Abbreviations, annotations and conventions used in the Mark Scheme	/ = alternative and acceptable answers for the same marking point ; = separates marking points NOT = answers which are not worthy of credit ( ) = words which are not essential to gain credit _____ = (underlining) key words which must be used to gain credit ecf = error carried forward AW = alternative wording ora = or reverse argument

Question **Expected Answers** **Marks**

1 (a) (i) the enthalpy change when 1 mole of compound/species/substance is formed ✓
[mention of 1 mole of *elements* negates this mark]

from its elements [NOT atoms/ions] (under standard conditions) ✓ [2]

(ii) $25^oC/298K$ **and** 1 atmos/1 x 10^5 Pa ✓ [1]

(b) $Pb(s) + \frac{1}{2}O_2(g) \longrightarrow PbO(s)$ *(balancing for 1 mol of PbO)* ✓
(state symbols) ✓u/c [2]

(c) (i) $\Delta H^{\ominus} = -718 - 3(-217)$

$= \mathbf{-67}$ (kJ mol^{-1}) *(use of correct data & multiplier ✓)*
(correct signs ✓)
(correct calculation of value ✓) [3]

some possible ecf values: +67 [2]
-501 [2]
+501 [1]
-1369 [2]
+1369 [1]

(ii) $\Delta H^{\ominus}_f = -718 + 10 + 2(217)$

$= \mathbf{-274}$ (kJ mol^{-1}) *(use of correct data & multiplier ✓)*
(correct signs ✓)
(correct calculation of value ✓) [3]

some possible ecf values: -57 [2]
-284 [2] -294 [2]
+424 [1] +444 [2] -491 [2]
-511 [1] -708 [1] -1142 [2]

for others, work through the calc: -[1] for each error.

Total: 11

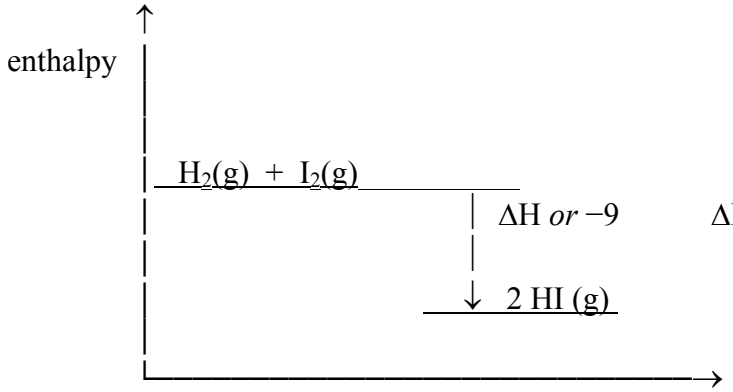
2 (a) $I\text{-}I(g) \longrightarrow 2I(g)$ *(state symbols ✓)* *(1 mole I_2 ✓)* [2]

(b) $\Delta H_r^{\ominus} = 151 + 436 - 2(298)$

$= \mathbf{-9}$ kJ mol^{-1} *(all the right numbers & x2)* ✓ *(use of the – sign)* ✓ *(L – R: using - sign the right way round)* ✓ [3]

some ecf values: +9 [2]
+289 [2]
+1183 [1]

(c)



ΔH **and** direction (ecf from (b)) ✓

2 HI(g) ✓ [2]

(d) (i) fizzing/gas/hydrogen evolved *or* Mg dissolves/disappears ✓ [1]
[an incorrect observation negates this mark]

(ii) $2HCl + Mg \longrightarrow MgCl_2 + H_2$
[correct formula for $MgCl_2$. Allow equation with HI/MgI_2 instead of HCl] ✓
[balancing: e.g. $2HCl + 2Mg \rightarrow 2MgCl + H_2$ will get this mark but not the 1st] ✓ [2]

(iii) $2H^+ + Mg \longrightarrow Mg^{2+} + H_2$ ✓ (ecf if Mg^+) [1]
[NO spectator ions allowed]

(e) strong acids are completely ionised/dissociated (in solution) ✓

weak acids are incompletely ionised/dissociated (in solution) ✓ [2]

[the comparative statement that *strong acids are more ionised than weak acids* is worth [1] mark]

Total: 13

3 (a) *(When a system in dynamic equilibrium is subjected to a change in conditions....)*
the (position of) equilibrium will shift ✓
in the direction that minimises the effect of /opposes the change ✓ [2]
[NOT negates, nullifies or cancels]

(b) Any two of the following bullet points ✓✓ [2]
- forward rate = reverse rate [NOT just "forward reaction = reverse reaction"]
- can be approached from either direction
["*forward rate of reaction = reverse rate of reaction"* is worth both the above bullet points]
- no change in overall macroscopic properties *or* a specific one (e.g. colour)
- takes place in a closed system
[N.B. every wrong point negates a correct one]

(c) (from yellow) to orange ✓
increasing $[H^+]$ *or* more acid/HCl
moves equilibrium/reaction to the left *or* produces more $Cr_2O_7^{2-}$ ✓ [2]

(d) (i) turns lighter brown/colourless ✓
(equilibrium/reaction moves to the right):
fewer molecules/particles/moles on right *or* 2 moles → 1 mole ✓ [2]

(ii) turns darker (brown) ✓
(equilibrium/reaction moves to the left): L→R/forward rxn is exothermic. ✓ [2]

[in (i) and (ii) mark the observation first, and then the reason. Each mark is unconditional on the other.]
[in (ii), if neither mark is scored and you are convinced that the only error is mixing up endo/exo-thermic, you may award [1] mark]

Total: 10

4 (a) (adding a catalyst):

- speeds up a reaction
- provides an alternative route *or* forms an intermediate of some sort
- of lower E_{act} (can be read into a label on a Boltzmann distribution)
- so more molecules have $E > E_{act}$ *or* more collisions are successful
- weakens bonds in the reactants

[any 4 points. Look for these in part (b) if not all stated in (a)] ✓✓✓✓ [4]

(b) General scheme for each example:

- identity of all reactants and all products (by names or the **correct** formulae in an (unbalanced) equation [if words given, ignore incorrect formulae] ✓
- identity of catalyst ✓
- whether the catalyst is hetero or homo-geneous. ✓

example A: converting nitrogen and hydrogen into ammonia (in the Haber process)
iron/Fe [NOT Fe^{2+} etc]
heterogeneous ✓✓✓

example B: converting unsaturated oils into fats for margarine with hydrogen
nickel/Ni
heterogeneous
✓✓✓ [6]

communicating the correct sense of the terms heterogeneous *or* homogeneous QwC✓ [1]

[N.B. allow other examples, as long as they are of economic or environmental importance.]

other possibilities: catalytic converter: platinum
$CO + NO \longrightarrow CO_2 + N_2$
heterogeneous

fermentation: (yeast) <u>enzymes</u> , or <u>zymase</u>
starch/sugar $\longrightarrow$ ethanol + CO_2
homogeneous

esterification: H_2SO_4 *or* HCl (***conc.*** not needed, but ***dil*** or ***aq*** is incorrect)
acid + alcohol $\longrightarrow$ ester + water
homogeneous

Total: 11