Question number	Answer	Accept	Reject	Marks
1 (a)(i)	shifts to left	moves in the endothermic direction shifts to the side of the reactants		1 1
(ii)	shifts to the right	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		
(b)	**M1** – greater proportion of NO_2 **M2** – (increase of) temperature has a greater effect than (increase of) pressure	more NO_2 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		$CO + H_2O \rightleftharpoons CO_2 + H_2$	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	$K_2CO_3 + CO_2 + H_2O \rightarrow 2KHCO_3$	M1 for all formulae correct and on the correct sides M2 for balancing M2 DEP on M1	2

(Total for Question 2 = 9 marks)