GENERAL COMMENTS

The 2001 criteria for this examination were:

1. Understanding of qualitative and quantitative aspects of chemical reactions, including acid-base and redox reactions and their application in the analysis of a variety of consumer products by a range of common laboratory techniques and modern instrumental methods
2. Understanding of the principles of equilibrium, reaction rate and energy change and their relationships to the outcomes of chemical reactions, including those in living systems and small scale laboratory reactions
3. Understanding of chemical reactions and the relevant concepts in the production of important industrial chemicals, including sulfuric acid and substances derived from petroleum
4. Knowledge of experimental measurement and observation
5. Analysis, interpretation and synthesis of information.

SPECIFIC INFORMATION

Section A: Multiple-choice questions (22 x 1 mark)

Question	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Correct response	%	Study area
1	*				*	**C**	45	1.3
2	*				*	**D**	51	2.10
3	*				*	**C**	69	2.10
4	*				*	**C**	43	1.3
5			*			**C**	63	3.1
6			*			**C**	83	3.1
7			*			**D**	78	3.1
8	*		*			**A**	56	2.9
9	*	*		*		**B**	81	2.9
10	*	*				**C**	37	2.9
11	*	*				**B**	54	2.9
12		*				**C**	80	2.6
13	*		*			**A**	82	3.2; 3.4
14	*		*			**A**	76	3.2; 3.4
15	*		*			**D**	92	3.2; 3.4
16			*			**A**	60	3.2
17			*			**C**	85	3.2
18			*			**B**	50	1.4
19	*					**B**	58	1.4
20	*					**A**	50	2.9
21		*				**D**	62	2.11
22		*				**B**	51	2.11

Comments on questions that were poorly answered by most students.

Question 1
The incorrect response A was selected by 27% of students, who obviously mistook ‘molecule’ in the stem for ‘mole’.

Question 2
The incorrect response most frequently selected was A, with students mistaking concentration of the required logarithmic pH scale.

Question 4
Those who answered B forgot that only half a mole of Mg is used up by each mole of H+.

Question 10
This was the most difficult question with over 25% selecting B, presumably thinking that, because the degree of dissociation was increased by the dilution, the concentration of H+ should also increase.

Question 18
A similar error as in Question 4, with students not realising that each mole of water had two H atoms to go with the one C atom in each mole of CO_2 and chose response A.

Question 20
The most common error was to choose B and to think that the stronger acid will have a higher pH (more H+??) than the weaker.

Section B: Short-answer questions

Number	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5	Marks	Study area
1	*	*		*	*	11	1.4; 2.3; 2.5
2	*				*	9	1.1; 1.2; 1.6; 2.4
3				*	*	7	1.5; 2.4
4		*			*	9	1.2; 2.6
5			*		*	17	3.2; 3.3

* Indicates each available mark

For simplicity, molecular structures are omitted.

Question 1 (11 marks)
ai. (Average mark 2.06/Available marks 3)
(2.00/100.1) = 0.0200 mol*; V = (nRT/p)* = (0.0200 x 8.31 x 291/101.3) = 0.477 L*
aii. (0.46/2)
mass loss = 0.0200 x 44* = 0.879 g* (note that this refers to the CO_2 evolved)

This caused enormous difficulty. Many embarked on fruitless calculations of the mass of $CaCO_3$ and/or the HCl used when what was required was the perception that only the CO_2 will escape the system.
aiii. (1.68/4)
initial HCl amount = (100/1000) x 0.500 = 0.0500) mol*;
amount of HCl used = 2 x 0.0200 = 0.0400 mol*;
mol of HCl remaining = 0.0500 − 0.0400 = 0.0100*; HCl conc. remaining = 0.100 M*.

These 'c – x' calculations are always found to be difficult.
b. (1.13/2)
larger total surface area leads to faster reaction*; on graph, show reaction proceeding more rapidly* (it is essential that the line be drawn so as to finish at the *same* final mass).

Nearly all students inserted a line of some sort below the one provided. The mark was not given if the line wandered too far away from the final mass – which had to be the same for both experiments.

Question 2 (9 marks)
a. (0.62/1)
to ensure that reaction is complete*
b. (0.47/1)
green – orange is transmitted by the orange solution and could not be absorbed*

The mark was for explaining that if the solution looked orange then it must be transmitting orange light. Many students, having said 'green', then went on to talk about the solution 'reflecting' rather than 'transmitting' the orange light, and continued by saying something about the green light being absorbed. There is little doubt that the basics of absorption spectroscopy are in general not well understood.
c. (0.93/1)
0.010*
d. (1.64/4)
Initial amount of dichromate = (10.0/1000) x 0.100 = 0.00100* mol $K_2Cr_2O_7$; amount of dichromate remaining = (100/1000) x 0.0028 = 0.00028 mol*; amount of dichromate used = 0.00100 − 0.00028 = 0.00072 mol*; amount of ethanol reacted = (3/2) x 0.00072 = 0.000108 mol* (1.1 x 10^{-3} g)

Another 'c – x' calculation in a different environment with some similarity to Q1aiii.
e. (0.82/2)
mol of ethanol per mL = 2 x 0.000108 = 0.000216 mol*; mass of ethanol per mL = 0.000216 x 46 = 0.10 g*

Question 3 (7 marks)
a. (0.72/1)
paper chromatography*
b. (1.35/2)
the rate of movement will vary depending on the differing degrees* of adsorption* of the different substances.
c. (2.92/4)
student B. Each experiment shows effectively the same* R_f value – thus for A
R_f = 3.5/5.1 = 0.69*; for B R_f = 6.2/9.1 = 0.68*. It follows that the two yellow samples could be the same substance*.

Overall, this question was well done. In order to respond correctly to Q3c it was necessary to write a sentence or two. Many students were not able to construct and write down a few coherent sentences.

Question 4 (9 marks)
a. (3.37/6)
Test 1: darker* – bromide ions move equilibrium to left*.
Test 2: darker – hydrogen ions consume hydroxide ions*, thereby moving equilibrium to the left*.
Test 3: lighter – since reaction is endothermic*, raising the temperature will move equilibrium to the right*.

This part was fairly well done. Test 2 was where the H^+ removes the OH^- from the RHS so the reaction moves to the left and the solution becomes darker. Many students got it right for the wrong reason and only got half marks.
b. (2.38/3)
0*; -1*; 1*.

Question 5 (17 marks)
a. (1.78/2)
alkane*; alkene*
b. (2.42/4)
$C_3H_8(g) + Cl_2(g) \rightarrow C_3H_7Cl(g) + HCl(g)$*
1-chloropropane*; substitution*
c. (1.32/3)
(1.32/3 $C_3H_6(g) + Cl_2(g) \rightarrow C_3H_6Cl_2(g)$*; addition*.
This part was less well done than part (b). Students did not understand it as well as the very similar Question 5b.
d. (2.15/5)
take portion* of ethanol and convert to ethanoic acid: $CH_3CH_2OH \rightarrow$ (with $K_2Cr_2O_7$*) CH_3CO_2H*; then react with remaining ethanol: $CH_3CH_2OH + CH_3CO_2H \rightarrow$ (H^+* catalyst) $CH_3COOCH_2CH_3$.*

This proved to be a difficult question. To get full marks, students had to perceive that the ethanol sample had to be divided so that part of it could be converted to ethanoic acid which was then reacted with the remaining ethanol to make the required ethyl ethanoate. Note that a description of what must be done, coupled with correct formulas, satisfies the question – equations are not strictly necessary.
e. (2.2/3)
(no comment provided)