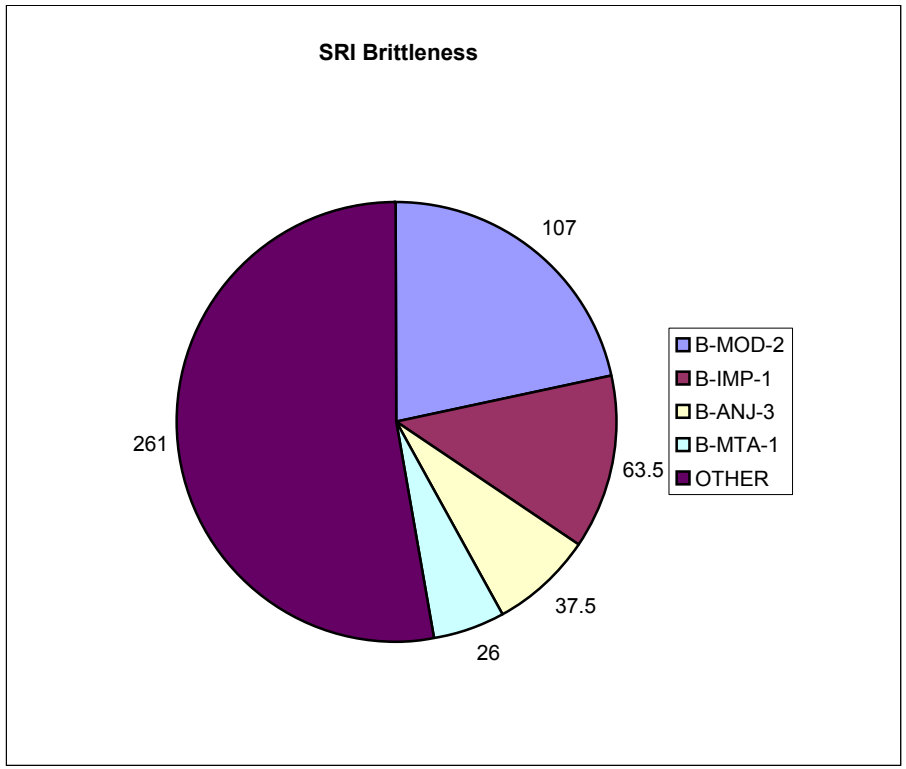
Summary

		Answers				Justifications				Total			
Brittleness Category	**Code**	**MC**	**DA**	**FF**	**Total**	**MC**	**DA**	**FF**	**Total**	**MC**	**DA**	**FF**	**Total**
Modelling	**B-MOD-1**	0	7	2.5	9.5	0	3	2	5	0	10	4.5	14.5
	B-MOD-2	0	35.5	14	49.5	2.5	41	14	57.5	2.5	76.5	28	107
	B-MOD-3	0	0	0	0	0	0	0	0	0	0	0	0
	B-MOD-4	0	0	0	0	0	0	0	0	0	0	0	0
Implementation, Language	**B-IMP-1**	3	7.5	22	32.5	6	7	18	31	9	14.5	40	63.5
	B-IMP-2	0	0	0	0	0	0	0	0	0	0	0	0
	B-IMP-3	0	0	0	0	0	0	0	0	0	0	0	0
Management	**B-MGT-1**	0	0	0	0	0	0	0	0	0	0	0	0
	B-MGT-2	0	0	0	0	0	0	0	0	0	0	0	0
	B-MGT-3	0	7.5	0	7.5	1.25	7.5	0	8.75	1.25	15	0	16.25
Formation, Learning	**B-KFL-1**	0	0	0	0	0	0	0	0	0	0	0	0
	B-KFL-2	0	0	0	0	0	0	0	0	0	0	0	0
Inference, Reasoning	**B-INF-1**	0	0	0	0	0	0	0	0	0	0	0	0
	B-INF-2	0	0	0	0	0	0	0	0	0	0	0	0
	B-INF-3	0	7.5	3	10.5	0	7.5	3	10.5	0	15	6	21
	B-INF-4	0	0	0	0	0	0	0	0	0	0	0	0
	B-INF-5	0	0	0	0	0	1	0	1	0	1	0	1
Query Management	**B-QMN-1**	0	0	0	0	0	0	0	0	0	0	0	0
	B-QMN-2	0	5	3	8	0	3.5	1	4.5	0	8.5	4	12.5
Answer Justification	**B-ANJ-1**	0	0	0	0	8.25	1	0	9.25	8.25	1	0	9.25
	B-ANJ-2	0	1	3	4	1.5	0.5	5	7	1.5	1.5	8	11
	B-ANJ-3	0	2	2	4	6.5	15	12	33.5	6.5	17	14	37.5
Quality Metrics	**B-QMT-1**	0	0	0	0	0	0	0	0	0	0	0	0
Meta-capabilities	**B-MTA-1**	0	2.5	10.5	13	0	2.5	10.5	13	0	5	21	26
Non-brittleness	**OTHER**	42	64.5	14.5	121	47.5	69	23.5	140	89.5	133.5	38	261
	Total	**45**	**140**	**74.5**	**259.5**	**73.5**	**158.5**	**89**	**321**	**118.5**	**298.5**	**163.5**	**580.5**


SRI Brittleness
107
63.5
37.5
26
261
B-MOD-2
B-IMP-1
B-ANJ-3
B-MTA-1
OTHER

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
Description	*Please be consistent in the language that is used for every explanation.* *Use capitalization and periods for each entry.* *Do not use extra spaces or extra formatting within the cell.* *Do not merge cells together.* *If a explanation is used more then once, enter in every cell which uses that data.*	*Use the Brittleness Code B-XXX-Y:PointsLost; if more then one code applies, use semi-colons to separate.*	*Please be consistent in the language that is used for every explanation.* *Use capitalization and periods for each entry.* *Do not use extra spaces or extra formatting within the cell.* *Do not merge cells together.* *If a explanation is used more then once, enter in every cell which uses that data.*	*Use the Brittleness Code B-XXX-Y:PointsLost; if more then one code applies, use semi-colons to separate.*
Example	The failure of this question was due to incomplete coverage of the domain. We were unable to show what the concentration c the base in a buffer was given the pH, Ka, and concentration c the acid.	B-MOD-1:2; B-MOD2:1	This justification is long and excessively mathematical, but it does clearly state the complete ionic equation and show the identification of common ions to determine the spectator ions.	B-ANJ-1:2; B-MOD-4:1
Multiple Choice				
MC 01			A typo in the answer justification template ("bicarbonate" should have read "carbonate"). SME1 wanted discussion of the solubility of CO2 in H2O; the KB has no knowledge of when a solubility should be justified if it is not explicitly asked for	B-MOD-2:1.5
MC 02			SME1 wanted justification of our choice of N 3- (as opposed to some other N anion); it is a memorized fact in the KB that doe not (by default) trigger any justification (such facts are normally considered too specific a detail to include in justifications)	B-ANJ-3:0.5
MC 03			Our system justified classifying the reaction as an oxidation-reduction reaction based on the change of oxidation state of Na. SME2 wanted discussion of N as well. The KB considers i sufficient if at least one chemical undergoes a change of oxidation state and does not consider others.	B-MOD-2:1
MC 04				
MC 05	Not submitted (we were unable to encode metal/nonmetal reactions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to encode metal/nonmetal reactions by the sequestration deadline).	OTHER:3
MC 06			SME1 gave 0 on justification, claiming the explanation was too long and was unfocused and illogical. The justification looks at each of the five possibilities in turn, checking first qualitative then quantitative measures of conductivity of each. Breaking the encoding into five subquestions would have allowed us to demarcate the five parts better, perhaps making the focus and logic of the justification more obvious.	B-ANJ-1:1

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MC 07				
MC 08			SMEs complained of excessive irrelevant information in the explanation (SME1 gave 0.5 on justification, SME2 and SME3 both gave 0). For each of the five parts of the question, the system justified the type of reaction (needed to determine the products), the products of the reaction (needed to check for precipitates), and for each product, its solubility. A bug in the interface resulted in the nested justifications being flattened, detracting further from the readability of the justification. This flattening bug appeared in the SHAKEN interface, but not in the tty interface used at the KB development site. Currently does not load	B-MGT-3:1.25; B-ANJ-1:1.25
MC 09				
MC 10				
MC 11				
MC 12				
MC 13			SME1 deducted half marks because the justification was "a bit lengthy". There is no irrelevant information provided in the justification, but there may be ways to tighten up the wording.	B-ANJ-3:0.5
MC 14			SME1 gave 0 for a justification he noted was "correct" and "proper", but "lengthy". The question asks if carbon dioxide is formed, if water is formed, if carbon monoxide is formed, how the oxidation number of oxygen is affected, and how the oxidation number of carbon is affected. It might be possible to build a system that justifies at a coarser level of detail as more things require justification. Or a system that justifies at a coarser level if there is risk of a full page of justification.	B-ANJ-3:1
MC 15				
MC 16			SME1 deducted 0.5 marks for a correct, but lengthy justification. In general our justifications that involve computing oxidation numbers for multiple species are lengthy.	B-ANJ-3:0.5
MC 17	An accidental gap in the KB prevented us from handling vanadium and OCl-.	OTHER:3	An accidental gap in the KB prevented us from handling vanadium and OCl-. Justification showed that the system knows how to compute changes in oxidation number.	OTHER:2
MC 18				

Team:	SRI			
	Answer		Justification	
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MC 19			SME1 gave 0 for justification because it contained "more information than needed". It might be possible to build a system that, given a question with five similar parts, omits some justification in parts 2-5 if it is the same as information in the first part.	B-ANJ-3:1
MC 20				
MC 21	Not submitted (we were unable to encode laws on the concentration of OH- in strong bases by the sequestration deadline).	OTHER:3	Not submitted (we were unable to encode laws on the concentration of OH- in strong bases by the sequestration deadline).	OTHER:3
MC 22				
MC 23				
MC 24				
MC 25				
MC 26				
MC 27				
MC 28			The question asks "How many moles of HF must be present to form a solution with a pH of 1.85?". Instead of computing the number of moles given the pH, our system tried each of the five possible answers to see which would produce a pH of 1.85. All three SMEs gave us 0 on justification. The justification might have been easier to follow if we had stated the solution strategy in the template encoding.	B-ANJ-1:3
MC 29			The question asks "What concentration of acetic acid would form a solution with a pH of 2.90?". Instead of computing the concentration given the pH, our system tried each of the five possible answers to see which would produce a pH of 2.90. All three SMEs gave us 0 on justification. The justification might have been easier to follow if we had stated the solution strategy in the template encoding.	B-ANJ-1:3
MC 30			No justification was produced. The KB is missing the inverse encoding of an encoded law. We have investigated ways to infer inverse laws automatically from encoded laws.	B-IMP-1:3
MC 31	Not submitted. Even if the system could confirm that all five statements are true, it would require some higher level reasoning to determine which of the five true statements is most relevant to the claim.	B-IMP-1:3	Not submitted. Even if the system could confirm that all five statements are true, it would require some higher level reasoning to determine which of the five true statements is most relevant to the claim.	B-IMP-1:3

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	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
MC 32	In the absence of the axioms needed to solve this question correctly, the system falls back on an inappropriate method of solving the question. If the correct axioms were present, the system would be prevented from defaulting to the incorrect method. (In this case, it might be said that the system is not brittle enough and should have failed rather than reasoning inappropriately).	OTHER:3	In the absence of the axioms needed to solve this question correctly, the system falls back on an inappropriate method of solving the question. If the correct axioms were present, the system would be prevented from defaulting to the incorrect method. (In this case, it might be said that the system is not brittle enough and should have failed rather than reasoning inappropriately).	OTHER:2.5
MC 33				
MC 34			The system was able to answer the question by looking up memorized facts in the KB. These do not (by default) trigger any justification (such facts are normally considered too specific a detail to include in justifications). In this case, justification would have been appropriate.	B-ANJ-3:3
MC 35			The KB was incomplete in the law for computing pH of salt solutions and unable to justify its answer properly.	OTHER:2
MC 36	Not submitted (gap in the KB for computing pH of salt solutions and identification of some chemicals).	OTHER:3	Not submitted (gap in the KB for computing pH of salt solutions and identification of some chemicals).	OTHER:3
MC 37	Gap in the KB for computing results of hydrolysis of salts. Our chemist asserts that the Vulcan answer key is wrong -- that (e is the correct answer, not (a).	OTHER:3	Gap in the KB for computing results of hydrolysis of salts. Our chemist asserts that the Vulcan answer key is wrong -- that (e is the correct answer, not (a).	OTHER:3
MC 38				
MC 39			We incorrectly stated that only cations can be Lewis acids. Although identifying Lewis acids based on Lewis structures is out of scope, the statement is clearly false to Chemists.	B-ANJ-2:1.5
MC 40	The KB has incomplete knowledge of Lewis acids.	OTHER:3	The KB has incomplete knowledge of Lewis acids.	OTHER:3
MC 41	We were unable to encode metal/nonmetal reactions by the sequestration deadline.	OTHER:3	We were unable to encode metal/nonmetal reactions by the sequestration deadline.	OTHER:3
MC 42	Not submitted (we were unable to complete the laws governin solutions of two substances by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin solutions of two substances by the sequestration deadline).	OTHER:3
MC 43				
MC 44	The KB is incomplete in its identification of CH3NH2 as a base and CH3NH3Cl as a salt.	OTHER:3	The KB is incomplete in its identification of CH3NH2 as a base and CH3NH3Cl as a salt.	OTHER:3
MC 45			We were unable to attach justification templates to laws governing buffer solutions by the sequestration deadline.	OTHER:2.5
MC 46			We were unable to attach justification templates to laws governing buffer solutions by the sequestration deadline.	OTHER:2.5

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	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
MC 47	The KB does not contain laws or definitions for "buffer capacity".	OTHER:3	The KB does not contain laws or definitions for "buffer capacity".	OTHER:3
MC 48	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
MC 49	The KB is incomplete in the laws governing pH of buffered solutions.	OTHER:3	The KB is incomplete in the laws governing pH of buffered solutions.	OTHER:3
MC 50	The KB is incomplete in the laws governing pH of buffered solutions. The existing knowledge was able to eliminate three of the five possibilities so the system generated both (b) and (d) as its answer. We would have expected half marks for correctness.	OTHER:3	The KB is incomplete in the laws governing pH of buffered solutions.	OTHER:3

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
Detailed Answer				
DA 01a				
DA 01b				
DA 01c				
DA 01d				
DA 01e				
DA 02a	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2a, we searched for a reaction with an insoluble product, but we failed to check that there were aqueous solutions in the reactants and/or an aqueous solution product in addition to the insoluble product.	B-QMN-2:2	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2a, we searched for a reaction with an insoluble product, but we failed to check that there were aqueous solutions in the reactants and/or an aqueous solution product in addition to the insoluble product.	B-QMN-2:1
DA 02b	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2b, we found a valid oxidation-reduction reaction, but SME2 wanted a better explantion of what species was being oxidized. The answer justification template for oxidation-reduction reactions could be improved.	B-ANJ-2:1		
DA 02c	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2c, we searched for a combustion reaction and found one in one of our software test cases. Unfortunately, the example (which was meant only to test the software correctness, not the soundness of the Chemical knowledge) contained an imaginary species: 2CH4O.	B-MOD-1:1; B-MOD-2:0	The justification template for combustion reaction did not contain a satisfactory definition.	B-ANJ-2:0.5; B-QMN-2:0.5
DA 02d				

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Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 02e	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2e, we searched for any reaction, failing to check that it was ionic. As luck would have it, the first reaction found was not ionic, and resulted in a meaningless computation of net ionic equation.	B-QMN-2:3	Question D2 asked for a representative example of types of reaction. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In D2e, we searched for any reaction, failing to check that it was ionic. As luck would have it, the first reaction found was not ionic, and resulted in a meaningless computation of net ionic equation.	B-QMN-2:2
DA 03a				
DA 03b				
DA 03c	The KB does not contain any knowledge of reactions that may occur when a single chemical is heated.	B-MOD-2:3	The KB does not contain any knowledge of reactions that may occur when a single chemical is heated.	B-MOD-2:3
DA 03d				
DA 03e				
DA 04a	The question asked for the reactants and products of the reaction as well as the balanced net ionic equation. The system's answer showed and justified the reactants and products and the net ionic equation. The KB does not currently balance net ionic equations (an oversight in KB coding). For that reason alone SME2 and SME3 gave zero for the answer.	B-MOD-2:2	The question asked for the reactants and products of the reaction as well as the balanced net ionic equation. The system's answer showed and justified the reactants and products and the net ionic equation. The KB does not currently balance net ionic equations (an oversight in KB coding). For that reason alone SME1 gave zero on justification.	B-MOD-2:1
DA 04b	The KB contains the incorrect assumption that all chemicals are in solution when computing the complete ionic equation.	B-MOD-2:1	The KB contains the incorrect assumption that all chemicals are in solution when computing the complete ionic equation, rendering the justification meaningless.	B-MOD-2:2.5
DA 04c	Question D4 asked for solutions for five of the eight parts. Since our chemical name translator could not translate "coppe hydroxide", we chose not to encode D4c.	OTHER:3	Question D4 asked for solutions for five of the eight parts. Since our chemical name translator could not translate "coppe hydroxide", we chose not to encode D4c.	OTHER:3
DA 04d	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5
DA 04e	Officially out of scope.		Officially out of scope.	
DA 04f	Question D4 asked for solutions for five of the eight parts. We chose not to encode D4f.	OTHER:3	Question D4 asked for solutions for five of the eight parts. We chose not to encode D4f.	OTHER:3
DA 04g	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 04h			SME1 gave 0 for justification because it was "long" (28 lines).	B-ANJ-3:1
DA 05a			Question D5 required three things: the identification of the products of each reaction, the identification of any precipitates among those products and the net ionic equation of each reaction (requiring explanation of solubility and electrolyte status for all reactants and products). SME1 gave zero on justification because it was "much too long just to show what the precipitate is". SME2 also gave zero because the justification was long. The justification included 2 lines to identify the type of reaction, 2 lines to explain what the products were, 6 lines each to determine whether the two products were precipitates and 32 lines to compute the net ionic equation (4 lines for each reactant and product to determine its solubility and 4 lines for each reactant and product to determine its electrolyte status). The wording could no doubt be tightened up, but to give a complete, coherent justification the same credit as no justification at all (or as an incoherent erroneous justification) is unreasonable.	B-ANJ-3:2
DA 05b			The justification for a reaction with no net ionic equation could be much shorter.	B-ANJ-3:2

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Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 05c			Question D5 required three things: the identification of the products of each reaction, the identification of any precipitates among those products and the net ionic equation of each reaction (requiring explanation of solubility and electrolyte status for all reactants and products). SME1 gave zero on justification because it was "much too long just to show what the precipitate is". SME2 also gave zero because the justification was long. The justification included 2 lines to identify the type of reaction, 2 lines to explain what the products were, 6 lines each to determine whether the two products were precipitates and 32 lines to compute the net ionic equation (4 lines for each reactant and product to determine its solubility and 4 lines for each reactant and product to determine its electrolyte status). The wording could no doubt be tightened up, but to give a complete, coherent justification the same credit as no justification at all (or as an incoherent erroneous justification) is unreasonable.	B-ANJ-3:2
DA 06a	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct answer for the oxidation numbers.	B-MOD-2:1	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct justification for the oxidation numbers. It seems harsh for SME1 to have given no credit at all for justifications.	B-MOD-2:1.5
DA 06b	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct answer for the oxidation numbers.	B-MOD-2:1	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct justification for the oxidation numbers. It seems harsh for SME1 to have given no credit at all for justifications.	B-MOD-2:2.5

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DA 06c	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct answer for the oxidation numbers.	B-MOD-2:1	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct justification for the oxidation numbers. It seems harsh for SME1 to have given no credit at all for justifications.	B-MOD-2:1.5
DA 06d	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct answer for the oxidation numbers.	B-MOD-2:1	Question D6 required the oxidation numbers of each element and an identification of which species were oxidized and which were reduced. The KB did not have the knowledge required to determine which species were oxidized and reduced, but the system produced the correct justification for the oxidation numbers. It seems harsh for SME1 to have given no credit at all for justifications.	B-MOD-2:1.5
DA 07a	Our system did not have the ability to prepare activity series fo three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5	Our system did not have the ability to prepare activity series fo three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5
DA 07b	Our system did not have the ability to consider reactivity of three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5	Our system did not have the ability to consider reactivity of three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5
DA 07c	Our system did not have the ability to consider oxidation readiness of three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5	Our system did not have the ability to consider oxidation readiness of three anonymous species.	B-MOD-2:1.5; B-IMP-1:1.5
DA 08a	Our KB was incomplete in areas required to deal with partial hydrolysis.	B-MOD-2:2.5	There were no justification templates in the (incomplete) KB laws dealing with partial hydrolysis	B-MOD-2:3
DA 08b	Our KB was incomplete in areas required to deal with partial hydrolysis.	B-MOD-2:2.5	There were no justification templates in the (incomplete) KB laws dealing with partial hydrolysis	B-MOD-2:2.5
DA 09a	A bug in the system prevented it from identifying the ionic parts of HCl. Since part of the question was to produce the balanced molecular equation, which our system did, getting no credit for this question from two SMEs seems harsh.	B-MOD-1:3	A bug in the system prevented it from identifying the ionic parts of HCl. Since part of the question was to produce the balanced molecular equation, which our system did, getting no credit for this question from two SMEs seems harsh.	B-MOD-2:2
DA 09b	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5
DA 09c	A bug in the system prevented it from identifying the ionic parts of HBr. Since part of the question was to produce the balanced molecular equation, which our system did, getting no credit for this question seems harsh.	B-MOD-1:3	A bug in the system prevented it from identifying the ionic parts of HBr. Since part of the question was to produce the balanced molecular equation, which our system did, getting no credit for this question seems harsh.	B-MOD-1:3

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DA 09d	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5
DA 10	Question D10 did not require a solution to a problem, but a discussion of the system's ability to solve types of problems (a kind of meta-reasoning).	B-MTA-1:1.5; B-IMP-1:1.5	Question D10 did not require a solution to a problem, but a discussion of the system's ability to solve types of problems (a kind of meta-reasoning).	B-IMP-1:1.5; B-MTA-1:1.5
DA 11a				
DA 11b				
DA 11c	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 11d	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 12a				
DA 12b	The KB was incomplete in one of the laws for computing dissociation constants. Furthermore, the system had trouble inferring knowledge about the unknown (CH3)NH2NO3.	B-MOD-2:2.5	The justification templates were incomplete in one of the laws for computing dissociation constants. Furthermore, the system had trouble inferring knowledge about the unknown (CH3)NH2NO3.	B-MOD-2:3
DA 12c	Not submitted (gap in the KB for computing pH when one solution or chemical is added to another solution).	OTHER:3	Not submitted (gap in the KB for computing pH when one solution or chemical is added to another solution).	OTHER:3
DA 12d	Not submitted (gap in the KB for computing pH when one solution or chemical is added to another solution).	OTHER:3	Not submitted (gap in the KB for computing pH when one solution or chemical is added to another solution).	OTHER:3
DA 13a	The KB was incomplete in its coverage of polyprotic acids (a missing exception to a general rule).	B-MOD-2:3	The KB was incomplete in its coverage of polyprotic acids (a missing exception to a general rule).	B-MOD-2:3
DA 13b	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 13c	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 13d	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 14a			Marks were deducted for not rounding three significant figures down to one. Marks were deducted for using a KB term ("concentration change constant") in the justification that is not a general Chemistry term.	B-ANJ-1:1; B-INF-5:1

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 14b			The system was able to answer the question by looking up memorized facts in the KB. These do not (by default) trigger any justification (such facts are normally considered too specific a detail to include in justifications). In this case, justification would have been appropriate.	B-ANJ-3:1.5
DA 14c				
DA 14d	The KB was incomplete in its coverage of polyprotic acids (a missing exception to a general rule).	B-MOD-2:3	The KB was incomplete in its coverage of polyprotic acids (a missing exception to a general rule).	B-MOD-2:2
DA 15a	The system produced the correct answers for pH and pOH, but gave an incorrect justification due to gaps in the KB for Kw. Curiously, no marks were entered in the "Results Compilation" for SME2 or SME3. Is this possibly a clerical error? (SME2 had "check marks" on the answer and on the justification of pH).	B-MOD-2:1.5; OTHER:1	The system produced the correct answers for pH and pOH, but gave an incorrect justification due to gaps in the KB for Kw. Curiously, no marks were entered in the "Results Compilation" for SME2 or SME3. Is this possibly a clerical error? (SME2 had "check marks" on the answer and on the justification of pH).	B-MOD-2:1.5; OTHER:1
DA 15b	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 15c	Not submitted (we were unable to complete the laws governin buffer capacity by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin buffer capacity by the sequestration deadline).	OTHER:3
DA 16a	The KB does not have sufficient knowledge of Henderson-Hasselbalch equations and buffer solutions. There are also no laws specific to blood.	B-MOD-2:3	The KB does not have sufficient knowledge of Henderson-Hasselbalch equations and buffer solutions. There are also no laws specific to blood.	B-MOD-2:3
DA 16b	The KB does not have sufficient knowledge of Henderson-Hasselbalch equations and buffer solutions. There are also no laws specific to blood.	B-MOD-2:3	The KB does not have sufficient knowledge of Henderson-Hasselbalch equations and buffer solutions. There are also no laws specific to blood.	B-MOD-2:3
DA 17a	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5	Encoded but not submitted (a difference in the UT and SRI environments caused this question to run indefinitely at SRI).	B-MGT-3:1.5; B-INF-3:1.5
DA 17b			An incompleteness in explanation generation prevented the calculation of Ki from being justified.	B-ANJ-3:1

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 17c	Question D17c asked for the pH of the carbonic acid solution, [HCO3-] and [CO3-]. The system produced the correct answer for pH and [HCO3-], but not [CO3-]. SME3 gave no credit for this question. In the absence of the axioms needed to solve for [CO3-] correctly, the system falls back on an inappropriate method of solving the question. If the correct axioms were present, the system would be prevented from defaulting to the incorrect method. (In this case, it might be said that the system is not brittle enough and should have failed rather than reasoning inappropriately).	OTHER:1.5	Question D17c asked for the pH of the carbonic acid solution, [HCO3-] and [CO3-]. The system produced the correct justification of pH and [HCO3-], but not [CO3-]. SME3 gave no credit for this question.	OTHER:2.5
DA 17d	The KB was incomplete in one of the laws for computing dissociation constants.	OTHER:3	The KB was incomplete in one of the laws for computing dissociation constants.	OTHER:3
DA 18a			The system was able to answer the question by looking up memorized facts in the KB. These do not (by default) trigger any justification (such facts are normally considered too specific a detail to include in justifications). In this case, justification would have been appropriate.	B-ANJ-3:3
DA 18b				
DA 19a				
DA 19b	In the absence of the axioms needed to solve for concentrations correctly, the system falls back on an inappropriate method of solving the question. If the correct axioms were present, the system would be prevented from defaulting to the incorrect method. (In this case, it might be said that the system is not brittle enough and should have failed rather than reasoning inappropriately).	OTHER:2.5	In the absence of the axioms needed to solve for concentrations correctly, the system falls back on an inappropriate method of solving the question. If the correct axioms were present, the system would be prevented from defaulting to the incorrect method. (In this case, it might be said that the system is not brittle enough and should have failed rather than reasoning inappropriately).	OTHER:2.5
DA 20	In the absence of knowledge of electronegativity and acidity, the system calculated pH based on memorized dissociation constants. Although this approach produced a correct ordering on acidity, SME2 and SME3's prerogative to give no credit at all.	B-ANJ-3:2	In the absence of knowledge of electronegativity and acidity, the system calculated pH based on memorized dissociation constants, rendering the justifications trivial. Although this approach produced a correct ordering on acidity, it was within SME2 and SME3's prerogative to give no credit at all for justification.	B-ANJ-3:2.5

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
DA 21a	After trying to insert pages from batch2 into batch1, SME2 lost the ordering of batch2 answers and was unable to find the answer to D21a. The KB was incomplete in the law for computing pH of salt solutions, making it unable to calculate the pH for this question. It was only able to report whether the pH would increase or decrease as a result of ion hydrolysis.	OTHER:3	After trying to insert pages from batch2 into batch1, SME2 lost the ordering of batch2 answers and was unable to find the answer to D21a. The KB was incomplete in the law for computing pH of salt solutions, making it unable to calculate the pH for this question. It was only able to report whether the pH would increase or decrease as a result of ion hydrolysis.	OTHER:3
DA 21b	The justification correctly states that Fe 3+ is more acidic due to the greater charge (SME1 and SME3 gave full credit). SME2 seems to have overlooked the justification.	OTHER:1		
DA 22a	The system was able to determine that the normal pH calculation produced an unreasonable value (> 7 for an acid). The ability to perform a calculation permitted by the KB and then reflect on the appropriateness of that calculation is beyond the current system/language.	B-MTA-1:1; B-IMP-1:1.5	The system was able to determine that the normal pH calculation produced an unreasonable value (> 7 for an acid). The ability to perform a calculation permitted by the KB and then reflect on the appropriateness of that calculation is beyond the current system/language. The justification hinted a the inappropriateness ("the acid solution is basic"), but not giv any explanation.	B-IMP-1:1; B-MTA-1:1
DA 23a	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 23b	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3	Not submitted (we were unable to complete the laws governin pH of buffered solutions by the sequestration deadline).	OTHER:3
DA 24a			Gap in the KB for computing pH of salt solutions. (Default pH was correct for this part).	OTHER:3
DA 24b	Gap in the KB for computing pH of salt solutions. Our Chemist claims that the answer in the Vulcan key is incorrect.	OTHER:3	Gap in the KB for computing pH of salt solutions. Our Chemist claims that the answer in the Vulcan key is incorrect.	OTHER:3
DA 24c	Gap in the KB for computing pH of salt solutions.	OTHER:3	Gap in the KB for computing pH of salt solutions.	OTHER:3
DA 24d	Gap in the KB for computing pH of salt solutions.	OTHER:3	Gap in the KB for computing pH of salt solutions.	OTHER:3
DA 24e	Gap in the KB for computing pH of salt solutions.	OTHER:3	Gap in the KB for computing pH of salt solutions.	OTHER:3
DA 25	Our laws governing buffer solutions were incomplete.	OTHER:1.5	We were unable to attach justification templates to laws governing buffer solutions by the sequestration deadline.	OTHER:3

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	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
Free Form		Code:Deduction; Code:Deduction		Code:Deduction; Code:Deduction
FF 01	Not submitted. Although subscripts and coefficients are captured distinctly in KB constructs, there is no explicit meta-knowledge of why they are distinct (just as there is explicit meta-knowledge of why oxidation numbers and aqueous solutions are distinct concepts).	B-MTA-1:1.5; B-IMP-1:1.5	Not submitted. Although subscripts and coefficients are captured distinctly in KB constructs, there is no explicit meta-knowledge of why they are distinct (just as there is explicit meta-knowledge of why oxidation numbers and aqueous solutions are distinct concepts).	B-MTA-1:1.5; B-IMP-1:1.5
FF 02	Since "tap water" was not covered in the in-scope material, we searched the internet and found that H2SiF6 is a common component in tap water. The system solved the question by comparing the conductivity of H2O to a very low concentration aqueous solution of H2SiF6. The SMEs did not accept the reasoning (though it's possible that a better justification would have convinced them).	B-QMN-2:2	Since "tap water" was not covered in the in-scope material, we searched the internet and found that H2SiF6 is a common component in tap water. The system solved the question by comparing the conductivity of H2O to a very low concentration aqueous solution of H2SiF6. The lack of explanation of this approach in the justification was an oversight.	B-ANJ-2:3
FF 03	Giving a complete answer to this question would have required activity series for all metals (which is arguably out of scope).	OTHER:1.5	Giving a complete answer to this question would have required activity series for all metals (which is arguably out of scope).	OTHER:2.5
FF 04a	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5
FF 04b	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5
FF 04c	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5	Not submitted (requires more complete knowledge of activity series as well as some meta-level reasoning).	B-MTA-1:1.5; B-IMP-1:1.5
FF 05	Not submitted. Normally Copper does not react with acids. That it reacts with Nitric Acid is an exception not captured in the KB.	B-MOD-2:3	Not submitted. Normally Copper does not react with acids. That it reacts with Nitric Acid is an exception not captured in the KB.	B-MOD-2:3
FF 06	A simple bug in the calculation of oxidation state of S caused the system to report an incorrect answer. There were also two typos in the exam and our encoding only fixed one of them.	B-MOD-1:2.5	A simple bug in the calculation of oxidation state of S caused the system to report an incorrect answer. There were also two typos in the exam and our encoding only fixed one of them.	B-MOD-1:2
FF 07	Encoded but not submitted. The solution required at least 24 hours of cpu time in the UT environment, making it unlikely that it would finish at all in the SHAKEN environment.	B-INF-3:3	Encoded but not submitted. The solution required at least 24 hours of cpu time in the UT environment, making it unlikely that it would finish at all in the SHAKEN environment.	B-INF-3:3

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	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
FF 08	Question FF8 would require a kind of meta-knowledge for the system to "reflect on what it knows". It would have been possible to simply query all of the Chemistry-specific slots for the two solutions, but initial experiments suggested that would not be fruitful. It would be worth investigating whether an analogy system (like Ken Forbus' Structure Matching Engine) would turn up interesting results.	B-MTA-1:1.5; B-IMP-1:1.5	Question FF8 would require a kind of meta-knowledge for the system to "reflect on what it knows". It would have been possible to simply query all of the Chemistry-specific slots for the two solutions, but initial experiments suggested that would not be fruitful. It would be worth investigating whether an analogy system (like Ken Forbus' Structure Matching Engine) would turn up interesting results.	B-MTA-1:1.5; B-IMP-1:1.5
FF 09	Both SME1 and SME2 gave full credit for this question. The entry in Vulcan's Results Compilation is blank for SME3. Is it possible SME3 missed this question?	OTHER:1	Both SME1 and SME2 gave full credit for this question. The entry in Vulcan's Results Compilation is blank for SME3. Is it possible SME3 missed this question?	OTHER:1
FF 09a	The KB does not account for non-water solvents.	B-MOD-2:3	The KB does not account for non-water solvents.	B-MOD-2:3
FF 09b	Not submitted (the KB does not account for non-water solvents).	B-MOD-2:3	Not submitted (the KB does not account for non-water solvents).	B-MOD-2:3
FF 09c	The KB does not account for non-water solvents.	B-MOD-2:3	The KB does not account for non-water solvents.	B-MOD-2:3
FF 10	Question FF10 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB.	B-MTA-1:1.5; B-IMP-1:1.5	Question FF10 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB.	B-MTA-1:1.5; B-IMP-1:1.5
FF 11	Question FF11 asks for the difference in pH of two solutions, one of which has a 1000 times greater concentration of H3O+. The system invented two solutions with specific concentrations and calculated their pH values to be 1 and 4. Instead of subtracting the two values and concluding: "one value is 3 greater than the other", we divided the two values and concluded "one value is 4 times greater than the other". It seems harsh that SME1 and SME2 would give no credit.	B-ANJ-2:3	Question FF11 asks for the difference in pH of two solutions, one of which has a 1000 times greater concentration of H3O+. The system invented two solutions with specific concentrations and calculated their pH values to be 1 and 4. Instead of subtracting the two values and concluding: "one value is 3 greater than the other", we divided the two values and concluded "one value is 4 times greater than the other". It seems harsh that SME1 and SME2 would give no credit, given that the justification clearly shows that the system knew the key to solving the question was in the logs of the concentration.	B-ANJ-2:2

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
FF 12	Question FF12 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB. Nonetheless, the system was able to propose an answer by looking at a specific acid, concentrated and dilute. Interestingly, SME1 appreciated the novel approach ("Interesting apporach, logical with good focus. Not what I was expecting") and gave full credit. SME2 and SME3 did not accept the alternative approach (giving no credit at all).	B-MOD-2:1; B-IMP-1:1	Question FF12 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB. Nonetheless, the system was able to propose an answer by looking at a specific acid, concentrated and dilute. Interestingly, SME1 appreciated the novel approach ("Interesting apporach, logical with good focus. Not what I was expecting") and gave full credit. SME2 and SME3 did not accept the alternative approach (giving no credit at all).	B-MOD-2:1; B-IMP-1:1
FF 13	Question FF13 asks for an observation in the abstract. The system produced an answer based on specific chemicals.	B-IMP-1:1.5	Question FF13 asks for an observation in the abstract. The system produced an answer based on specific chemicals.	B-IMP-1:1.5
FF 14a	The system was only able to confirm the acid strength relationships given, not explain them (and even then, it was nc able to confirm all the relationships). This is partly due to the inability of the system to "reflect" on its knowledge.	B-IMP-1:2	The system was only able to confirm the acid strength relationships given, not explain them (and even then, it was nc able to confirm all the relationships). This is partly due to the fact that some acid strength relationships are memorized facts in the KB, which are not by default explained in justifications. It is also partly due to the inability of the system to "reflect" on its knowledge.	B-ANJ-3:3
FF 14b	The system was only able to confirm the acid strength relationships given, not explain them (and even then, it was nc able to confirm all the relationships). This is partly due to the inability of the system to "reflect" on its knowledge.	B-IMP-1:3	The system was only able to confirm the acid strength relationships given, not explain them (and even then, it was nc able to confirm all the relationships). This is partly due to the fact that some acid strength relationships are memorized facts in the KB, which are not by default explained in justifications. It is also partly due to the inability of the system to "reflect" on its knowledge.	B-ANJ-3:3
FF 15a	We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3	We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3
FF 15b			We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3
FF 15c	We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3	We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3

Team:	SRI			
	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
FF 15d			We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:3
FF 15e			We were unable to complete the laws governing pH of buffere solutions and of salts by the sequestration deadline.	OTHER:2
FF 16			SME2 wanted to see an equation. This was simply left out of the answer justification template as giving too much detail. It could easily be added.	B-ANJ-3:1
FF 17a				
FF 17b			SME1 wanted more detail on the definition of Lewis acids.	B-ANJ-3:0.5
FF 17c				
FF 17d	Question FF17d asked for an example of a buffer solution with pH close to 7.0. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In this case, the system foun information in a question on this exam, classifying blood as a buffer solution whose pH is close to 7.0. SMEs wanted much more information about the buffer than was available in the example found.	B-MOD-2:1; B-QMN-2:1	Question FF17d asked for an example of a buffer solution with pH close to 7.0. We completely failed to anticipate this kind of question and had not built examples into our representations explicitly. We were able to find examples by searching through the KB's test cases (embedded in the KB concepts) and through the question encodings. In this case, the system foun information in a question on this exam, classifying blood as a buffer solution whose pH is close to 7.0. SMEs wanted much more information about the buffer than was available in the example found.	B-MOD-2:1; B-QMN-2:1
FF 18	The system was only able to confirm the acid strength based on oxygen atoms in oxyacids, not explain why. This is partly due to the inability of the system to "reflect" on its knowledge.	B-IMP-1:3	The system was only able to confirm the acid strength based on oxygen atoms in oxyacids, not explain why. This is partly due to the inability of the system to "reflect" on its knowledge.	B-IMP-1:3
FF 19	Question FF19 asked if all Lewis acids are Bronsted-Lowry acids. The system found an example of a Lewis acid that is nc a Bronsted-Lowry acid, proving by counterexample that not all Lewis acids are Bronsted-Lowry acids. Presumably, the SMEs wanted the system to explain the difference between the two classes of acid. The KB does not encode the meta-knowledge of why different classes are distinct.	B-IMP-1:1	Question FF19 asked if all Lewis acids are Bronsted-Lowry acids. The system found an example of a Lewis acid that is nc a Bronsted-Lowry acid, proving by counterexample that not all Lewis acids are Bronsted-Lowry acids. By default there are nc justification tags associated with superclass-subclass relationships in the KB.	B-IMP-1:2

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	Answer		Justification	
Question Type & Number	Answer Failure Explanation	Brittleness Causes	Justification Failure Explanation	Brittleness Causes
FF 20			The system's answer was based on equilibrium, but the justification grounded out eventually in looking up memorized facts for comparative acid strengths. These facts do not (by default) trigger any justification (such facts are normally considered too specific a detail to include in justifications). In this case, justification would have been appropriate.	B-ANJ-3:1.5
FF 21	The system answered the question by showing specific reactions where HCO3- first acts as an acid, then as a base. The approach to solving the question could have been stated more clearly in the justification.	B-ANJ-3:2		
FF 22	Not submitted. Question FF22 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB.	B-MTA-1:1.5; B-IMP-1:1.5	Not submitted. Question FF22 requires knowledge of "why things are done a certain way in the field of Chemistry", which is different from the pure Chemistry knowledge in the KB (though the former is certainly justified by the latter). This is a kind of meta-knowledge not encoded at all in the KB.	B-MTA-1:1.5; B-IMP-1:1.5
FF 23	A gap in the KB for computing pH when acids and bases react.	OTHER:3	A gap in the KB for computing pH when acids and bases react.	OTHER:3
FF 24	In the absence of appropriate knowledge to answer the question, the system merely reported the definition of monoprotic acid.	OTHER:3	In the absence of appropriate knowledge to answer the question, the system merely reported the definition of monoprotic acid.	OTHER:3
FF 25			The system was able to determine the equilibrium shift, but unable to justify it acceptably in concise terms.	B-ANJ-3:3