

Question number	Answer	Accept	Reject	Marks
1 (a)(i)	shifts to left	moves in the endothermic direction		1
(ii)	shifts to the right	shifts to the side of the reactants OWTTE		1
(iii)	impossible to know which shift is greater / impossible to know which change has the greater effect	moves in the exothermic direction shifts to the side of the products OWTTE shifts to the side with fewer (gas) moles/molecules  OWTTE the (two) effects are opposing one another		1
(b)	<b>M1</b> – greater proportion of NO <sub>2</sub>  <b>M2</b> – (increase of) temperature has a greater effect than (increase of) pressure	more NO <sub>2</sub> present equilibrium shifts to left		2

**Total 5 marks**

Question number			Answer	Notes	Marks
2	a	i	high / higher (temperature) because (forward) reaction is endothermic /absorbs heat	Accept reverse reaction is exothermic Accept reaction shifts in endothermic direction /favours the endothermic reaction (more) Ignore references to Le Chatelier's principle	1
		ii	low / lower (pressure) because more moles/molecules (of gas) on RHS / products side / hydrogen side	Accept fewer moles/molecules on LHS Accept 2 mol on LHS and 4 mol on RHS Accept particles in place of molecules Accept shift to side with more moles Ignore references to Le Chatelier's principle	1
	b		provides an alternative route /pathway/mechanism with lower activation energy  OR (gas) molecules adsorb/stick to surface of catalyst (covalent) bonds in molecules weakened	Ignore just a route/path  If no reference to <u>activation</u> energy, then accept references to energy if qualified by idea of being needed to start the reaction MAX 1 if any reference to particles gaining energy or moving more quickly	2

Question number		Answer	Notes	Marks
2	c	$\text{CO} + \text{H}_2\text{O} \rightleftharpoons \text{CO}_2 + \text{H}_2$	M1 for all formulae correct M2 for balancing AND reversible arrow Ignore state symbols M2 DEP on M1	2
	ii	(carbon/it) gains/reacts with oxygen / oxygen is added	Accept oxygen atom/molecule Accept increase in oxidation number Accept actual oxidation numbers if correct (+2 to +4) Reject oxide ion Ignore references to gain or loss of electrons	1
	iii	$\text{K}_2\text{CO}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow 2\text{KHCO}_3$	M1 for all formulae correct and on the correct sides M2 for balancing M2 DEP on M1	2

(Total for Question 2 = 9 marks)