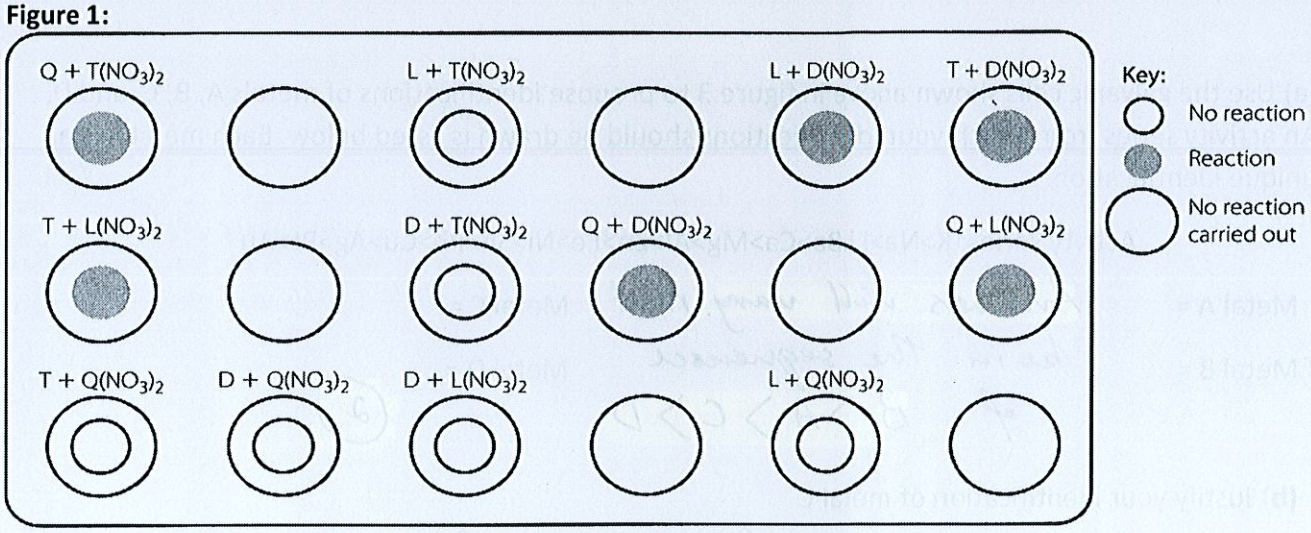
Data Test Practice Questions

The following questions use data as the basis for asking you to identify, analyse, argue, conclude, and justify. The questions are not in any perticular order. These questions are not taken from data tests of other schools.

Redox Questions

Q1. A student carried out a series of experiments on a number of unknown metals. On her laboratory bench she had four unknown metals labelled Q, T, L and D. She also had solutuions of the nitrate of each metal, a spotting plate and dropping pipettes. Figure 1 shows the results of the experiments.

Figure 1:



(a) list the metals from most reactive to least reactive?

Q, T, L, D

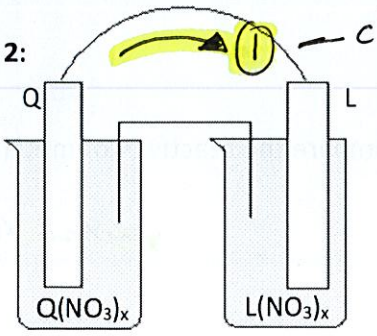
– 1 mark each sequencing error

(2 marks)

(b) A galvanic cell constructed from metal Q in a solution of its nitrate, and metal L in a solution of its nitrate, is shown below in figure 2. On the diagram label the direction of electron flow in the external wire.

(1 mark)

Figure 2:



– clear, obvious direction shown

(c) Two galvanic cells were constructed. The first was a galvanic cell using metal D in a solution of its nitrate with metal Q in a solution of its nitrate The second was a galvanic cell using metal T in a solution of its nitrate with metal L in a solution of its nitrate. Which galvanic cell would produce the greatest voltage? Provide a reason for your answer.

D/Q Galvanic cell would produce highest voltage

Q is the highest reactivity and D has the lowest of the metals

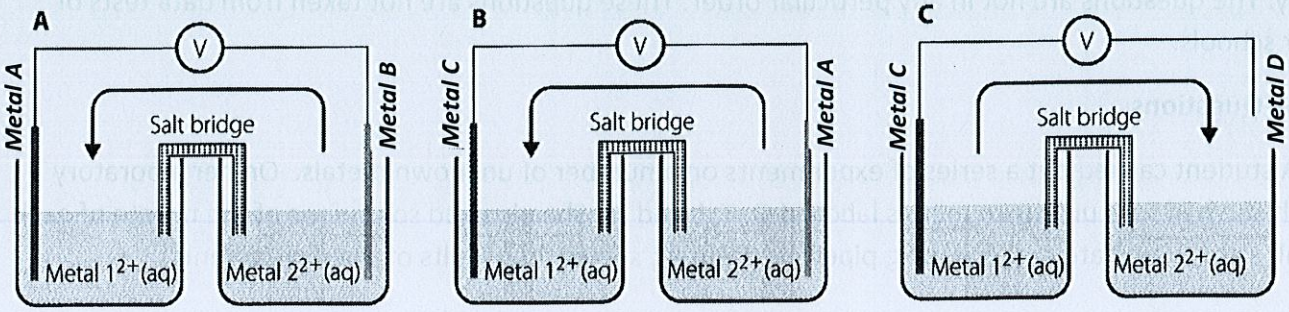
AND/OR

Q + D have the greatest difference in reactivity of the 4 metals

(2 marks)

Q2. A series of galvanic cells were constructed using unknown metals. The structure of the galvanic cells and the flow of electrons in the external wire aree shown below in figure 3.

Figure 3:



(a) Use the galvanic cells shown above in figure 3 to propose identifications of metals A, B, C, and D. An activity series from which your identifications should be drawn is listed below. Each metal has a unique identification.

Activty series: K>Na>Li.Ba>Ca>Mg>Al>Zn>Fe>Ni>Sn>Pb>Cu>Ag>Pt>Au

Metal A = Answers will vary. Must be in the sequence of B>A>C>D (2)

Metal B =

Metal C =

Metal D =

(b) Justify your identification of metal C

C is more reactive than D (cell C) (1)

C is less reactive than A (cell B) (1)

(4 marks)

(c) Compare the reactivity of metal A with the reactivity of metal D.

metal A is more reactive than D (1)

(1 mark)

(d) If a piece of metal A was placed in the nitrate solution of metal C, would a reaction occur? Provide a reason for your answer.

Yes (1)

Metal A is more reactive than metal C (1)

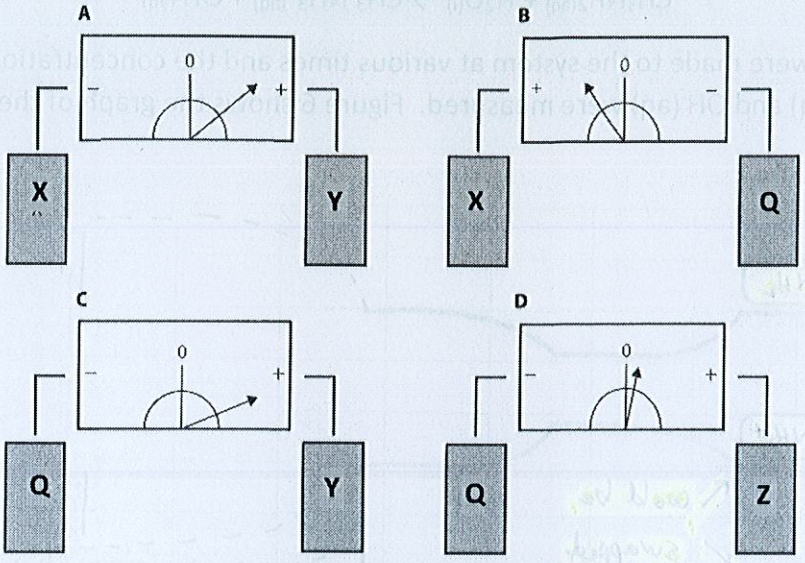
(2 marks)

Q3. An experiment was carried out in which a number of galvanic cells were constructed using electrodes of metals X, Y, Z, and Q, dipped into solutions of their respective ions. The external circuit in each case included a centre reading galvanometer that measures the voltage produced by each cell and the direction of current.

Figure 4 shows partial cell diagrams in which only the electrodes and the external circuit are visible. A part of the activity series provides information to be used in your answer:

(more reactive) Ca>Mg>Al>Zn>Fe (less reactive)

Figure 4:



(a) Use the given metal identities in the partial activity serties to identify the metals X, Y, Q, Z.

Answers will vary. Sequence of identities has to be Q > Z > X > Y

(2 marks)

(b) Justify your identifications.

Cell A: X > Y — (1)

Cell B: Q > X — (1)

Cell C: Q > Y — confirms cell A + B

Cell D: Q ~~=~~ > Z — voltage reading is smaller than cell B, indicating Z > X (1)

(1)

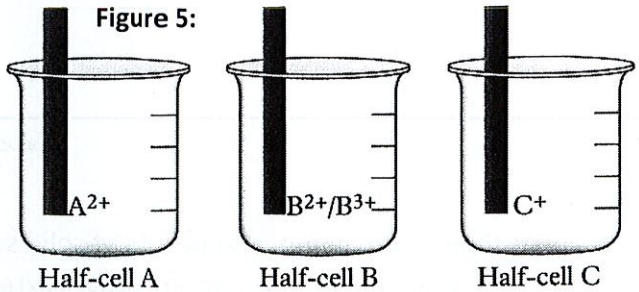
(4 marks)

Q4. Three half-cells A, B and C were constructed from unknown solutions according to the diagrams in Figure 5.

The following information was determined experimentally when the half-cells were combined:

- The electrode in half-cell B is negative when combined with half-cell A.
- The electrode in half-cell C is negative when combined with half-cell B.

Figure 5:



(a) Given a list of possible chemical species below identify which would be the strongest reductant:

A. A
B. C^+
C. B^{2+}
D. C (1)

(1 mark)

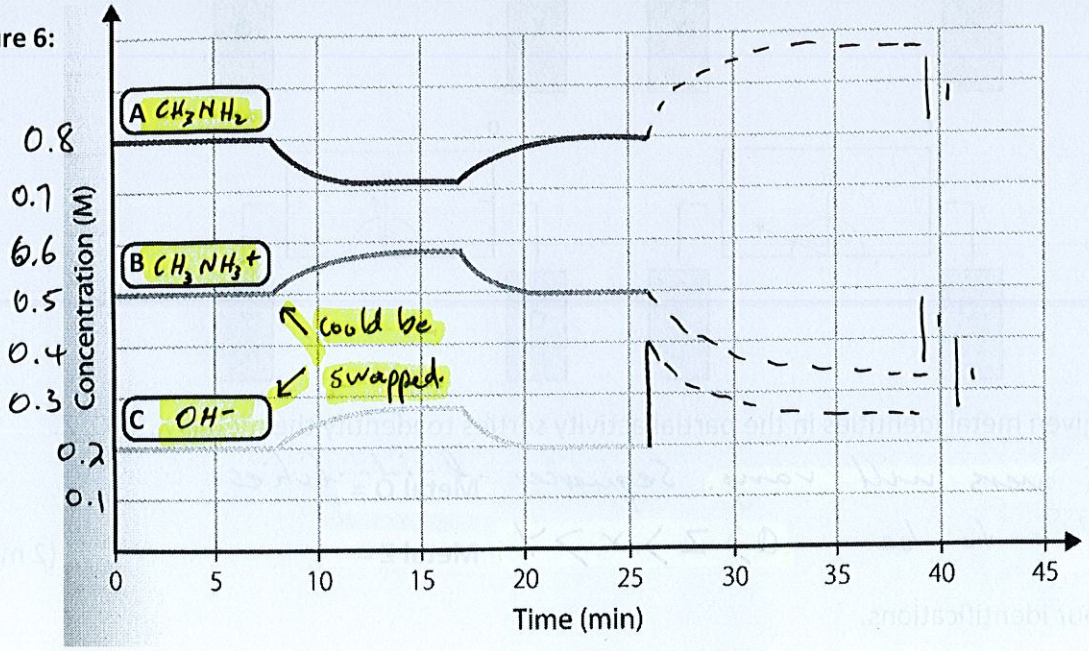
Equilibrium Questions

Q5. An experiment was carried out with the methylamine ammonium chloride buffer system:

$$CH_3NH_{2(aq)} + H_2O_{(l)} \rightarrow CH_3NH_3^+{}_{(aq)} + OH^-_{(aq)}$$

A number of changes were made to the system at various times and the concentrations of CH_3NH_2(aq), H_2O(1) → $CH_3NH_3^+$(aq) and OH^-(aq) were measured. Figure 6 shows the graph of the results

Figure 6:



(a) In figure 4 above write the formula of the chemical that correspond to chemicals A, B, and C.

see graph. no errors (1 mark)

(b) The equilibrium constant equation for this equilibrium is $K_{eq} = \frac{[CH_3NH_3^+] \times [OH^-]}{[CH_3NH_2]}$

Calculate the equilibrium constant value for this reaction.

$K_{eq} = \frac{0.5 \times 0.2}{0.8}$ – (1)

$= 0.125$ – (1)

Answers will vary and could be $K_{eq} = \frac{0.58 \times 0.28}{0.72}$ (1)

$= 0.26$ (2)

diff values as temp was changed, causing eq. const to change

2 marks ~~(3 marks)~~

(c) At time =26 mins, several pellets of solid sodium hydroxide (NaOH) were dissolved into the beaker containing the equilibrium above. Extending the lines on figure 4 from the 26 minute mark so that each line would accurately reflect the changes in concentration of one of the three chemical species.

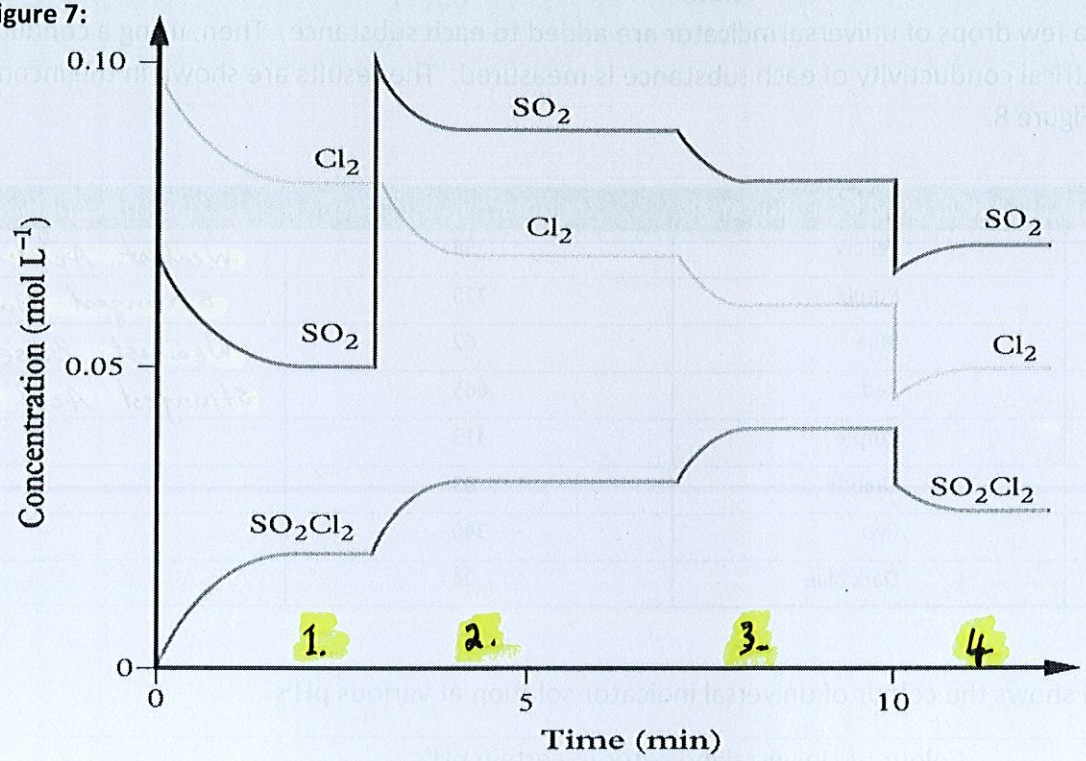
A inc, B/C dec (1) ratios 1:1:1 (1)

Vertical line showing initial inc. in [C] (1)

(3 marks)

Q6. For a particular equilibrium experiment, the concentrations of the three substances involved are plotted against time in the following graph – figure 7.

Figure 7:



a) Write a balanced equation for the equilibrium reaction.

$Cl_2 + SO_2 \rightleftharpoons SO_2Cl_2$ – or reverse.

same side (1) opp. sides (1)

(2 marks)

b) Write the numbers 1 to 4 along the time axis to identify time intervals at which the reaction was at equilibrium.

–(1) each error.

(2 marks)

c) Identify the change in equilibrium in which the value of the equilibrium constant for this equilibrium changes. Provide a reason for your answer.

change at $t \approx 7$ mins – (1)

ratio of reactants to products has changed relative to each other – (1)

OR

Product conc increased, react conc dec

(2 marks)

d) Identify what change was made to the system at:

I. 3 minutes - inc conc of SO_2 (1)

II. 7 minutes - change in temp (1) (accept inc or dec)

III. 10 minutes - inc in pressure – (1)

(2 marks)

Acid and Base Questions

Q7. An experiment is carried out on a number of acids and bases, P-Z. One mL Acid or base was mixed with water to make a total of ten mLs of solution. Two test were the performed on each acid/Base solution. First, a few drops of universal indicator are added to each substance. Then, using a conductivity probe, the electrical conductivity of each substance is measured. The results are shown in the incomplete table below – Figure 8.

Figure 8:

SUBSTANCE	COLOUR IN UNIVERSAL INDICATOR	CONDUCTIVITY (μS)	IDENTIFICATION
P	Yellow	58	Weakest Acid
Q	Purple	728	Strongest Base.
R	Blue	62	Weakest Base
S	Red	665	Strongest Acid
T	Purple	413	
X	Orange	83	
Y	Red	340	
Z	Dark blue	94	

Figure 9 below shows the colour of universal indicator solution at various pH's

FIGURE 9:	Colour of Universal indicator in certain pH's												
1	2	3	4	5	6	7	8	9	10	11	12	13	14
Red	Pink	Orange	Beige	Yellow	Lime Green	Green	Dark Green	Turquoise	Pale Blue	Blue	Dark blue	Violet	Purple

(a) In the table above, in the column labelled "identification", identify the following:

(i) The strongest acid in the list

(ii) The weakest acid in the list

(iii) The strongest base in the list

(iv) The weakest base in the list

(4 marks)

(b) In the space below provide one or more reasons for your answers to question 4,a,i and 4,a,iv.

4,a,i – lowest pH AND highest conductivity (1) (1)

4,a,iv – lowest pH above 7 (1)

~~(3 marks)~~

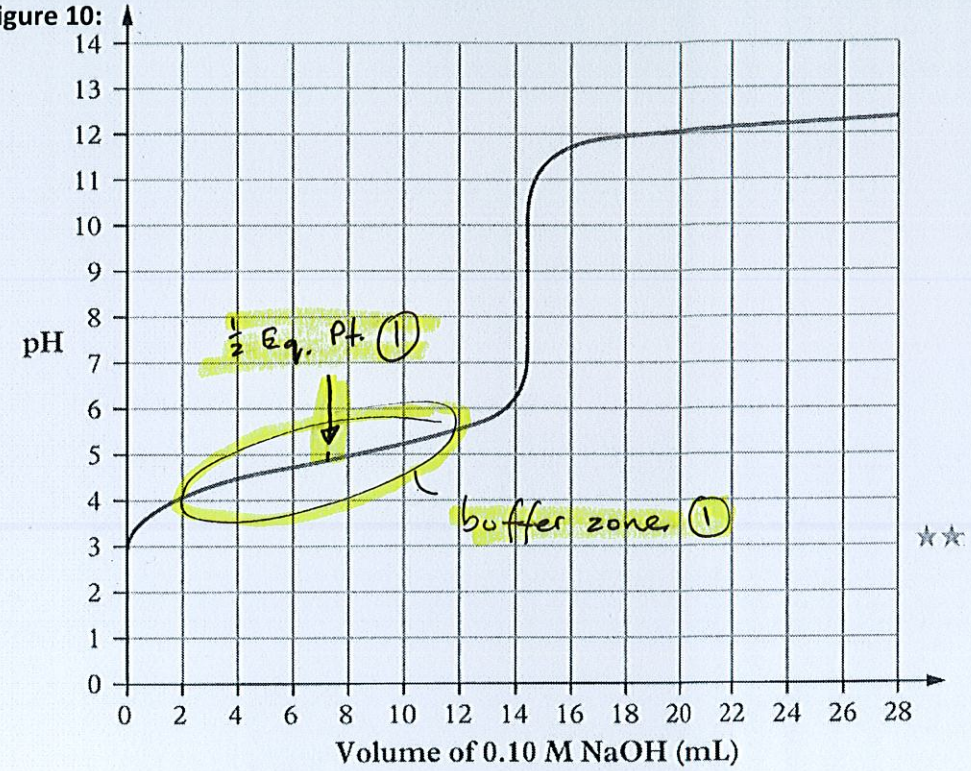
(b) Identify the relationship between conductivity and PH

The closer the pH is to 7, the lower the conductivity (1)

(1 mark)

Q8. To determine the concentration of a solution of HA (a weak acid), a student titrates a 20.0mL aliquot of HA with a standard 0.100M sodium hydroxide solution ($NaOH_{(aq)}$). The titration curve is shown in Figure 10.

Figure 10:



(a) Determine the volume of NaOH required to completely neutralise the aliquot of HA?

14.5 mL (1) ±0.2 mL

(1 mark)

(b) On Figure 10, identify the buffer zone for this titration by circling and labelling it

(1 mark)

(c) Using the information in figure 9 and 10, determine the colour of universal indicator at the end point of this titration?

Dark Green (1) OR Dark Green/Turquoise

(1 mark)

(d) Identify the half-equivalence point on the graph with a arrow and a label.

at 7.25mL on line

(1 mark)

(e) Calculate Ka value for HA.

pH at ½ eq. pt = 4.8 (1)

$pK_a = 10^{-4.8}$

$= 1.6 \times 10^{-5}$ (1)

~~(1 mark)~~ 2 marks

(f) Determine the concentration of the HA solution.

moles OH^- = 0.100M × 14.5/1000 L

= 0.00145M

Conc HA = 0.00145 / 0.020dm

= 0.0725 M (1)

(1) logical process shown could use simple ratios 14.5 : 20 ? : 0.100M

(2 marks)