OCR

RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary GCE

CHEMISTRY (SALTERS) 2850

Chemistry for Life

Friday **17 JANUARY 2003** Morning 1 hour 15 minutes

Additional materials:
Data Sheet for Chemistry (Salters)
Scientific calculator
Candidates answer on the question paper.

Candidate Name	Centre Number	Candidate Number

TIME 1 hour 15 minutes

INSTRUCTIONS TO CANDIDATES

- Write your name in the space above.
- Write your Centre number and Candidate number in the boxes above.
- Answer **all** the questions.
- Write your answers in the spaces provided on the question paper.
- Read each question carefully and make sure you know what you have to do before starting your answer.

INFORMATION FOR CANDIDATES

- The number of marks is given in brackets [ ] at the end of each question or part question.
- You may use a scientific calculator.
- You may use the *Data Sheet for Chemistry (Salters)*.
- You are advised to show all the steps in any calculations.

FOR EXAMINER'S USE		
Qu.	Max.	Mark
1	18	
2	20	
3	20	
4	17	
TOTAL	75	

This question paper consists of 11 printed pages and 1 blank page.

Registered Charity Number: 1066969
[Turn over

Answer **all** the questions.

1 A green colour in fireworks is often caused by barium compounds and a crimson colour is given by strontium compounds.

(a) (i) In which group of the Periodic Table are strontium and barium found?

.....[1]

(ii) What is similar about the electronic structures of the elements in this Group?

.....

.....[2]

(b) (i) A barium atom loses an electron more easily than a strontium atom. Explain why.

.....

.....

.....[2]

(ii) Ionisation enthalpies measure how easily atoms lose electrons. Give the equation for the **second** ionisation enthalpy of **barium**, showing state symbols.

[3]

(c) Strontium and barium are both found naturally as their carbonates. On heating in a firework, strontium carbonate, $SrCO_3$, decomposes to give strontium oxide, SrO, and carbon dioxide.

(i) Give the equation, **showing state symbols**, for the action of heat on strontium carbonate.

[2]

(ii) Calculate the volume of carbon dioxide (measured at room temperature and pressure) which would be made by heating 29.6 g of $SrCO_3$.
[A_r: Sr, 88; C, 12; O, 16]
[1.0 mol of molecules of a gas at room temperature and pressure occupies 24 dm^3]

Answer ..... [3]

(iii) Circle the Group 2 carbonate below which decomposes **most easily** when heated.

barium carbonate **calcium carbonate**

magnesium carbonate **strontium carbonate**

[1]

(d) The nature of the flame colour of barium can be investigated by studying the lines in its atomic emission spectrum.

Explain how hot barium atoms emit light and why the emission spectrum contains light of only certain frequencies.

.....

.....

.....

.....

.....

.....[4]

[Total: 18]

2 A fuel called 'biodiesel' is being researched. This is made by treating vegetable oils, for example waste frying oil, with concentrated sulphuric acid and methanol.

(a) (i) Draw the **full structural** formula of methanol, CH_3OH.

[1]

(ii) Draw a dot-cross diagram for methanol, showing the outer shell electrons only.

[2]

(iii) State the approximate value of the  bond angle in a molecule of methanol.

.....[1]

Biodiesel behaves somewhat like normal diesel which is produced from crude oil.

(b) Normal diesel contains compounds such as $C_{16}H_{34}$. To which homologous series does a compound with formula $C_{16}H_{34}$ belong?

.....[1]

(c) A diesel engine works by the auto-ignition of a compressed mixture of fuel vapour and air.

(i) Explain what you understand by the term *auto-ignition*.

.....

.....

.....[2]

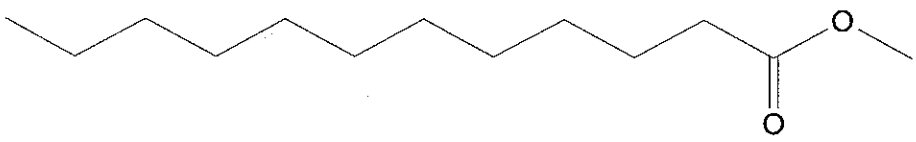
(ii) There are many isomers of $C_{16}H_{34}$. What feature of the structure of an isomer would cause it to auto-ignite easily?

.....

.....

.....[1]

(d) The diagram shows the skeletal formula of one of the molecules in biodiesel.



(i) How many carbon atoms does this molecule contain?

.....[1]

(ii) Write down the **molecular formula** of this compound.

.....[2]

(e) Those researching on biodiesel claim that it produces less carbon monoxide than normal diesel when used as a fuel for cars.

(i) How does a diesel engine produce carbon monoxide?

.....

.....[2]

(ii) Name the element present in the biodiesel molecule above which suggests that it might produce less carbon monoxide than normal diesel.

.....[1]

(f) Scientists studying the biodiesel compound shown in **(d)** measure its $\Delta H^{\ominus}_{combustion}$. What do you understand by this term?

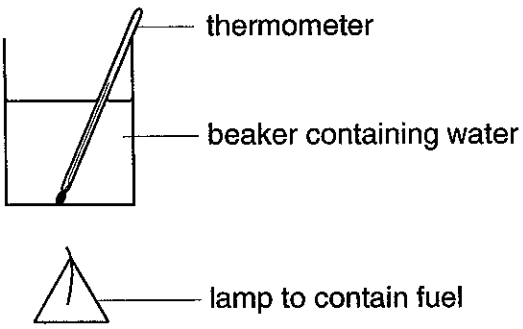
.....

.....

.....

.....[3]

(g) In a simple laboratory experiment, using the apparatus shown, 1.00 g of the biodiesel compound raised the temperature of 500 g of water by 16.0 K (16.0 °C).



(i) Calculate the heat transferred to the water in **kJ**.
[Use the expression:
heat transferred (J) = mass of water (g) x 4.18 ($J\,g^{-1}\,K^{-1}$) x temp rise (K)]

Answer .....kJ [1]

(ii) Calculate a value for the enthalpy change of combustion of the biodiesel compound from your result in **(i)**.
[M_r of the biodiesel compound = 214]

Answer $\Delta H_{combustion}$ = ...$kJ\,mol^{-1}$ [2]

[Total: 20]

BLANK PAGE

3 'Depleted uranium' is used to make military shells which can penetrate armour plating. It is very effective because of the high density of uranium. These shells were used in the Gulf War and in the Balkans. There are, however, concerns over the use of depleted uranium because of health risks.

Depleted uranium consists of natural uranium from which most of the isotope ^{235}U has been removed for use in nuclear power reactors.

(a) The main isotope of uranium is $^{238}_{92}U$.

Write down the numbers of protons, neutrons and electrons in an atom of this isotope.

protons .....

neutrons .....

electrons.....[3]

(b) During the separation of the two isotopes, UF_4 is produced. The UF_4 is reduced to uranium using calcium.

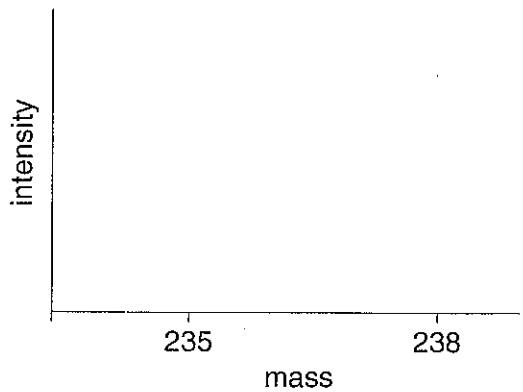
(i) Write the equation for the reaction of UF_4 with calcium metal to give uranium and calcium fluoride.

[3]

(ii) Calculate the mass of calcium which would be needed to produce 1000 g of uranium. [A_r: Ca, 40; U, 238]

Answer .....g [3]

(c) A sample of uranium contains a small amount of ^{235}U, the rest being ^{238}U.
Show on the axes below how a mass spectrometer trace from this sample would show the relative amounts of the two isotopes.



[2]

(d) As the uranium shell destroys its target, it catches fire and burns to form an oxide. Particles of this oxide, if inhaled into the lungs, can cause health problems.

The oxide of uranium contains 11.9% of oxygen. Calculate the formula of this oxide.
[A_r: O, 16; U, 238]

Formula ..... [2]

(e) ^{238}U is radioactive, with a half-life of 4.51×10^9 years. It decays by emitting α-particles.

(i) Write a nuclear equation for the radioactive decay of a ^{238}U nucleus.

[3]

(ii) The main hazard from ^{238}U is to people who breathe it in.
Suggest **two** reasons why ^{238}U is otherwise unlikely to harm people.

Reason 1 .....

.....

Reason 2 .....

.....[2]

(f) The ^{235}U which has been separated from the natural uranium ore is used in nuclear power reactors. It undergoes an exothermic fission reaction when bombarded with neutrons.

$$^{235}_{92}U + {}^{1}_{0}n \rightarrow {}^{140}_{56}Ba + 3{}^{1}_{0}n + ...$$

Complete the nuclear equation by writing the formula of a suitable nucleus on the dotted line in the equation. [2]

[Total: 20]

4 Catalytic converters are fitted to cars with petrol engines to remove polluting gases from the exhaust gases.

(a) What does the term *catalyst* mean?

.....

.....

.....[2]

(b) One of the reactions catalysed in the exhaust system is shown below.

$$2CO(g) + 2NO(g) \rightarrow N_2(g) + 2CO_2(g)$$ **equation 4.1**

(i) Describe how nitrogen monoxide is formed in an engine.

.....

.....

.....[2]

(ii) On a journey, an engine makes 1500 dm^3 of nitrogen monoxide. Use **equation 4.1** to write down the volume of nitrogen (measured at the same temperature and pressure) which this produces in the exhaust gases if the catalytic converter is 100% efficient.

.....[1]

(iii) In the reaction represented by **equation 4.1**, the entropy decreases. Explain why this is so.

.....

.....

.....[2]

(iv) The first two steps in the mechanism of operation of the catalyst in this reaction can be described as follows.

- The reactants (CO and NO) are adsorbed on to the catalyst surface.
- The bonds between C and O, and between N and O, break.

Describe the last two steps of this process in similar detail.

.....

.....

.....

.....

.....

.....

.....[5]

(c) Petrol containing lead compounds cannot be used in cars with catalytic converters. Explain in chemical terms why this is so.

.....

.....

.....[2]

(d) A catalytic converter does not work well when the engine is first started. Why is this?

.....

.....[1]

(e) Name **one** pollutant (**apart from** CO_2, CO and NO_x) that is present in the exhaust gases from a petrol engine and give its polluting effect.

Pollutant .....

Polluting effect.....

.....[2]

[Total: 17]