



General Certificate of Education

Chemistry 5421

**CHM2 Foundation Physical and
Inorganic Chemistry**

Mark Scheme

2008 examination - June series

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CHM2

Question 1

- (a) (i) $\text{TiCl}_4 + 4\text{Na} \rightarrow \text{Ti} + 4\text{NaCl}$ 1 Accept multiples
- $\text{TiCl}_4 + 2\text{H}_2 \rightarrow \text{Ti} + 4\text{HCl}$ 1 Accept multiples
Not [H]
Penalise CL, NA, h once
- (a) (ii) Hydrogen/it is explosive/ HCl is an acid/forms an acid/ hydrogen stored under high pressure/ HCl corrosive/ HCl toxic/ HCl reacts with metal 1 *Not flammable or dangerous alone*
Not HCl produced
- (b) Titanium carbide forms/TiC forms/ Ti goes brittle 1 Not Ti reacts with C
- (c) (i) $\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 2\text{Fe} + 3\text{CO}$ 1 Accept multiples
Or $2\text{Fe}_2\text{O}_3 + 3\text{C} \rightarrow 4\text{Fe} + 3\text{CO}_2$ *Not equations from Fe_3O_4 or FeO*
Accept in range 1000-2000°C
Do not accept heat
- High temperature/ 1500°C 1
- (c) (ii) Limestone/calcium carbonate 1 Must have name
Penalise contradiction of name and formula
- $\text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2$ 1
- $\text{CaO} + \text{SiO}_2 \rightarrow \text{CaSiO}_3$ 1
- Allow
 $\text{CaCO}_3 + \text{SiO}_2 \rightarrow \text{CaSiO}_3 + \text{CO}_2$
For 2 marks
Allow multiples
- (c) (iii) roads/ breezeblocks/ concrete slabs/ cement/ tarmac/ ballast for railway sleepers/ insulation blocks/ hard core/ aggregate 1 *Not just building materials/ blocks/ bricks*
- (d) (i) $\text{Al}^{3+} + 3\text{e}^- \rightarrow \text{Al}$ 1 Accept multiples
 $2\text{O}^{2-} \rightarrow \text{O}_2 + 4\text{e}^-$ 1 *Not O*
- (d) (ii) Lowers melting point/ solvent/ dissolves bauxite/ reduces temperature 1 *Not lowers mp of Al*
Lowers mp of Al_2O_3 is OK
Ignore temps if quoted
Not conductor/ catalyst
- (e) Saves energy/ saves electricity 1 *Ignore cost /mining/ melting*
Can have comparison answers w.r.t electrolysis

Question 2

(a)	Enthalpy <u>change</u> when 1 mole of substance	1	Accept heat energy change <i>Not in air</i>
	Completely burns or reacts in oxygen/ burns in XS oxygen	1	
	Under standard conditions	1	298K and 100kPa Accept 1 bar <i>Not 1 atm</i>
(b)	<u>Enthalpy change is independent of the route taken</u>	1	Accept heat energy change
(c)	$(\Delta H_f) = \Sigma \Delta H_{\text{reactants}} - \Sigma \Delta H_{\text{products}}$	1	If + 108 give 3 ticks. If wrong work back <i>Ignore units even if wrong</i> -108 = 1 mark <i>If AE for mark 2 mark on for mark 3</i>
	$= (-394 \times 4) + (-286 \times 3) - (-2542)$	1	
	$= -2434 - -2542$	1	
	$= (+) 108 \text{ (kJmol}^{-1}\text{)}$	1	
	allow $\Delta H_c \text{ C}_4\text{H}_6 = \Sigma \Delta H_{\text{prods}} - \Sigma \Delta H_{\text{reactts}}$ or good cycle as alternative to mark 1		
(d)	$\Delta H_f - 240 = \Sigma \text{Bonds broken} - \Sigma \text{bonds made}$	1	Allow $-240 = 2\text{C}=\text{C} + 872 - (696 + 1648)$ If 616 give 3 ticks If 1232 give 2 ticks <i>Ignore units</i> Last mark is for $\div 2$ $-616 = \text{max } 1$
	$-240 = (6 \times 412) + 2 \text{C}=\text{C} + 348 + (2 \times 436) - [(3 \times 348) + (10 \times 412)]$	1	
	$-240 = 3692 + 2\text{C}=\text{C} - 5164$		
	$2 \text{C}=\text{C} = 1232$ $\text{C}=\text{C} = 616 \text{ (kJmol}^{-1}\text{)}$	1	

Question 3

- | | | | |
|------------|--|---|---|
| (a) | Gains/ receives./ accepts/ takes electrons | 1 | <i>Not pairs of electrons</i> |
| (b) | (i) $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$
or
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{e}^- \rightarrow \text{SO}_2 + 2\text{H}_2\text{O}$ | 1 | allow multiples |
| (b) | (ii) $2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{e}^-$ | 1 | allow multiples |
| (b) | (iii) $\text{H}_2\text{SO}_4 + 2\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$ or
$\text{SO}_4^{2-} + 4\text{H}^+ + 2\text{Br}^- \rightarrow \text{SO}_2 + \text{Br}_2 + 2\text{H}_2\text{O}$ | 1 | allow multiples

<i>penalise BR, br, h once in b(i), (ii) and (iii)</i>
allow equation with 2HBr
accept equation with NaBr and spectator sodium ions on RHS |
| (b) | (iv) Reducing agent/ electron donor/
reduces sulphuric acid/ reduces H_2SO_4 | 1 | Not electron proton donor ie contradictions |
| (c) | (i) Cl^- or F^- or <u>chloride</u> or <u>fluoride</u> | 1 | <i>Not chlorine</i>
<i>Not Cl</i>
<i>Not fluorine</i>
<i>Not F</i>
<i>Not Chlorine ion</i>
<i>Not fluoride ion</i> |
| (c) | (ii) $\text{Cl}^- + \text{H}_2\text{SO}_4 \rightarrow \text{HCl} + \text{HSO}_4^-$ or
$\text{F}^- + \text{H}_2\text{SO}_4 \rightarrow \text{HF} + \text{HSO}_4^-$ or
$\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow \text{HCl} + \text{NaHSO}_4$ or
$\text{NaF} + \text{H}_2\text{SO}_4 \rightarrow \text{HF} + \text{NaHSO}_4$ or
$2\text{NaCl} + \text{H}_2\text{SO}_4 \rightarrow 2\text{HCl} + \text{Na}_2\text{SO}_4$ or
$2\text{NaF} + \text{H}_2\text{SO}_4 \rightarrow 2\text{HF} + \text{Na}_2\text{SO}_4$ etc | 1 | Allow multiples |
| (c) | (iii) Acid/ proton donor | 1 | |
| (d) | Oxidising agent/ electron acceptor/
Oxidises NaBr/ oxidises Br^- | 1 | <i>Not electron <u>pair</u> acceptor</i> |
| (e) | (i) Cl^- or or <u>chloride</u> | 1 | <i>Not chlorine</i>
<i>Not Cl</i>
<i>Not Chlorine ion</i> |
| (e) | (ii) $\text{Ag}^+ + \text{Cl}^- \rightarrow \text{AgCl}$

$\text{AgNO}_3 + \text{Cl}^- \rightarrow \text{AgCl} + \text{NO}_3^-$ | 1 | Accept multiples |
| (e) | (iii) F^- or <u>fluoride</u> | 1 | <i>Not fluorine</i>
<i>Not F</i>
<i>Not fluoride ion</i> |

Question 4

(a)	<u>Rate</u> of forward reaction = rate of backward reaction	1	Accept speed of F reaction = speed of B reaction Accept rate of both rxns is same <i>Not speeds are constant</i>
(b)	(i) Reaction is endothermic	1	<i>If exo CE = 0</i>
	System moves to absorb heat/ oppose or counter change/ decrease temp	1	
(b)	(ii) Cost (of energy) is high/ expensive/ amount of energy is high Or safety factor with a reason	1	<i>Not dangerous</i>
(c)	Decrease	1	<i>If trend wrong CE = 0 If blank mark on</i>
	2 moles on left and 4 moles on right/ more moles on right/ goes to side with more moles	1	<i>If no's they must be correct</i>
	System opposes change/ increases pressure	1	
(d)	Changes/ speeds up/ increases the rate of both the forward and backward reactions	1	Look for rate/ speed <u>and</u> change/ increase rate
	equally	1	Dependant on first mark

Question 5

- (a) Activation energy is the minimum energy needed 1 Accept lowest amount
for a reaction to occur or start / successful collision 1
- (b) Q = most probable/ likely/ common/ abundant 1 *Not energy most molecules have*
energy of molecules or modal energy
Area under curve represents (total) number/ 1
amount of molecules 1 *Penalise atoms once*
Curve starts at the origin since all molecules have
some energy/ no molecules have no energy
(Do not allow 'if there are no molecules there will
be no energy') 1
(very) few/ small no of molecules have high
energy/ energy greater than E_a
- (c) Curve becomes flatter /lower 1 can get these 2 marks from a
and shifts to right 1 diagram if both curves drawn
ignore wider/ spread out
Area does not change 1
 E_a does not change 1
Q is higher / increases/ to the right 1
'Many' dependant on second
mark
(Increasing temp increases rate since there are)
many 1
more molecules/collisions with $E > E_a$ / more 1
successful collisions/ more molecules with enough
energy to react
- (d) Catalyst lowers activation energy 2 Allow any 2 of 3 points
More molecules have $E > E_a$ / more successful
collisions
allow alternative route /forms intermediate/
surface