NEW ZEALAND QUALIFICATIONS AUTHORITY
MANA TOHU MĀTAURANGA O AOTEAROA

Level 2, 2003

Chemistry: Describe principles of chemical reactivity (90310)

National Statistics

Assessment Report

Assessment Schedule

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National Statistics

Number of Results	Percentage achieved			
	Not Achieved	Achieved	Merit	Excellence
8,517	43.6%	42.7%	10.6%	3.1%

Assessment Report

General Comments

Every candidate for a National Certificate of Educational Achievement examination paper is expected to:

- read the question and do what the question asks
- allow adequate time to complete answers
- be accurate: check and/or proofread
- use appropriate technical terms
- bring the correct equipment
- write and/or draw clearly
- use pen if work is to be eligible for reconsideration.

In order to show an understanding of '*principles of chemical reactivity'*, candidates must be able to use the related language of chemistry accurately and clearly. Candidates who were able to do this, were then able to link the information and write answers of high quality showing a good understanding of the chemistry involved.

However, a significant number of candidates were limited in the level of achievement gained due to poor use of chemical language. Questions in which this was an issue were those related to:

- reaction rate. Many candidates failed to recognise that an *explanation of factors affecting rates of reactions* must involve 'time', ie rate is 'per time', and that the activation energy of a reaction is a factor to consider when the temperature is changed. Diluting a solution does not change the energy of reactant particles.
- acid-base systems. *Proton transfer* needs to be understood as transfer of a hydrogen ion not a hydrogen atom. In *recognition of acid-base properties of ionic compounds* ammonium chloride in solution forms NH_4^+ ions and Cl^- ions and it is only the NH_4^+ ion that reacts further with water. In *comparison of properties of aqueous solutions of strong and weak acids* the relationship between pH and strong / weak acids was often poorly answered. A lower pH of the solution does not necessarily imply a stronger acid, as the concentrations of the solutions may be different. An acid and an acidic solution were often considered to be the same thing.
- equilibrium systems. Descriptions related to the *direction in which reaction occurs on changing a system at equilibrium* often lacked clarity, as did the *explanations* for these.

Candidates should be encouraged to clearly show all steps in questions involving calculations. Candidates who were able to do this often showed evidence towards achievement, even when the final answer was incorrect. The difference between amount and mass of substance, and the use of appropriate units was often misunderstood, as was the appropriate use of significant figures. The incorrect use of a calculator often lead to a hydroxide ion concentration of 1×10^{-9} mol L^{-1} for a solution where the hydronium ion had been determined as 5.75×10^{-6} mol L^{-1}. This showed limited understanding of the chemical principles involved in acid-base systems.

Most candidates were able to *write equilibrium constant expressions for homogenous systems from given equations*. However, some failed to recognise $H_2O(g)$ is a variable in a gaseous system, while others wrote the inverse expression for the aqueous system or omitted the charges of the ionic species involved.

Candidates should be encouraged to relate experimental observations and use these as evidence to support chemical principles. Questions involving a description of an observation were poorly answered. An equilibrium system cannot be observed as ‘more’ or ‘less’ of a gas but needs to be described in terms of the colours observed using the information provided. Similarly, strong and weak acids need to be described by *comparison of properties* of what is actually seen when a test is carried out. Another property, other than that of pH, was expected to be described.

Assessment Schedule

Chemistry: Describe principles of chemical reactivity (90310)

Evidence Statement

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
ONE (a)	increase decrease increase the same	4 answers correct.		
(b)	An increase in temperature means particles have more kinetic energy. An increased number of collisions of particles, in a given time, will now reach the activation energy for the reaction. Thus the frequency of successful collisions is increased.	Recognises particles have more kinetic energy (eg move faster) **OR** recognises increase in frequency of collisions.	Explanation links increase in kinetic energy of particles to increase in frequency / rate of collisions of particles.	Explanation relates increase in rate to increase in frequency of collisions / rate of collisions of particles reaching activation energy.
	Water added has diluted the solution. There are now fewer acid particles in the same volume and so the collision rate with $CaCO_3$ is decreased. Thus the frequency of successful collisions is decreased.	Recognises that there are fewer /less particles **OR** decrease in frequency of collisions.	Explanation refers to fewer particles per volume unit (ie explanation of decrease in concentration) **OR** decrease in frequency of collisions of particles.	Explanation refers to fewer particles per volume unit **AND** decrease in frequency of collisions of particles.
TWO (a) (b) (c) (d) (e)	exothermic endothermic exothermic exothermic endothermic	4 answers correct.		
THREE (a)	5 × 98.2 = 491 kJ	Correct (positive) energy value.		

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
(b)	mol $O_2 = \frac{1\text{ g}}{32\text{ g mol}^{-1}} = 0.03125$ mol 1/2 mol ⇒ 98.2 kJ 0.03125 mol ⇒ $\frac{98.2 \times 0.03125}{1/2} = 6.14$ kJ	1 step of calculation shown correctly.	Correct (positive) energy value, including correct unit.	
(c)	98.2 kJ from 1 mol H_2O_2 600 kJ from $\frac{600}{98.2} = 6.11$ mol H_2O_2 $m(H_2O_2) = 6.11\text{ mol} \times 34\text{ g mol}^{-1}$ $= 207.7$ g H_2O_2 (OR 208 g)	1 step of calculation shown correctly.	2 steps of calculation shown correctly.	correct (positive) mass, including correct unit.
FOUR (a) (b) (c)	$K_c = \frac{[SO_3]^2}{[SO_2]^2 [O_2]}$ $K_c = \frac{[NO]^4 [H_2O]^6}{[NH_3]^4 [O_2]^5}$ $K_c = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$	2 expressions correct. (If incorrect brackets used all 3 expressions must be correct.) Species must be correctly shown. States not required.		
FIVE (a)	NO_2 If N_2O_4 given, ignore answer in (b).			
(b)	Value of K_c is very small (smaller than 0.001) and since $K_c = \frac{[N_2O_4]}{[NO_2]^2}$ then $[NO_2] >> [N_2O_4]$		Explanation links magnitude / value of K_c ($< 10^{-3}$) and ratio / fraction of K_c to concentrations of species.	

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
(c)(i) (ii)	Obs: gas goes darker brown/implies colour more intense. Obs: gas goes darker brown/implies colour more intense.	1 observation correct.		
(c)(i)	Increase in temperature adds energy to the system. Equilibrium position will move to minmise the effect of the change and will absorb energy favouring the endothermic reaction. Since reaction given is exothermic / ΔH is –ve, this is the reverse reaction producing more NO_2, thus is observed as darker brown.		Explanation links appropriate shift in the equilibrium position with some, but limited, reasoning.	Full explanation noting forward reaction is exothermic or reverse is endothermic and relates this to temperature change and equilibrium shift.
(c)(ii)	Addition of NO_2 leads to increase in NO_2 concentration. Equilibrium position will move to minimise the effect of the change and will use up some of added NO_2. ie Some NO_2 will react to form N_2O_4, but not all, so there will still be more NO_2 in new equilibrium mixture and is observed as darker brown. **OR** Addition of NO_2 leads to increase in pressure. Equilibrium position will move to minimise the effect of the change and decrease the pressure by forming fewer molecules of gas. Some NO_2 will react to form N_2O_4, but not all, so there will still be more NO_2 in new equilibrium mixture and it is observed as darker brown.	Describes equilibrium shift to right / N_2O_4 / favours product.	Explanation links shift to right due to added NO_2.	Full explanation noting increase in concentration / pressure of NO_2 and equilibrium shift. Still higher $[NO_2]$ at new equilibrium.

Question	Evidence	Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
SIX (a) (b)	HY If HX given, answer to (b) ignored. Both acids are 0.10 mol L^{-1}. A pH of 1 is due to $[H^+]$ of 0.10 mol L^{-1} thus HY has fully dissociated to form $[H^+]$ ions in solution, a strong acid. A pH of 3 is due to $[H^+]$ of 0.0010 mol L^{-1} thus HX has only partly dissociated to form $[H^+]$ ions in solution, a weak acid.	Recognition of lower pH and higher $[H^+]$ for stronger acid in some way.	Explanation compares pH values / concentration of H^+ ions **AND** links to degree of dissociation.	
(c)	Suitable test: eg the conductance of each acid (brief procedure). The stronger acid, HY, will be a better conductor. **OR** Add a (same sized) piece of metal (suitable named metal eg magnesium) / or carbonate / bicarbonate (named carbonate eg $CaCO_3$) / to a sample (same volume) of each acid. Both will bubble / fizz but the stronger acid, HY, will bubble / fizz more rapidly. OR using **small** piece of magnesium this will bubble and disappear in a shorter time in the stronger acid, HY.	Appropriate test described **OR** expected observation described. (eg If *metal* used as test, but not named or unsuitable **and** expected observations correctly described for *type* of test.)	An appropriate test described **AND** expected observations linked to this **AND** correct conclusion stated. (Full expt'l detail not required.)	
SEVEN (a) (b)	BASE If acid given, answer to (b) ignored. HCO_3^- has accepted H^+ to become H_2CO_3. A H^+ acceptor is a base.	Base identified as a proton acceptor. **OR** Reacts with water to form OH^- ions.		
EIGHT	$NH_4Cl(s) \longrightarrow NH_4^+(aq) + Cl^-(aq)$ then $NH_4^+ + H_2O \longrightarrow NH_3 + H_3O^+$ or $NH_4Cl + H_2O \longrightarrow NH_3 + H_3O^+ + Cl^-$ The increase in $[H_3O^+]$ (or $[H^+]$) makes the solution acidic. (Note: incorrect equation cannot be used as evidence but may be used to support words.)	Recognises presence of NH_4^+ ions. (Could be by the solubility equation.) **OR** Recognises increase in $[H^+]$ / $[H_3O^+]$.	Explanation links increase in $[H_3O^+]$ / $[H^+]$ / change in pH with **link** to NH_4^+ ions.	Full explanation recognising NH_4Cl forms ions in solution and NH_4^+ is acidic. Includes correct equation forming H_3O^+ / H^+ ions from NH_4^+ and H_2O.

Question		Evidence			Evidence contributing to Achievement	Evidence contributing to Achievement with Merit	Evidence contributing to Achievement with Excellence
NINE	A	3.47×10^{-13}		12.5	One answer correct. (Answer may have 2–4 sf.)	One row correct. (Answer may have 2–4 sf.)	All answers correct. (Answer may have 2–4 sf.)
	B	5.75×10^{-6}	1.74×10^{-9}				

Judgement Statement

Judgement statements (formerly referred to as sufficiency statements) help students understand how their overall results for each standard were arrived at.

Achievement: **8** of the Achievement opportunities. Answers given for Merit or Excellence may provide alternative evidence of Achievement.

Merit: **6** of the Merit opportunities plus **3 A's**. Answers given for Excellence may provide alternative evidence of Merit.

Excellence: **4** of the Excellence opportunities, plus **3 M**'s plus **3 A**'s