The Open University

Science Supplementary Material
S205 The Molecular World

Tutor Marked Assignment

Make sure you know how to complete and send in your TMA and PT3 form: detailed instructions are given in the booklet *Completing TMA and CMA forms*.

Course and assignment number:
S205 TMA 02

Covering: **Book 4**

Cut-off date:
Friday 11 April 2003

This assignment is made up of three questions. For each question, the following Table indicates:

the percentage of the total marks for this assignment allocated to the question;

the box number on the Assignment Form in which your tutor will indicate the marks that you obtain for the question.

Question number	*Percentage of total marks*	*Box No. on Assignment Form*
1	33	1
2	40	2
3	27	3

Question 1

This question carries 33 per cent of the marks for this assignment, and tests Learning Outcomes 1, 2, 3, 4 and 15 of Book 4.

(a) (i) (*7 marks*) Describe what happens when the unknown metal M1 is treated with 2 mol litre^{-1} hydrochloric acid. This is illustrated in the final sequence of the videocassette associated with Book 4 (band 5 on Videocassette 2). Write a balanced equation for any reaction that you see. As below, you should write the metal M1 as M, and assume that it forms the ion M^{2+}(aq). Use your observations to classify metal M1 according to the criteria in Sections 2–4 of Book 4.

(ii) (*6 marks*) When the reaction appeared to have finished, a few copper turnings were added to the solution. What happened? Record your observations from the videocassette sequence. In the next experiment, a small amount of metal M was added to a solution of copper sulfate, $CuSO_4$, in water. Although it is hard to spot on the videocassette, reddish particles appeared in the metal powder at the bottom of the test-tube. Record any other relevant observations, and write balanced equations describing any reactions that you observed, stating what is oxidized and what is reduced.

(b) On the basis of arguments developed in Book 4, predict what changes, if any, you would expect to see when the following substances are mixed at room temperature. Where you think that a reaction is likely to occur, write a balanced chemical equation, and indicate which species are oxidized, and which are reduced.

(i) (*2 marks*) Silver metal and M^{2+}(aq).

(ii) (*6 marks*) Magnesium metal and M^{2+}(aq).

(iii) (*6 marks*) Metal M and Hg^{2+}(aq).

(c) (*6 marks*) What criticisms can be made of the arguments that you have used in answering part (b) of this question?

Question 2

This question carries 40 per cent of the marks for this assignment, and tests Learning Outcomes 1, 5, 9, 12–15, 19 and 20 of Book 4.

Table 1 contains thermodynamic data for the same metal M (unknown metal M1) that you saw tested in the videocassette sequences used in Question 1. Any other data that you need in order to answer this second question should be taken from the S205 *Data Book*.

(a) (*20 marks*) Calculate the value of $\Delta G_f^{\ominus}$ (M^{2+}, aq) at 298.15 K. Use this calculated value to identify the position that metal M1 would have in Book 4, Table 12.1. Is this position consistent with the answers that you gave to part (b) of Question 1? Explain your reasoning for each of the three reactions of Question 1b.

Table 1 Thermodynamic data at 298.15 K for metal M1 and some of its compounds

Substance	State	$\Delta H_f^{\ominus}$ / kJ mol^{-1}	$\Delta G_f^{\ominus}$ / kJ mol^{-1}	$S^{\ominus}$ / J K^{-1} mol^{-1}
M	s	0	0	29.87
MO	s	−239.7		37.99
M^{2+}	aq	−54.00		−128.9

(b) (*20 marks*) For the reaction

$$C(s) + \tfrac{1}{2}O_2(g) = CO(g) \qquad (1)$$

$\Delta G_m^{\ominus} = -137.3$ kJ mol^{-1} at 300 K, and −289.4 kJ mol^{-1} at 2 000 K.