UNIVERSITY OF SWAZILAND

FACULTY OF EDUCATION

SUPPLEMENTARY EXAMINATION PAPER 2011

B. Ed. II/PGCE

July 2011

Title of paper: Curriculum Studies: Chemistry

Course number: EDC 279

Time allowed: 3 hours

Instructions:

1. This paper contains SIX questions.
2. Question 1 is COMPULSORY. You may then choose and answer ANY THREE questions from questions 2, 3, 4, 5, 6.
3. Marks for each question are indicated at the end of the question.
4. Any piece of material or work that is not intended for marking purposes should be clearly CROSSED OUT.
5. Ensure that responses to questions are NUMBERED CORRECTLY.

Special Requirements

Four (4)-page attachment

QUESTION 1

This question is compulsory

A teacher might need to use the demonstration method when teaching concepts in the topic ***C10.2. Reactivity series*** (see attachment for syllabus section and book chapter).

a) Why might a teacher prefer to use the demonstration method for teaching the topic- *Reactivity Series*? [7]

b) Describe how the teacher might go about using the demonstration method to ensure that the pupils learn the expected concepts. [12]

c) What might be the role of the lecture method in teaching concepts relating to the reactivity series? [6]

[25]

QUESTION 2

The aims of education include developing pupils' affective, cognitive, physical, and interpersonal abilities. Science is a discipline that has qualities that indicate that its teaching can fulfil the development of pupils' abilities in these areas.

Using the relevant qualities of the nature of science discuss how science teaching might contribute to the development of pupils in the areas noted above. Provide relevant chemistry examples to illustrate your discussion. **[25]**

QUESTION 3

Discuss fully the importance and uses of instructional objectives (or learning outcome) for Chemistry education

[25]

QUESTION 4

Practical work is an integral part of science teaching and learning and the assessment of practical skills in the SGCSE Physical Science national examinations contributes 20% to the pupils' overall grade in the subject.

Discuss the approaches used in the assessment of practical skills in SGCSE Physical Science. In your discussion, indicate clearly the following:

The characteristic of the approach

The strengths of the approach in the purpose pursued

The limitations of using the approach **[25]**

QUESTION 5

"Motivation is too important to be left to chance. It is the key to both leaning and discipline in class." (Clark and Starr 1991: 95. *Secondary and Middle School Teaching Methods.* Macmillan)

a) Why is motivation important for learning and management in a chemistry class? [5]

b) Discuss how the following factors may affect pupils' motivation in a chemistry classroom.

   i) Subject matter

   ii) Teacher preparation

   iii) Learners' aspirations [15]

c) How may the following factors promote learner motivation in a chemistry class?

   i) significance

   ii) assessment [5]

[25]

QUESTION 6

Teaching practice is a time when student teachers put into practice the theoretical perspectives of teaching and learning. Discuss your views on the need to prepare adequately for science lessons.

[25]

C10.2 Reactivity series - place in order of reactivity: calcium, aluminium, copper, (hydrogen), iron, magnesium, potassium, sodium, zinc and gold by reference to their reactions, if any, with aqueous ions of other metals, reaction with water, steam and hydrochloric acid. - deduce an order of reactivity from a given set of experimental results.	- account for the apparent unreactivity of aluminium in terms of the oxide layer adhering to the metal.

12 The metal elements

When we first think of metals we may think of solids that conduct electricity, are strong and can be hammered into shape without shattering. In Chapter 4 we saw that to a chemist the word metal means much more than this. Metals have many properties in common. These common properties distinguish them from non metals.

Even though metals have many common properties they are different in many ways. *Example*: Potassium bursts into flames as soon as it is dropped into water, whereas gold can be recovered untarnished from the sea bed after hundreds of years. Chemists say that potassium is a very *reactive* metal and gold is a very *unreactive* metal.

12.1 The reactivity of metals

It is useful to arrange the metal elements in a reactivity series. This is a list of elements in which the most reactive element is at the top and the metals become less reactive as we go down the list. The reactivity series of common metals is shown in the following Table.

Some simple experiments can be performed in the laboratory to show that the above reactivity series is correct.

potassium	↓	*most reactive*
sodium		
lithium		
calcium		
magnesium		
aluminium		
zinc		*decreasing reactivity*
iron		
lead		
copper		
mercury		
silver		
gold	↓	*least reactive*

A. Reaction of metals with water, steam and dilute hydrochloric acid

1. *Water*

Table 1 shows what happens when a *small* piece of each metal is dropped into a trough of cold water.

METAL	REACTION	EQUATION	ORDER IN REACTIVITY SERIES
potassium	It reacts violently on the surface of the water. Enough heat is produced in the reaction to melt the potassium into a ball and to light the hydrogen gas formed. The hydrogen burns with a lilac flame. The remaining solution is alkaline.	potassium + water → potassium hydroxide + hydrogen ↑ $2K + 2H_2O \rightarrow 2KOH + H_2\uparrow$	*first*
sodium	It reacts violently on the surface of the water. Enough heat is produced to melt the sodium, but not enough to ignite the hydrogen gas formed. The remaining solution is alkaline.	sodium + water → sodium hydroxide + hydrogen ↑ $2Na + 2H_2O \rightarrow 2NaOH + H_2\uparrow$	*second*
lithium	The lithium floats on the surface of the water reacting vigorously to produce hydrogen gas and an alkaline solution. The reaction is not as violent as that of sodium. Not enough heat is produced to melt the lithium or to ignite the hydrogen gas.	lithium + water → lithium hydroxide + hydrogen ↑ $2Li + 2H_2O \rightarrow 2LiOH + H_2$	*third*
calcium	Calcium sinks and reacts steadily producing hydrogen gas and leaving an alkaline solution.	calcium + water → calcium hydroxide + hydrogen ↑ $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2\uparrow$	*fourth*
magnesium	Magnesium turnings sink and a very slow reaction takes place, producing hydrogen gas. The apparatus needs to be left for several days to collect a single test tube of hydrogen gas. The solution left is slightly alkaline.	magnesium + water → magnesium hydroxide + hydrogen ↑ $Mg + 2H_2O \rightarrow Mg(OH)_2 + H_2\uparrow$	*fifth*

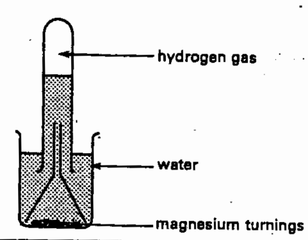

Table 1

It can be seen that as we go down the reactivity series metals react less violently with water. Metals below magnesium in the reactivity series do not react with cold water.

2. *Reaction of metals with steam*

To investigate the reaction of metals with steam the apparatus in Fig 12.1 can be used:

The metal is strongly heated until it is very hot and then the mineral wool is heated so that steam passes over the hot metal. Table 2 shows what happens.

Note: Great care must be taken with this experiment to stop the water sucking back from the trough into the hot test tube.

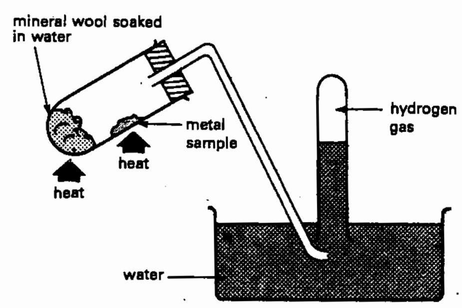

Fig 12.1

METAL	REACTION	EQUATION	ORDER IN REACTIVITY SERIES
magnesium	The hot magnesium reacts very violently with the steam. A bright white glow is produced and hydrogen gas is collected. White, powdery magnesium oxide is left in the tube.	magnesium + steam → magnesium oxide + hydrogen ↑ $Mg + H_2O \rightarrow MgO + H_2\uparrow$	*fifth*
zinc	When steam is passed over red hot zinc powder the zinc glows slightly more brightly and hydrogen gas is collected. Zinc oxide powder is left in the tube. It is yellow when hot and white when cold.	zinc + steam → zinc oxide + hydrogen ↑ $Zn + H_2O \rightarrow ZnO + H_2\uparrow$	*seventh*
iron	When steam is passed over red hot iron some hydrogen is formed. The iron cools and must be constantly heated while the steam is passed over it.	iron + steam ⇌ iron (III) oxide + hydrogen ↑ $2Fe + 3H_2O \rightleftharpoons Fe_2O_3 + 3H_2\uparrow$	*eighth*

Table 2

As we go down the reactivity series metals react less violently with steam. Metals below iron in the reactivity series do not react with steam.

3. *Reaction of metals with dilute hydrochloric acid*

Potassium, sodium, lithium and calcium (the most reactive metals) should *never* be added to dilute acid as they react explosively.

Magnesium, zinc, iron and lead, from the middle of the reactivity series, react with dilute hydrochloric acid to form the metal chloride and hydrogen gas.

Example:

magnesium + hydrochloric acid → magnesium chloride + hydrogen ↑

$$Mg + 2HCl \rightarrow MgCl_2 + H_2 \uparrow$$

The reaction of dilute hydrochloric acid on magnesium is fairly fast, but the *lower* the reactivity of the metal the slower the reaction becomes.

Lead reacts very, very slowly with dilute hydrochloric acid.

Copper, mercury, silver and gold (the least reactive metals) *do not* react with dilute hydrochloric acid.

Note: in the reactions of metals with water, steam, or dilute hydrochloric acid, the metal is always changed into an ionic compound.

Therefore metal atoms change into positively charged metal ions:

Example:

$Mg \rightarrow Mg^{2+} + 2e$

metal atom → metal ion + electrons

$Na \rightarrow Na^{+} + e$

metal atom → metal ion + electron

The reactivity of a metal depends on the ease with which it forms positive ions. The more reactive metals like sodium form positive ions far more easily than the less reactive metals such as copper.

B. Displacement of metals from solutions of salts

A more reactive metal will displace a less reactive metal from a solution of one of its salts.

Example: If a small piece of zinc is dropped into blue copper (II) sulphate solution, brown copper metal is formed and the zinc dissolves.

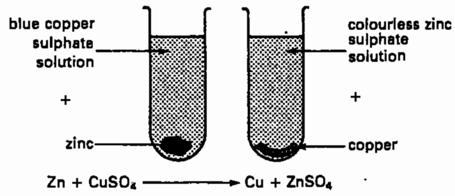

Fig 12.2

The more reactive metal (zinc) has displaced the less reactive metal (copper) from a solution of one of its salts (copper (II) sulphate).

Note: if copper is placed in zinc sulphate solution no reaction takes place.

In the displacement reactions of metals the more reactive metal changes into metal ions:

Example: $Zn \rightarrow Zn^{2+} + 2e$

The ions of the less reactive metal are changed into metal atoms.

Example: $Cu^{2+} + 2e \rightarrow Cu$

C. Competition of elements for oxygen

A more reactive metal will steal the oxygen from the oxide of a less reactive metal if heat energy is provided.

Example: If zinc powder is mixed with lead oxide powder on a tin lid, *no* reaction takes place. If the lid is heated a red glow starts to spread through the mixture. This glow continues to spread even if the heat is removed. Silvery beads of lead are formed. Therefore a chemical reaction takes place.

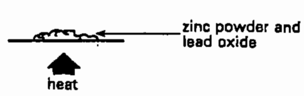

Fig 12.3

zinc + lead oxide → zinc oxide + lead

$$Zn + PbO \rightarrow ZnO + Pb$$

The more reactive metal (zinc) has stolen the oxygen from the oxide of the less reactive metal (lead).

If zinc oxide and lead are heated together no reaction takes place.

It is sometimes difficult to think in terms of chemical reactions. You may find that this story helps you to understand the competition method of determining a reactivity series.

A jackel was sitting in its cage in a zoo, very happy, because it had just been given a juicy joint of meat. Just as the jackel was about to eat the meat, the cage door opened and in came a lion. The lion saw the meat, strolled over and ate it, knowing the jackel wasn't strong enough to object. The jackel feeling sad and hungry left the cage to look for some more meat. He followed his nose until he came to another cage which contained another juicy joint of meat. The jackels excitement was short lived: another lion was in the cage and at that moment started to eat the meat.

The motto of this story may well be 'Jackels can't win when there are lions about', but a chemist would see it slightly differently. We can write 2 equations:

lion + jackel with meat → lion with meat + jackel
lion with meat + jackel → no change

Wild animals often compete for food and the stronger animal usually wins. In much the same way we can consider that elements compete to combine with oxygen and the more reactive element wins the competition.

The competition of elements for oxygen may be used to place two important non-metals in the reactivity series.

1. *Carbon*

If burning magnesium is placed in a gas jar of carbon dioxide it continues to burn. White magnesium oxide is formed as well as black specks of carbon.

magnesium + carbon dioxide → magnesium oxide + carbon

$$2Mg + CO_2 \rightarrow 2MgO + C$$

Magnesium steals the oxygen from carbon dioxide. Therefore magnesium is more reactive than carbon.

If zinc oxide powder is mixed with carbon and the mixture heated, a red glow spreads through the mixture and zinc metal is formed.

zinc oxide + carbon → zinc + carbon dioxide

$$ZnO + C \rightarrow Zn + CO_2$$

Carbon steals the oxygen from zinc oxide. Therefore carbon is more reactive than zinc.

2. *Hydrogen*

If hydrogen is passed over heated lead oxide, lead and water are formed.

hydrogen + lead oxide → lead + water

$H_2 + PbO \rightarrow Pb + H_2O$

Hydrogen steals the oxygen, therefore it is more reactive than lead.

If steam is passed over heated iron, iron (III) oxide and hydrogen are formed.

iron + steam ⇌ iron (III) oxide + hydrogen↑

$2Fe + 3H_2O \rightleftharpoons Fe_2O_3 + H_2\uparrow$

The iron steals the oxygen from water, therefore iron is more reactive than hydrogen.

A more complete reactivity series is therefore:

potassium sodium lithium calcium magnesium → aluminium carbon zinc iron hydrogen lead copper mercury silver gold
(most reactive → least reactive)

Aluminium: the peculiar one

Aluminium appears to be far less reactive than we would expect from its position in the reactivity series. Aluminium usually has a strongly held, thin film of oxide on the surface of the metal. This film stops it from reacting with water or air. If the oxide coating is removed, aluminium will corrode rapidly in air.

12.2 Uses of the reactivity series

If the position of a metal in the reactivity series is known, it is possible to predict a great deal about the properties of the metal and its compounds.

We can predict how the metal will react with various reagents.

Table 3 also tells us quite a lot about the uses of metals.

METAL	REACTION WITH WATER	REACTION WITH DILUTE HYDROCHLORIC ACID	REACTION WITH OXYGEN
potassium	React with cold water	Explosive	Burns brightly when heated
sodium			
lithium			
calcium		React forming metal chloride and hydrogen	Reaction becomes less violent (↓)
magnesium			
aluminium	Protected by oxide film		
zinc	Only react with steam		
iron			
lead	No reaction	Very slow	Tarnishes but does not burn
copper		No reaction	
mercury			
silver			
gold			No reaction

Table 3

Reactive metals like sodium and potassium are difficult to store. They are usually stored under oil to keep them out of contact with air and water. These metals are far too dangerous to find any uses in our homes. Fairly recently it has been found that, because they are good conductors of heat and have low melting points, they are suitable as coolants in nuclear reactors. In this very special case it is worth using them despite the enormous safety precautions needed.

The metal elements that we find in our homes tend to be the more unreactive ones. Make a list of all the different metals in your home and write down the use of each metal alongside. What fraction of the metals in your list come from the bottom half of the reactivity series?

We can also predict the reactions of some metal compounds. This can be seen in Table 4.

We can predict the solubility of some metal compounds in water:

METAL	SOLUBILITY OF CARBONATES	SOLUBILITY OF OXIDES
potassium	SOLUBLE	SOLUBLE
sodium		
lithium		
calcium	INSOLUBLE	
magnesium		INSOLUBLE
aluminium		
zinc		
iron		
lead		
copper		
mercury		
silver		
gold		

Table 5

METAL	HEAT ON CARBONATES	HEAT ON NITRATES	HEAT ON HYDROXIDES	HEATING CARBON WITH OXIDES
potassium	No reaction	Decompose producing oxygen gas as the only gas		No reaction
sodium				
lithium				
calcium	Decompose producing carbon dioxide	Decompose producing nitrogen dioxide and oxygen	Lose water and form oxide with greater ease ie at lower temperature (↓)	
magnesium				
aluminium				Metal and carbon dioxide formed
zinc				
iron				
lead				
copper				
mercury			No hydroxide exists	
silver	No carbonate			No oxide exists
gold				

Table 4