1. The ionization energy of oxygen is 1313.9 kJ/mol.
   a) Calculate the wavelength of the electromagnetic radiation just energetic enough to ionize oxygen. $9.11 \times 10^{-8}$ m
   b) Give this wavelength in nanometers. 91.1 nm
   c) Show the chemical equation for the ionization of oxygen.

2. a) Give the electron configuration for molybdenum, $_{42}$Mo. $[Kr]\,5s^1\,4d^5$
   b) Identify the valence subshell(s) of molybdenum, and give the orbital diagram and quantum numbers for it/them. $5s^1$ see notes
   c) Identify the highest energy subshell of molybdenum, and give the orbital diagram and quantum numbers for it. $4d^5$ see notes
   d) Give the electron configuration of the molybdenum(III) ion. $[Kr]\,5d^3$

3. For the elements: Be, F, He, K, N, Na, O
   a) Rank them in order of **increasing** size (or atomic radius). see notes
   b) Rank them in order of **increasing** ionization energy.
   c) Predict the most likely ion or ions for each

4. For the sulphur pentafluoride anion, $SF_5^-$:
   a) Draw the Lewis Diagram.
   b) Draw the VSEPR (molecular) geometry. Square pyramedal
   c) Indicate the bond orders all single (all = 1)
   d) Indicate the bond dipoles and net dipole (redraw the structure for this, please, so that I can see it better.) . towards F
      (Net - away from lone pair)

5. a) Draw and label a molecular orbital diagram for nitrogen monofluoride, NF. ***Use at least half a page.*** See notes

b) Give the bond order 2

c) Give the magnetism, and explain your choice briefly (a few words are enough) paramagnetic · 2 unpaired

d) If you ionized NF to give $NF^+$, would the bond be shorter or longer? Explain your reasoning briefly (again, a few words are plenty.)
shorter (stronger) because you remove an ANTIBONDING e⊖

6. Octane (the main component of gasoline) has a standard heat of vaporization of 38.9 kJ/mol, and a vapour pressure of 0.0145 atm at 20.0°C. Calculate its normal boiling point, **in Celsius**. T = 126°C

7. Using the phase diagram of water given with the data sheets:

a) Label regions A, B, and C, lines 1, 2, and 3, and points a and b. (*Use the letters and numbers given on the diagram and answer in your exam booklet.* ***Don't write it on the question paper; I don't want that handed in!)*** See notes

b) Describe **in POINT FORM** what happens when $H_2O$ is heated from –50°C to 370°C at a pressure of 25 atm. Make reasonable pressure and temperature estimates as needed.

c) Describe **in POINT FORM** what happens when the pressure of the $H_2O$ is raised from 0.1 atm to 217 atm at a temperature of 100 °C. Make reasonable pressure and temperature estimates as needed.

8. Magnesium acetate $Mg(CH_3COO)_2$ has been suggested as a less damaging option for road salt. A 3.85 M magnesium acetate solution has a density of 1.47 g/ml.

   a) Given the data on the data page, determine its normal freezing point. −23°C

   b) If you had a solution of sodium chloride with exactly the same molarity, would you expect its normal freezing point to be higher or lower than the magnesium acetate solution? Explain briefly (a few words is plenty)

   Fewer ions (i=2) smaller change higher NFP

9. The reaction of aluminum oxide reacts with sodium metal in the reaction:

$$Al_2O_{3(s)} + Na_{(s)} \rightarrow Na_2O_{(s)} + Al_{(s)}$$

LIMITING

If 5.00 kg of aluminium oxide are allowed to react with 6.70 kg of sodium, determine the mass of sodium oxide that is produced, in kilograms. ***Show enough work to justify your answer.*** 9.03 kg

10. Nitromethane (often just called nitro) is used as a fuel in drag racing. It reacts with oxygen according to the reaction:

$$C_2H_8N_{2(l)} + 2\ N_2O_{4(l)} \rightarrow 2\ CO_{2(g)} + 4\ H_2O_{(g)} + 3\ N_{2(g)}$$

   a) Determine the standard enthalpy of reaction at 25°C −1820.8 kJ

   b) Determine the standard entropy of reaction at 25°C 948.0 J/K

   c) Determine the standard free energy of reaction at 25°C −2103.3 kJ

   d) Determine the free energy of reaction at 120.°C, when the pressure of the carbon dioxide is 10.0 atm, the pressure of the water vapour is 20.0 atm, and the pressure of the nitrogen gas is 15.0 atm. −2112.6 kJ

NOTE: there is data on the data page for this question