

UNIT C4 (6244)

MARK SCHEME

JANUARY 2002

1 (a)

Lattice Energy:

- enthalpy or heat energy released (could mention the process is exothermic or value negative) (1)
- when gaseous ions (1)
- (come together to) form 1 mole solid / crystal / lattice (1) *but not substance*

if equation given could get state marks and energy change marks if ΔH shown

[3]

Enthalpy of Atomisation:

- heat energy change for the formation of one mole of gaseous atoms (1)
- from an element in its standard state (1)

*not standard conditions
if state or imply exothermic max 1*

[2]

(b) (i) correct step shown (1) *must identify change*

[1]

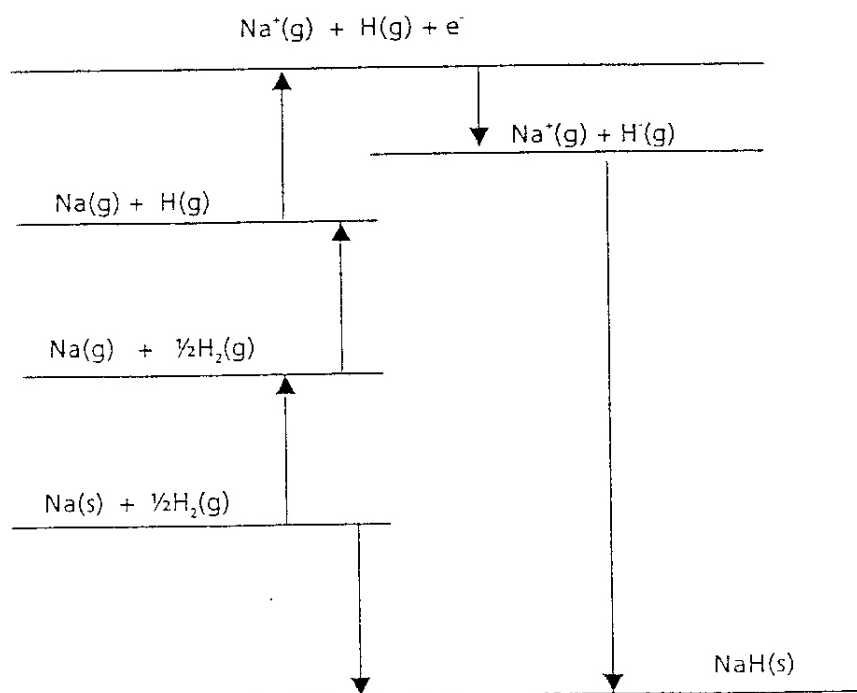
(ii) $+150 + 736 + 1450 + (2 \times 121) + 642 = 3220$
 $= 2493 + 2x$ (1)
 $2x = 727$

$x = -363 \pm 1$ (1) **sign vital**

n.b. -727 scores 1, -303 scores 1, -606 scores 0

[2]

(c)



Discourage student from standard conditions when not relevant. Likely to be penalised. Only state if standard is included in question see Unit 2 exam part & Jan.

Marking points on cycle :

- all correct species and steps plus state symbols where crucial **(1 mark)**

n.b. crucial steps Na (s) to Na (g) + gaseous ions to solid NaH.

- complete cycle **(1 mark)**
- $\frac{1}{2}H_2$ to H **(1 mark)**

n.b. the whole cycle could be doubled to give 2 x electron affinity

n.b. an energy diagram as above is not essential any correct cycle in any representation is equally acceptable

n.b. any cycle containing H^+ scores 0 marks

[3]

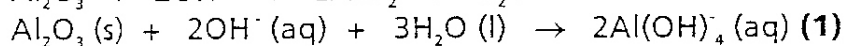
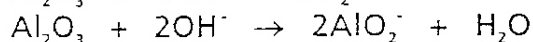
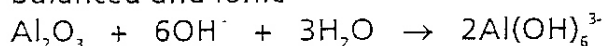
Total 11 marks

- 2 (a) (i) CO_2 / SiO_2 **(1)**
- (ii) $PbO / PbO_2 / SnO / SnO_2$ **(1)** [2]

- (b) (i) Reacts with both acids and bases / can act as both an acid or a base / has both acidic and basic properties or characteristics **(1)** [1]

- (ii) $Al_2O_3(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2O(l)$ **(1)**

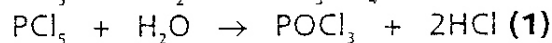
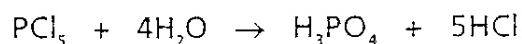
Balanced and ionic



1 mark / equation

Evidence of understanding of meaning of amphoteric **(1)** = bonus even if i.e. two equations, one with H^+ and one with OH^- couldn't balance eq **[4]**
state symbols **(1)**

- (c) (i) $NaCl + H_2O \xrightarrow{+aq} Na^+ + Cl^-$ **(1)** Bad question - tried to be helpful
do not penalise omission of water
 $pH = 7$ **(1)** ± 0.1



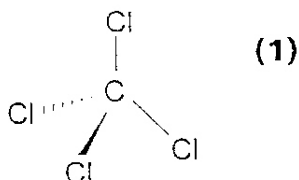
$pH < 1$ **(1)** allow 0 to 3

[4]

- (ii) NaCl ionic only dissolves **(1)**

PCl_5 covalent reacts (with water to produce H^+) / hydrolyses **(1)** [2]

(d) (i)



must be 3-D

[1]

(ii) Two layers formed / no reaction / nothing / immiscible (1)

[1]

f HCl given off
mark only if 'steamy'
not just white fumes.

(iii) (Violent) reaction / hydrolysed (1)

Identification of one product / description of one product (1)
e.g. steamy fumes / white fumes / white solid / named product
or representation of correct products in an equation provided
state symbol included

[2]

(iv) • The reaction takes place by the interaction of the **lone pair** of electrons on the water (1)

• Bonding to central (silicon/carbon) atom / attaching to central atom (1)

• In silicon the **3d** orbital is available to accept the pair of electrons (1)

• In carbon no similar orbital is available / not enough energy available to utilise vacant carbon orbitals / carbon surrounded by chlorine atoms causing steric hindrance (1)

[4]

Total 21 marks

3 (a) only partially dissociated / ionised / not fully dissociated (1)
into H^+ ions / H_3O^+ / proton donor (1)

[2]

(b) $K_a = \frac{[H_3O^+][A^-]}{[HA]}$ (1)

[1]

(c) (i) 9.0 to 9.4 (1) Graph too horizontal

[1]

(ii) 9.0 to 9.4 (1)
or same answer as (c)(i)

[1]

(iii) $pK_a = 5.6$ (1)
 $K_a = 2.5 \times 10^{-6}$ (1) consequential

[2]

(d) (i) (a solution that) resists change in pH / retains an **almost constant** pH (1)
on addition of **small** quantities of acid or alkali (1)

[2]

- (ii) 5.2 to 5.8 (1)
 5.5 or 5.6 (1) or answer from (c) (iii) based on misreading scale of graph, e.g. 4.8 *Very confusing graph - too horizontal* [2]

- (e) Phenolphthalein (1)
 indicator changes colour between pH 7 and 10 this is vertical part of graph (1)
 methyl orange would change in acid / give pH between pH4 and pH6 (1)
n.b. must be +ve statement about methyl orange [3]

If a choice of a comparison, must give reasons within 2th of the possible choices

- (f) exothermic reaction / heat (energy) released during reaction (1)
 HCl is strong acid fully ionised (1)
 this is weak acid so some energy used for dissociation (1) [3]

- (g) (i) $\text{pH} = -\log_{(10)} [\text{H}^+]$ or in words [1]

(ii) $1.8 \times 10^{-5} = \frac{[\text{H}^+]^2}{1}$ (1)
 $[\text{H}^+] = \sqrt{1.8 \times 10^{-5}} = 4.24 \times 10^{-3}$ (1)

$\text{pH} = -\log(4.24 \times 10^{-3})$
 $= 2.37/2.4$ (1) 2 to 4 sig. figs. [3]

Total 21 marks

- 4 (a) (i) $K_p = \frac{P_{\text{SO}_2}^2 \times P_{\text{O}_2}}{P_{\text{SO}_3}^2}$ (1)
 [] no mark
 () OK [1]

(ii)

	2SO_3	\rightarrow	2SO_2	$+$	O_2	
Mols at start	2		0		0	
mols at equ	0.5		1.5		0.75	(1)

Mark by process

- 1 mark for working out mole fraction
 1 mark for x 10
 1 mark for correct substitution in K_p and answer
 1 mark for unit

i.e. $P_{\text{SO}_2} = \frac{1.5}{2.75} \times 10 = 5.46$
 $P_{\text{O}_2} = \frac{0.7}{2.75} \times 10 = 2.73$
 $P_{\text{SO}_3} = \frac{0.5}{2.75} \times 10 = 1.83$

n.b. could show mole fraction for all 3 and then x 10 later to give partial pressure.

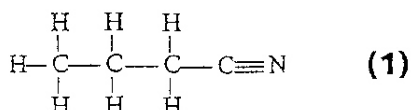
$$K_p = (5.46)^2 \times (2.73) / (1.83)^2 = 24.5 \text{ (1) atm (1)} \quad [5]$$

(b) (i) No effect (1) [1]

(ii) No effect (1) [1]

Total 8 marks

5 (a) (i) *n.b. if H omitted penalise only once in this question*

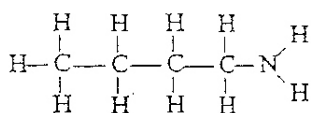


Give - can use or $\text{CH}_3\text{CH}_2\text{CH}_2\text{CN}$ [1]

(ii) $\text{LiAlH}_4 / \text{NaBH}_4 / \text{Na} + \text{C}_2\text{H}_5\text{OH} / \text{H}_2 + \text{Ni}$ or Pt catalyst / zinc plus acid (1)

Name or correct formula [1]

(iii)



(1)

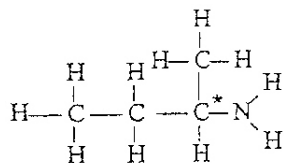
Penalised if didn't show all bonds.

must draw out

not $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ consequential on (i)

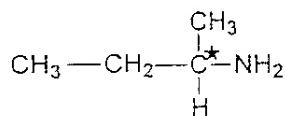
[1]

(b)

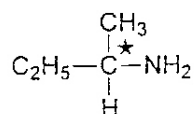


Draw in 3D if optical isomers are asked for.

Allow



or



(1+1)

[2]

(c) (i) lone pair of electrons on the N atom (1)

[1]

(ii) $\text{C}_4\text{H}_9\text{NH}_2 + \text{H}^+ \rightarrow \text{C}_4\text{H}_9\text{NH}_3^+$ (1)

not consequential on (b)
allow molecular equation
allow RNH_2

[1]

(d) (i) amide (1) [1]

(ii) faster / more control / better yield / not equilibrium / no need to heat (1) [1]

(e) (i) PCl_5 / PCl_3 / SOCl_2 (1) or name [1]

(ii) • Make a Grignard reagent using magnesium (1)

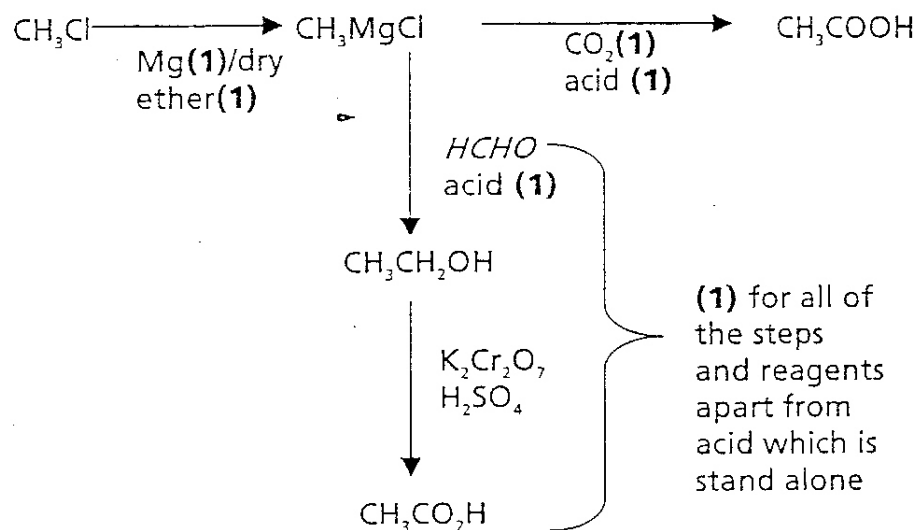
Condition marks are dependent on suitable reagents. • in dry ether (1) not stand alone mark

• react this with (solid) CO_2 (1)

• then hydrolyse with acid / + acid / + H^+ / + HCl (1) not stand alone added later - make clear

Alternative routes are possible

Or



[4]

Total 14 marks

PAPER TOTAL 75 MARKS