STANDARD LEVEL (SL) DP CHEM SUMMER ASSIGNMENT

Incoming 12th graders

Summer 2023

1. This packet is due on the first day of class.

2. Complete all questions on separate sheets of paper or an electronic document. **Show all work**.

3. Remember: Completing this packet will ensure that you are prepared for 12th Grade DP Chemistry and ready to re-take your 11th Grade DP Chemistry Final during the first week of class. This is a large packet so do not wait until the last minute to complete it.

1 Tin(II) chloride may be prepared by passing hydrogen chloride gas over heated tin:

$$Sn(s) + 2HCl(g) \rightarrow SnCl_2(s) + H_2(g)$$

When 5.00 g of tin is reacted with excess hydrogen chloride, 7.46 g of $SnCl_2$ is obtained. What is the percentage yield of $SnCl_2$? [3]

2 When silver nitrate is reacted with solutions containing chloride ions, insoluble silver chloride is precipitated:

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

a What mass of silver chloride is precipitated when 20.0 cm^3 of 0.100 mol dm^{-3} sodium chloride solution is reacted with excess silver nitrate solution? [3]

b What mass of silver chloride is precipitated when 25.0 cm^3 of 0.0600 mol dm^{-3} silver nitrate solution is added to 20.0 cm^3 of 0.100 mol dm^{-3} sodium chloride solution? [5]

c What mass of silver chloride is precipitated when 30.0 cm^3 of 0.0800 mol dm^{-3} silver nitrate solution is added to 20.0 cm^3 of 0.0800 mol dm^{-3} $CaCl_2(aq)$? [6]

d 0.0100 mol of a metal chloride (MCl_x) is dissolved in water then reacted with excess silver nitrate solution. The mass of silver chloride precipitated was 4.30 g.
Determine the value of x. [2]

e 1.45 g of a mixture of sodium chloride and potassium chloride is dissolved in water and made up to a total volume of 250.0 cm^3. Excess 0.100 mol dm^{-3} silver nitrate solution is added to 25.00 cm^3 of this solution. 0.325 g of AgCl is precipitated. Determine the percentage NaCl and KCl in the original mixture. [6]

3 In each of the following cases work out the relative atomic mass of the element to **two** decimal places:

a Rhenium has two naturally occurring isotopes with natural abundances:

^{185}Re 37.40% ^{187}Re 62.60% [2]

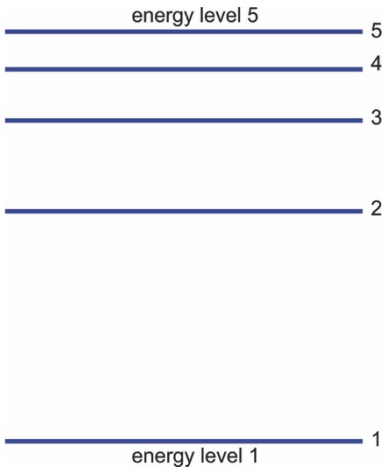
b Neodymium has seven naturally occurring isotopes with abundances:

^{142}Nd 27.13% ^{146}Nd 17.19%
^{143}Nd 12.18% ^{148}Nd 5.76%
^{144}Nd 23.80% ^{150}Nd 5.64%
^{145}Nd 8.30% [2]

4 Europium has two naturally occurring isotopes, Eu-151 and Eu-153, and a relative atomic mass of 151.96. Calculate the percentage abundance of each isotope of europium. [2]

5 The emission spectrum of hydrogen in the visible region, when observed through a spectroscope, consists of a series of coloured lines on a black background. Explain how the different lines in the spectrum arise. [3]

6 The diagram on the right represents the energy levels in a hydrogen atom. Draw arrows on the diagram to represent the following transitions: [3]



a a line in the infrared spectrum of a hydrogen atom

b the lowest energy line in the visible spectrum of hydrogen

c a line in the ultraviolet spectrum of a hydrogen atom.

7 Write an equation for the ionisation energy of hydrogen and explain what is meant by the term 'convergence limit'.

8 Write out the full electronic configurations of the following atoms: [8]

a $_{16}S$

b $_{35}Br$

c $_{26}Fe$

d Sn

e Sr

f Xe

g Cu

h Cr

9 Write out the full electronic configuration of the following ions: [8]

a Ca^{2+}

b Br^{-}

c P^{3-}

d Sn^{2+}

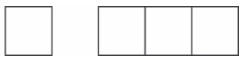
e I^{-}

f Sc^{3+}

g Ti^{2+}

h Cu^{2+}

10 Complete the following diagrams, showing electrons in boxes: [3]

a Al [Ne] 

b Co [Ar] 

c Te [Kr] 

11 Classify the following as ionic or covalent compounds: [5]

a NaCl

b C_3H_8

c CaF_2

d K_2O

e N_2H_4

12 **a** Explain why ionic compounds have high melting points. [1]

b Explain as far as possible the following data: [3]

Compound	**Melting point / °C**
sodium chloride	801
magnesium oxide	2852
calcium oxide	2614
caesium chloride	645

13 Draw Lewis structures for the following molecules. Work out the shapes and predict bond angles for the following molecules: [30]

a H_2O

b NH_3

c Cl_2O

d CO_2

e PF_3

f BF_3

g C_2H_4

h N_2H_4

i H_2O_2

j O_3

14 Draw Lewis structures for the following ions. Predict the shapes and suggest bond angles: [12]

a CO_3^{2-}

b NH_4^+

c NO_2^+

d NO_2^-

15 Explain what is meant by **electronegativity**. [1]

16 Select the polar molecules from the following list. For the polar molecules draw diagrams showing the dipoles. [8]

H_2O	**NH_3**	**Cl_2O**	**CF_4**	**CO_2**
PF_3	**BF_3**	**H_2**	**N_2**	**O_3**

17 The boiling points of the hydrides of group 5 are shown in the table below. Plot this data on a suitable graph and explain the trends shown. [5]

Compound	**Boiling point / °C**
NH_3	–33
PH_3	–88
AsH_3	–62
SbH_3	–18

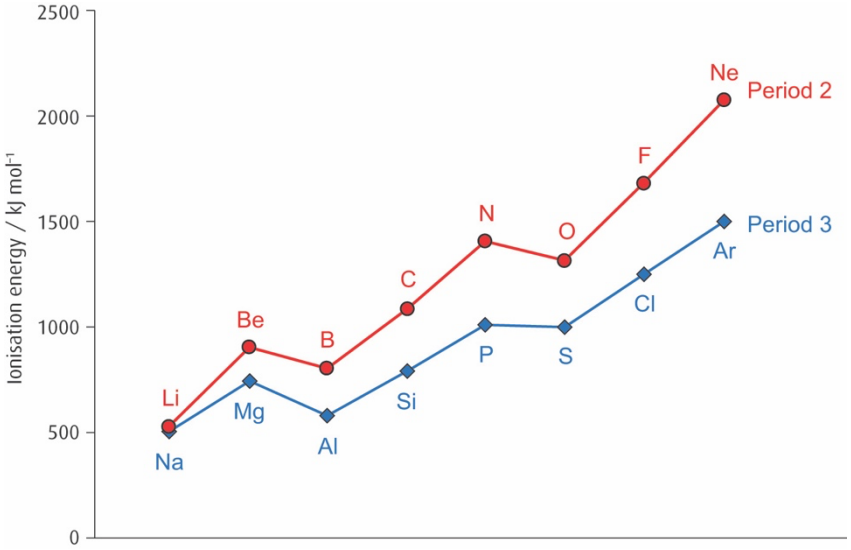
18 **a** Explain why diamond has a very high melting point. [4]

b Explain how the structure of graphite differs from that of diamond. [4]

19 **a** Explain, using a diagram, the bonding in a metal such as sodium. [2]

b Explain why magnesium has a higher melting point than sodium. [4]

20 The graphs below show the first ionisation energies of the elements in Period 2 and Period 3. **Explain** the similarities and differences between the graphs. [10]



21 Explain the following:

a Potassium has a lower first ionisation energy than lithium. [4]

b Fluorine is the most electronegative element in the periodic table. [4]

c A chlorine atom is smaller than a sodium atom. [4]

d A chloride ion is larger than a sodium ion. [2]

22 Arrange the following in order of increasing size and explain the order:

a Ar Cl^- K^+ [4]

b Na^+ Al^{3+} Mg^{2+} [4]

c I^- Cl Cl^- [3]

23 Complete and balance the following equations: [2]

a $Na + H_2O \rightarrow$ _____

b $Cl_2(aq) + KBr(aq) \rightarrow$ _____

24 Write equations for the reactions of the following oxides with water: [4]

a sodium oxide

b magnesium oxide

c phosphorus(V) oxide

d sulfur(VI) oxide

25 50.0 cm^3 of 1.50 mol dm^{-3} sodium hydroxide is mixed with 100.0 cm^3 of 1.00 mol dm^{-3} hydrochloric acid. Both solutions were initially at 19.3 °C and when they were mixed the temperature rose to a maximum of 28.3 °C.

a Write an equation for the reaction that occurs. [1]

b Calculate the number of moles of sodium hydroxide and of hydrochloric acid. [2]

c Calculate the enthalpy change of neutralisation. [3]

26 Given these enthalpy changes:

$CH_3CH_2CH_2OH(l) + {}^9/_2O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ $\Delta H^\ominus = -2010$ kJ mol^{-1}

$CH_3CH_2CH_2OH(g) + {}^9/_2O_2(g) \rightarrow 3CO_2(g) + 4H_2O(l)$ $\Delta H^\ominus = -2055$ kJ mol^{-1}

calculate the enthalpy change for the following process: [2]

$CH_3CH_2CH_2OH(g) \rightarrow CH_3CH_2CH_2OH(l)$

27 Write equations to represent the enthalpy change of formation of the following: [3]

a $C_6H_6(l)$

b $CH_3CHO(l)$

c $Li_3N(s)$

28 Calculate the enthalpy changes for the following reactions given the data in the table.

	$\Delta H_f^\ominus$ / kJ mol^{-1}
$SO_2(g)$	–297
$PCl_5(s)$	–444
$SOCl_2(l)$	–246
$Cl_2O(g)$	80
$POCl_3(l)$	–597
$NH_3(g)$	–46
$NH_4Cl(s)$	–314
$H_2O(g)$	–242

a $SO_2(g) + PCl_5(s) \rightarrow SOCl_2(l) + POCl_3(l)$ [2]

b $3Cl_2O(g) + 10NH_3(g) \rightarrow 2N_2(g) + 6NH_4Cl(s) + 3H_2O(g)$ [2]

29 Use the bond energies given in the table to calculate enthalpy changes for reactions below.

Bond	Bond enthalpy / kJ mol^{-1}
C–C	348
C=C	612
C≡C	837
N–N	163
N=N	409
N≡N	944

Bond	Bond enthalpy / kJ mol^{-1}
C–H	412
N–H	388
O–H	463
O–O	146
O=O	496
H–H	436

Bond	Bond enthalpy / kJ mol^{-1}
C–O	360
C=O	743
C≡O	1070
Cl–H	431

a $C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + 2H_2O(g)$ [5]

b $CO(g) + 3H_2(g) \rightarrow CH_4(g) + H_2O(g)$ [5]

c $4NH_3(g) + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$ [5]

30 Use the data given below and the bond energies in question 29 to calculate the Cl–Cl bond energy. [5]

$4HCl(g) + O_2(g) \rightarrow 2H_2O(g) + 2Cl_2(g)$ $\Delta H^\ominus = -112$ kJ mol^{-1}