. Reactivity and electronegativity  D. First ionization energy and melting point

40. The formula of cerium(III) sulfate is Ce₂(SO₄)₃. What is the correct formula of cerium(III) phosphate?
   A. CeP  B. Ce₂(PO₄)₃  C. Ce₃(PO₄)₂  D. CePO₄

41. What is the formula of magnesium fluoride?
   A. Mg₂F₃  B. Mg₂F  C. Mg₃F₂  D. MgF₂

42. What is the shape of the ammonia molecule, NH₃?
   A. Trigonal planar  B. Trigonal pyramidal  C. Linear  D. V-shaped (bent)

43. Which molecule is polar?
   A. CH₂Cl₂  B. BCl₃  C. Cl₂  D. CCl₄

44. Metal M has only one oxidation number and forms a compound with the formula MCO₃. Which formula is correct?
   A. MNO₃  B. MNH₄  C. MSO₄  D. MPO₄

45. What compound is formed when lithium reacts with selenium?
   A. LiSe  B. Li₂Se  C. LiSe₂  D. Li₂Se₂

46. Which statement is true for compounds containing only covalent bonds?
   A. They are held together by electrostatic forces of attraction between oppositely charged ions.
   B. They are made up of metal elements only.
   C. They are made up of a metal from the far left of the periodic table and a non-metal from the far right of the periodic table.
   D. They are made up of non-metal elements only.
47. Which statement is correct given the enthalpy level diagram below?

A. The reaction is endothermic and the products are more thermodynamically stable than the reactants.
B. The reaction is exothermic and the products are more thermodynamically stable than the reactants.
C. The reaction is endothermic and the reactants are more thermodynamically stable than the products.
D. The reaction is exothermic and the reactants are more thermodynamically stable than the products.

48. When some solid barium hydroxide and solid ammonium thiosulfate were reacted together, the temperature of the surroundings was observed to decrease from 15 °C to –4 °C. What can be deduced from this observation?

A. The reaction is exothermic and \( \Delta H \) is negative.
B. The reaction is exothermic and \( \Delta H \) is positive.
C. The reaction is endothermic and \( \Delta H \) is negative.
D. The reaction is endothermic and \( \Delta H \) is positive.

49. Which statement about chemical equilibria implies they are dynamic?

A. The position of equilibrium constantly changes.
B. The rates of forward and backward reactions change.
C. The reactants and products continue to react.
D. The concentrations of the reactants and products continue to change.

50. Consider the equilibrium below. \( \text{CH}_3\text{CH}_2\text{COOH}(aq) + \text{H}_2\text{O}(l) \rightleftharpoons \text{CH}_3\text{CH}_2\text{COO}^-(aq) + \text{H}_3\text{O}^+(aq) \)

Which species represent a conjugate acid-base pair?

A. \( \text{CH}_3\text{CH}_2\text{COOH} \) and \( \text{H}_2\text{O} \)
B. \( \text{H}_2\text{O} \) and \( \text{CH}_3\text{CH}_2\text{COO}^- \)
C. \( \text{H}_3\text{O}^+ \) and \( \text{H}_2\text{O} \)
D. \( \text{CH}_3\text{CH}_2\text{COO}^- \) and \( \text{H}_3\text{O}^+ \)

51. Which is not a conjugate acid-base pair?

A. \( \text{HNO}_3 \) and \( \text{NO}_3^- \)
B. \( \text{CH}_3\text{COOH} \) and \( \text{CH}_3\text{COO}^- \)
C. \( \text{H}_3\text{O}^+ \) and \( \text{OH}^- \)
D. \( \text{HSO}_4^- \) and \( \text{SO}_4^{2-} \)

52. Which 0.10 mol dm\(^{-3}\) solution would have the highest conductivity?

A. \( \text{HCl} \)
B. \( \text{NH}_3 \)
C. \( \text{CH}_3\text{COOH} \)
D. \( \text{H}_2\text{CO}_3 \)
53. The pH of a solution changes from pH = 2 to pH = 5. What happens to the concentration of the hydrogen ions during this pH change?

A. It decreases by a factor of 1000  
B. It increases by a factor of 1000  
C. It decreases by a factor of 100  
D. It increases by a factor of 100

54. Which statement about acids is correct?

A. A Brønsted-Lowry acid donates an electron pair.  
B. A Lewis acid donates a proton.  
C. A Brønsted-Lowry acid accepts a proton.  
D. A Lewis acid accepts an electron pair.

55. A solution of acid A has a pH of 1 and a solution of acid B has a pH of 2. Which statement must be correct?

A. Acid A is stronger than acid B  
B. [A] > [B]  
C. The concentration of H⁺ ions in A is higher than in B  
D. The concentration of H⁺ ions in B is twice the concentration of H⁺ ions in A

56. Which definition of oxidation is correct?

A. Loss of electrons and a decrease in oxidation number  
B. Loss of electrons and an increase in oxidation number  
C. Gain of electrons and a decrease in oxidation number  
D. Gain of electrons and an increase in oxidation number

57. What is the IUPAC name of Fe₂O₃?

A. Iron oxide  
B. Iron(II) oxide  
C. Iron(III) oxide  
D. Di-iron trioxide

58. In which species does sulfur have an oxidation number of 0?

A. SO₃  
B. S₈  
C. Na₂SO₄  
D. H₂S

59. Which compound contains nitrogen with an oxidation number of +3?

A. NH₄Cl  
B. HNO₃  
C. N₂O₄  
D. KNO₂

60. Which of the structures below is an aldehyde?

A. CH₃CH₂CH₂CH₂OH  
B. CH₃CH₂COCH₃  
C. CH₃CH₂COOCH₃  
D. CH₃CH₂CH₂CHO
61. Which is the correct classification of these alcohols?

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<tr>
<td>D.</td>
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62. Which three compounds can be considered to be a homologous series?

A. CH₃OH, CH₃CH₂OH, CH₃CH₂CH₂OH
B. CH₃CH₂OH, CH₃CHO, CH₃COOH
C. CH₃CH₂CH(OH)CH₃, CH₃CH₂CH₂CH₂OH, (CH₃)₃COH
D. CH₃CH₂CH₂CH₂OH, CH₃CH₂OCH₂CH₃, (CH₃)₂CH₂CHO

63. What is the IUPAC name for CH₃CH₂CH(CH₃)CH₃?

A. 1,1-dimethylpropane  B. 2-ethylpropane  C. 2-methylbutane  D. 3-methylbutane

64. What is the IUPAC name of the following compound?

A. 2-methylbutane  B. Ethylpropane  C. 3-methylbutane  D. Pentane

65. Which statement about successive members of all homologous series is correct?

A. They have the same empirical formula.
B. They differ by a CH₂ group.
C. They have the same physical properties.
D. They differ in their degree of unsaturation.

(Total 1 mark)
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