2005 Senior External Examination ©

Chemistry

Paper Two

Friday, 28 October 2005

1.15 p.m. to 3.25 p.m.

Queensland Studies Authority
Partnership and innovation

Queensland Government

Directions

1. Perusal time: **10 minutes**.
   You may make notes in this booklet during perusal time.
   A page for planning is on the reverse of this cover.
2. Working time: **2 hours**.
3. Materials provided:
   - resource booklet
   - work booklet.
4. Equipment allowed:
   - any hand-held, solar- or battery-operated non-programmable calculator
   - pens (blue or black ink). Do not use pencil
   - normal writing implements
   - this paper is an **open book** examination. You may refer to any paper-based written or printed material that you have brought into the examination room
   - other equipment as approved by the QSA.
5. This paper has **five** complex reasoning processes questions.
   Attempt **four** of the five questions.
   Give full reasoning.
6. You may take this booklet with you when you leave the examination room.

Notes

This paper assesses:

1. complex reasoning processes
2. use of correct English (punctuation, spelling, clarity and conciseness of expression), legibility and general neatness.

Planning space

There are five complex reasoning processes questions in this paper.

Answer only **four** questions.

The assessment criteria for each question are detailed in the work booklet.

In your answers give full reasoning, explaining as fully as you can in terms of your knowledge and application of chemistry, and using the range of scientific processes and complex reasoning objectives learned throughout the course.

Refer to page 1 of the work booklet for instructions on how to use and identify any sources of information that you use in your responses.

Question 1 – Gas Diffusion

According to Graham's Law, the rate of diffusion of a gas is inversely proportional to the square root of the gas density at a given temperature and pressure, that is,

$$R \propto \frac{1}{\sqrt{d}} \quad \text{where} \quad \begin{array}{l} R = \text{rate of diffusion} \\ d = \text{density of gas} \end{array}$$

It was found that, for a particular gas, 100 mL required 3.00 times as long to diffuse through a porous wall as did an equal volume of oxygen at the same temperature and pressure.

Calculate the molar mass of the gas.

Question 2 – Sodium reaction and its effect on ice

Consider the following experiment. A chunk of sodium metal weighing 0.25g was cautiously dropped into a mixture of 50.0 g water and 50.0 g ice at a temperature of 0°C.

The reaction between sodium and liquid water is:

$$2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2NaOH_{(aq)} + H_{2(g)} \qquad \Delta H = -368kJ$$

and the melting of ice is:

$$H_2O_{(s)} \rightarrow H_2O_{(l)} \qquad \Delta H = +6.0kJ$$

Questions

(a) Will the ice melt?

(b) Assuming that the final mixture has a specific heat capacity of 4.18 J per g per °C, that is, each gram of liquid requires 4.18 J to warm 1°C, calculate the final temperature.

Question 3 – Oxides of fluorine and sodium

Fluorine forms an oxide with the formula F_2O. Sodium also forms an oxide with a similar formula, Na_2O.

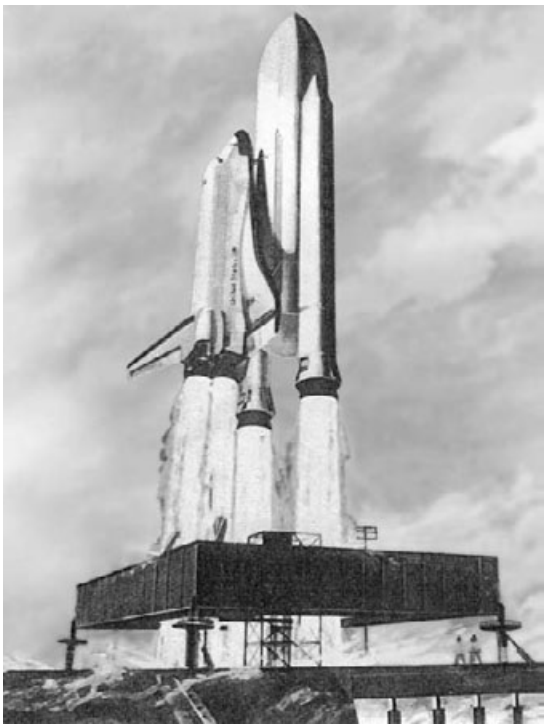
Explain clearly the differences you would expect in the physical and chemical properties of these two compounds.

Question 4 – Existence of ions in solution

There is a large body of evidence for the existence of ions in solution. Discuss the evidence available. You should describe as many different types of evidence and properties of solutions as you can.

Question 5 – Space shuttles blast-off

Photographs of blast-off of space shuttles usually show large and spectacular clouds of white smoke.



Close inspection of photographs of the take-off assembly will show that the space shuttle and two long, narrow booster rockets are all attached to a very large cylinder in the centre. This large cylinder is not the rocket engine. It is only a storage tank for liquid hydrogen and oxygen, which are fed into the rocket engine of the space shuttle during launch, and then jettisoned.

Of course the booster rockets provide the additional thrust necessary for blast-off. They are jettisoned when they have served this purpose. The booster rockets use a solid fuel which consists of a mixture whose main ingredients are aluminium powder and ammonium perchlorate NH_4ClO_4, a powerful oxidising agent.

It is common for people to think that the large, spectacular clouds of white smoke are clouds of water droplets.

Questions

(a) Why would they think this?

(b) What is wrong with their reasoning?

(c) What could the white clouds be?

End of Paper Two

Acknowledgments

Houghton Mifflin Company, USA, for adapted text from *Chemistry* (third edition) by Steven S. Zumdahl, University of Illinois, published by D.C. Heath and Company, Massachusetts, USA, 1993.

The Australian Academy of Science, Canberra, for adapted text from *Chemistry in action, A Resource for Chemistry Teachers* (No. 3) edited by A.R.H. Cole and R.B. Bucat, February 1986.

U.S. International Communications Agency for an adapted graphic.