Question 3

This question carries 22 per cent of the marks for this assignment, and tests Learning Outcomes 1 and 18–21 of Book 9.

Much of this question is concerned with material in the CD-ROM program *The Inert Pair Effect*, which appears on one of the CD-ROMs for Book 9. You will need to use the information in Table 1 in answering the ques-tion.

Table 1 The sum of the first two ionization energies for some Group II elements and for the elements of the zinc group

Element	$I_1 + I_2$ / kJ mol^{-1}	Element	$I_1 + I_2$ / kJ mol^{-1}
Ca	1 735	Zn	2 639
Sr	1 613	Cd	2 499
Ba	1 468	Hg	2 817
Ra	1 488	112	3 325

The pairs of elements Ca/Zn, Sr/Cd, Ba/Hg and Ra/112 occur in the same Period of the Periodic Table. In each case, the first element of the pair is in Group II, and the second is in the zinc group.

(a) (*8 marks*) Table 1 shows the sums of the first two ionization energies for these elements. What factor is mainly responsible for the increases in the quantity $I_1 + I_2$ from the Group II element to the element of the zinc group, across a Period? Explain why the increase is much larger between barium and mercury than between either calcium and zinc, or strontium and cadmium.

(b) (*8 marks*) Although isotopes of element 112 have been made, nothing is known about its chemistry. The value for the sum of the first two ionization energies for element 112 has been calculated by relativistic quantum mechanics. Explain why the increase in $I_1 + I_2$ between radium and element 112 is much larger than that between barium and mercury.

(c) (*6* marks) In most Groups of the Periodic Table, the tendency is for the ionization energies to *decrease* down the Group. However, among the heavier elements of Groups III–V *increases* are observed. Explain how such increases can be connected with the following obser-vations:

(i) When boiling tubes containing the dioxides of tin and lead are heated with a Bunsen burner, only one of the dioxides decomposes.

(ii) When indium and thallium metals dissolve in dilute sulfuric acid, hydrogen is evolved, and the aqueous ions of indium and thallium that are produced have different charges.

Question 4

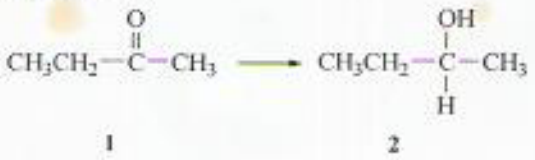
This question carries 12 per cent of the marks for t. . assignment, and tests Learning Outcomes 2, 4 and 5 of Book 10 Part 1.

(a) (*2 marks*) Draw a diagram showing the bonding in the carbonyl group, and identify the types of bond involved.

(b) (*2 marks*) Much of the reactivity of the carbonyl group is due to the polarity of the C=O bond. Which atom is slightly positive and which is slightly negative?

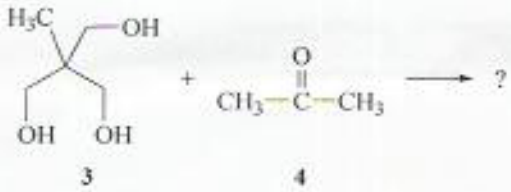
(c) (*4 marks*) Give one specific example of a reagent that will attack the carbon atom in a carbonyl group, and one reagent that will attack its oxygen atom.

(d) (*2 marks*) Identify the two reagents for the following transformation:



(1)

(e) (*2 marks*) What is the product of Reaction 2? Draw the structure of the product.

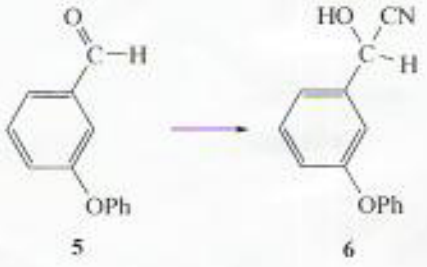


(2)

Question 5

This question carries 13 per cent of the marks for this assignment, and tests Learning Outcomes 4, 5, 6, 7 and 8 of Book 10 Part 1.

(a) (*6 marks*) Consider the synthesis of Compound **6** from Compound 5:



(3)

(i) What class of compound is **6**? (The IUPAC name is not required.)

(ii) Using curly arrows, draw a mechanism to show how **6** is formed from **5**.