Centre Number

Student Number

CATHOLIC SECONDARY SCHOOLS
ASSOCIATION OF NEW SOUTH WALES

2007
TRIAL HIGHER SCHOOL CERTIFICATE EXAMINATION

Chemistry

Afternoon Session
Friday 10 August 2007

Total marks – 100

General Instructions

- Reading time – 5 minutes
- Working time – 3 hours
- Write using blue or black pen
- Draw diagrams using pencil
- Board-approved calculators may be used
- Use the Data Sheet and Periodic Table provided
- Use the Multiple Choice Answer Sheet provided
- Write your Centre Number and Student Number at the top of this page and page 9

Section I

75 marks
This section has two parts, Part A and Part B

Part A – 15 marks
- Attempt Questions 1–15
- Allow about 30 minutes for this part

Part B – 60 marks
- Attempt Questions 16–29
- Allow about 1 hour and 45 minutes for this part

Section II

25 marks
- Attempt ONE question from Questions 30–34
- Allow about 45 minutes for this section

Section I 75 marks

Part A - 15 marks
Attempt Questions 1-15
Allow about 30 minutes for this part

Use the Multiple Choice Answer Sheet provided.

1. Which of the following can be used to identify the presence of an alkene?

(A) Bromine water
(B) Sulfuric acid
(C) Phenolphthalein
(D) Distilled water

2 Why is the maximum yield of ethanol produced by the yeast-catalysed fermentation of 1 litre of a glucose solution approximately 150 mL?

(A) The reaction is limited by the available water.
(B) There is too much heat generated if more ethanol is produced.
(C) Too much oxygen is generated if more ethanol is produced.
(D) The yeast can only tolerate an environment with a maximum 15% alcohol.

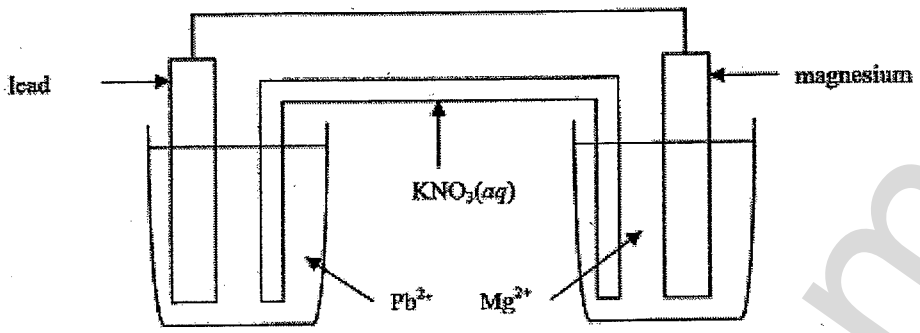
3. The reaction in an alkaline cell can be summarised by the following equation:

$Zn + 2MnO_2 \rightarrow ZnO + Mn_2O_3$

In this reaction the change in oxidation state of manganese is

(A) from 0 to +2.
(B) from +4 to +3.
(C) from +4 to +6.
(D) nil, as manganese is neither oxidised nor reduced.

4. The diagram below represents a galvanic cell.



Which of the following half-equations represents the reaction at the cathode?

(A) $Mg^{2+}(aq) + 2e^- \rightleftharpoons Mg(s)$

(B) $Mg(s) \rightleftharpoons Mg^{2+}(aq) + 2e^-$

(C) $Pb^{2+}(aq) + 2e^- \rightleftharpoons Pb(s)$

(D) $Pb(s) \rightleftharpoons Pb^{2+}(aq) + 2e^-$

5. In 2003, physicists bombarded an americium-243 target with a beam of energetic calcium-48 nuclei, producing a new element ununpentium (symbol Uup) containing 115 protons and 173 neutrons.

Which nuclear equation represents this process?

(A) $^{243}_{95}Am + ^{48}_{20}Ca \rightarrow ^{173}_{115}Uup + 118\ ^{1}_{0}n$

(B) $^{243}_{95}Am + ^{48}_{20}Ca \rightarrow ^{173}_{58}Uup + ^{118}_{57}La$

(C) $^{243}_{95}Am + ^{48}_{20}Ca \rightarrow ^{288}_{115}Uup + 3\ ^{1}_{0}n$

(D) $^{243}_{95}Am + ^{40}_{20}Ca \rightarrow ^{283}_{115}Uup$

6. A student produced a natural indicator from the petals of a red flower. In order to determine the usefulness of this indicator the student should test the indicator with

(A) dilute hydrochloric acid and dilute sodium hydroxide.

(B) bromothymol blue, phenolphthalein and methyl orange.

(C) a range of household substances.

(D) a pH probe.

7 A 4 mol L^{-1} solution of an acid, HX, was found to have a pH of 2.6. This solution would best be described as a

(A) concentrated solution of a strong acid.

(B) concentrated solution of a weak acid.

(C) dilute solution of a strong acid.

(D) dilute solution of a weak acid.

8 The Haber process is an important industrial process used to produce ammonia gas, NH_3, according to the equation

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

What volume of hydrogen gas, measured at 100kPa and 25°C, would have reacted to produce 51.10 g of ammonia?

(A) 16.53 L

(B) 24.79 L

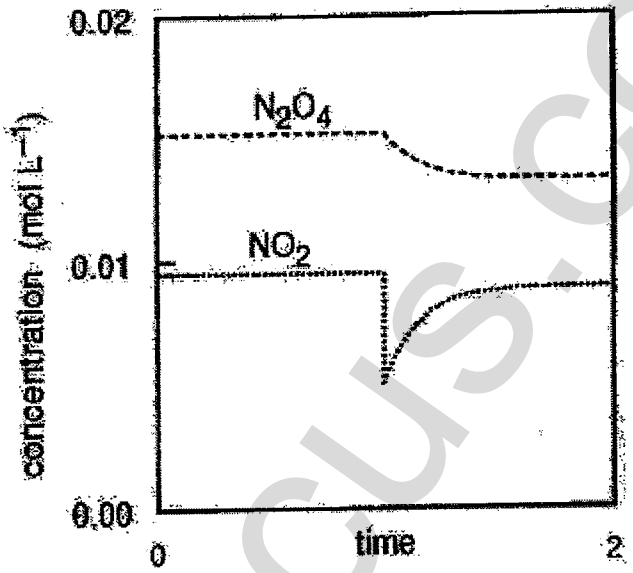
(C) 102.2 L

(D) 111.6 L

9. The decomposition of dinitrogen tetroxide can be summarised by the following equilibrium equation:

$$N_2O_4(g) \rightleftharpoons 2NO_2(g) \qquad \Delta H = 58.0 \text{ kJ mol}^{-1}$$

The graph below shows this equilibrium system undergoing a disturbance and shifting to re-establish a new equilibrium.



The disturbance shown in this graph was caused by

(A) the removal of $N0_2$ gas.

(B) an increase in temperature.

(C) a shift to the right.

(D) an increase in volume of the container.

10. An orange flavoured ester called octyl ethanoate can be prepared by refluxing. Which of the following correctly represents this reaction?

(A) $CH_3(CH_2)_6CH_2OH + CH_3COOH \longrightarrow CH_3(CH_2)_6COOCH_2CH_3 + H_20$

(B) $CH_3(CH_2)_6CH_2OH + CH3COOH \longrightarrow CH_3COOCH_2(CH_2)_6CH_3 + H_20$

(C) $CH_3CH_2OH + CH_3(CH_2)_6COOH \longrightarrow CH_3COOCH_2(CH_2)_6CH_3 + H_20$

(D) $CH_3(CH_2)_6CH_2OH + CH_3COOH \longrightarrow CH_3(CH_2)_6COOCH_2CH_3$

11. A catalyst is used in the Haber process, synthesising ammonia from nitrogen and hydrogen, because the catalyst

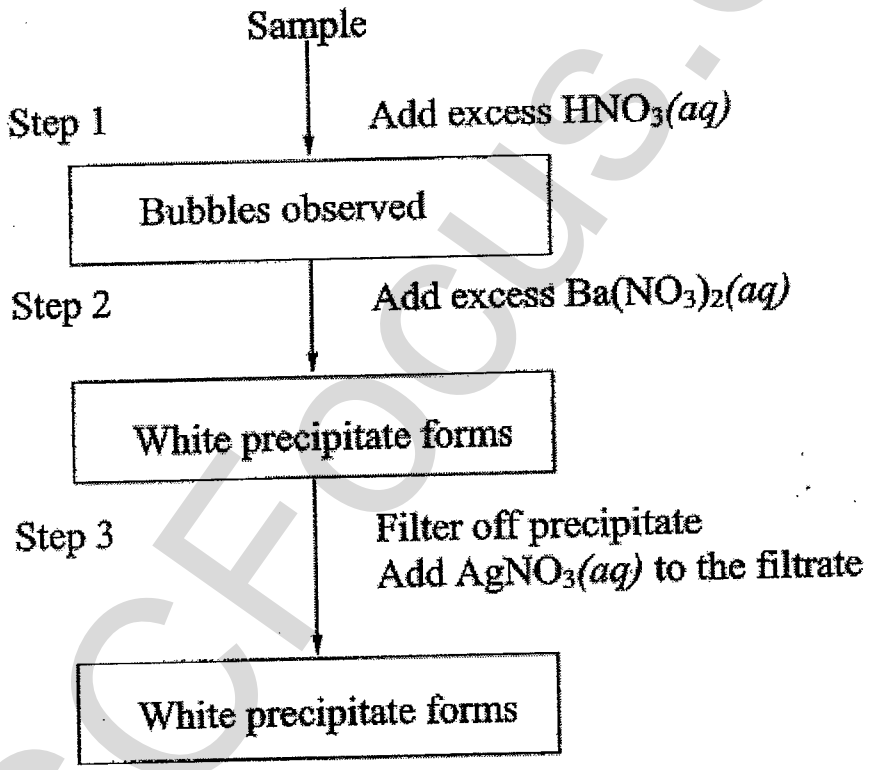
(A) increases the amount of ammonia produced.

(B) increases the rate of the process so that a greater percentage of ammonia can be produced.

(C) lowers the activation energy so that the bonds within the molecules are broken more easily.

(D) reduces the amounts of reactants required to produce the product.

12. The flow diagram below shows 3 steps that can be used to identify carbonate, chloride and sulfate ions present in a sample.



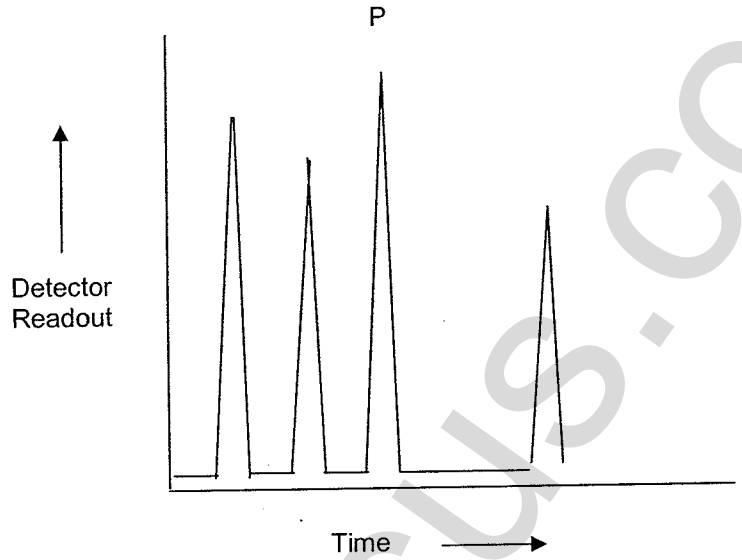
The products formed in the 3 steps, in order, are

(A) hydrogen gas, barium chloride, silver sulfate.
(B) carbon dioxide gas, barium sulfate, silver chloride.
(C) hydrogen gas, barium sulfate, silver chloride.
(D) carbon dioxide gas, barium chloride, silver sulfate.

13. Which of the following mixtures describes a buffer solution?

(A) A weak acid and a strong acid in water
(B) An acid in water
(C) A salt of a weak acid in water
(D) A weak acid and a salt of that acid in water

14. In gas chromatography, compounds may be separated by their molecular weight – the smaller molecular compounds leave the chromatograph first. A gas chromatographic analysis of a mixture of the four organic alcohols, 1-propanol, 1-butanol, 1-heptanol and ethanol, gave the result shown below.



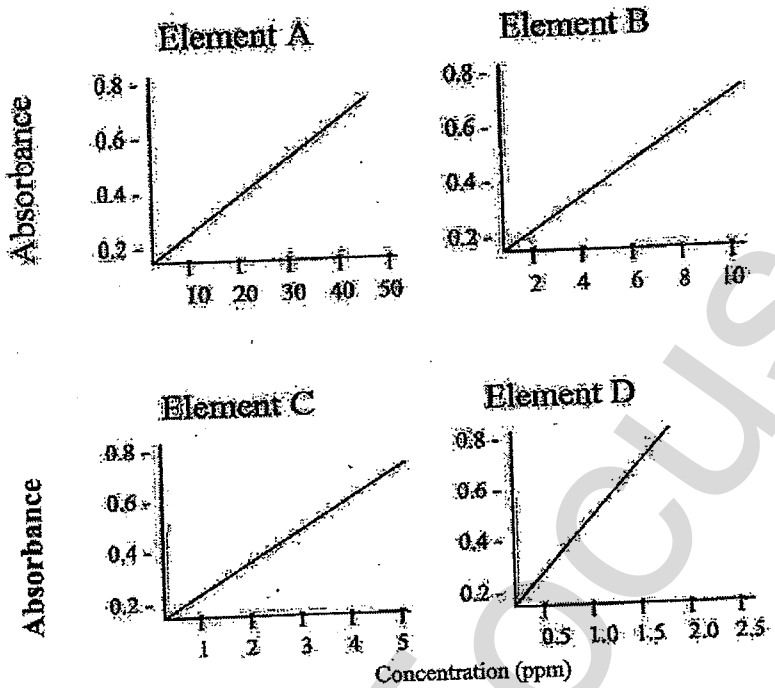
Which of the four compounds is represented by peak P?

(A) 1-propanol
(B) 1-heptanol
(C) 1-butanol
(D) ethanol

15 The wavelengths of light absorbed by four elements are as follows:

Element	Wavelength (nm)
A	354.8
B	551.9
C	443.7
D	587.4

Using Atomic Absorption Spectroscopy (AAS), standard solutions of these elements produced the following calibration curves.



A sample of waste water from a factory was analysed and the following results were obtained:

Wavelength emitted by sample	Absorbance
551.9	0.35
443.7	0.40
587.4	0.65
354.8	0.30

The element present with a concentration of 1.5 ppm in the waste water is:

(A) A
(B) B
(C) C
(D) D

Chemistry
Section I (continued)
Part B - 60 marks
Attempt Questions 16-29
Allow about 1 hour and 45 minutes for this part

Student Number

Answer the questions in the spaces provided.

Show all relevant working in questions involving calculations.

Marks

Question 16 (2 marks)

Poly(vinyl chloride), PVC, is an important industrial polymer.

(a) Draw a section of the polymer chain of PVC, showing THREE repeating units. 1

(b) Describe ONE use of PVC in terms of ONE of its properties 1

Marks

Question 17 (5 marks)

Ethanol can be produced industrially either by the hydration of ethylene or by fermentation.

(a) Write a balanced equation for the industrial production of ethanol by the hydration of ethylene. 1

(b) Write a balanced equation for the industrial production of ethanol by fermentation. 1

(c) Justify the increased production of ethanol by fermentation in Australia. 3

Marks

Question 18 (4 marks)

Discuss the benefits of a recently developed biopolymer. In your answer you should identify the raw material and process or organism from which it is produced. 4

Marks

Question 19 (5 marks)

(a) Identify a radioisotope used in medicine 1

(b) Explain a use of this radioisotope in terms of ONE of its chemical properties. 1

(c) Examine the table below. 3

Properties of Radioisotopes

Radioisotope	Major types of emission	Half-life
X	gamma	73 hours
Y	gamma	5.2 years
Z	alpha	433 years

Assess the potential of these THREE isotopes for use in medicine in terms of their radioactive emissions and half-lives.

Marks

Question 20 (4 marks)

(a) Define the term electrolyte. 1

(b) Identify the electrolyte in EITHER a dry cell OR a lead-acid cell. 1

(c) In terms of cost and practicality, compare the cell selected in (b), to ONE of the following cells: 2

- button cell
- fuel cell
- vanadium redox cell
- lithium cell
- liquid junction photovoltaic device

Marks

Question 21 (5 marks)

With the aid of appropriate equations, explain why the dihydrogen phosphate ion, $H_2PO_4^-$, is amphiprotic, yet an aqueous solution of KH_2PO_4 has a pH greater than 7. 5

Marks

Question 22 (3 marks)

Describe an example of a chemical reaction in industry which produces sulfur dioxide gas and explain how this can lead to a decrease in the pH of natural waterways. Include appropriate chemical equations in your response. 3

Marks

Question 23 (4 marks)

A titration was carried out in order to determine the concentration of an acetic acid solution. The end point of the titration was reached when 18.7 mL of a standard solution of 0.125 mol L^{-1} sodium hydroxide had reacted with 25.0 mL of the dilute acetic acid solution. 2

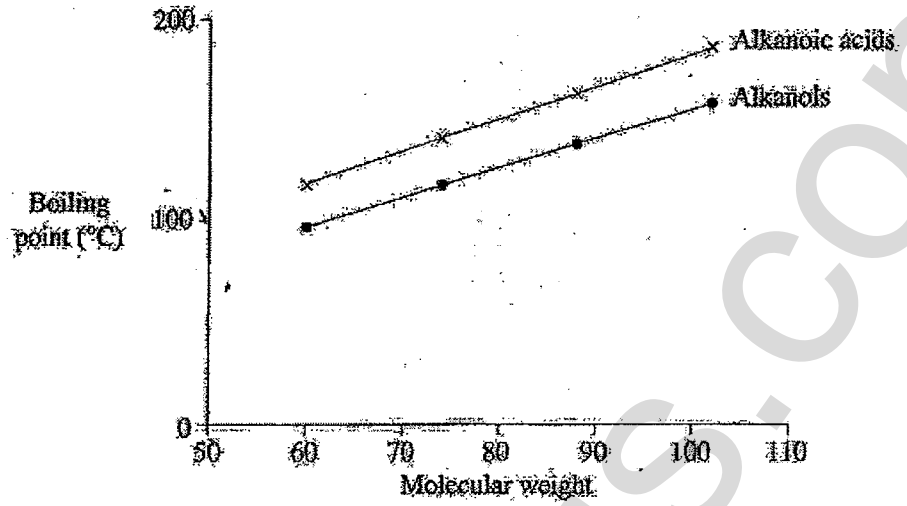
(a) Calculate the concentration of the acetic acid solution.

(b) In this titration, a 25.0 mL pipette was initially rinsed with distilled water and then used immediately to transfer the acetic acid solution to a conical flask. Identify the error associated with this procedure and explain how the error would affect the accuracy of the result. 2

Marks

Question 24 (8 marks)

(a) (i) Outline the trends and relationships shown in the graph below. 2

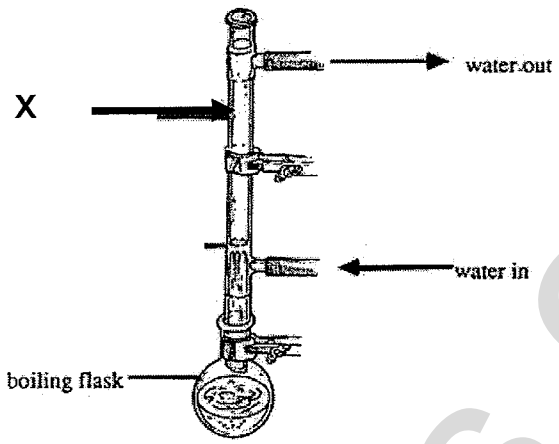


(ii) Explain ONE trend or relationship outlined in part (i). 2

Marks

Question 24 (continued)

(b) (i) The apparatus used for refluxing is drawn below: 1



Identify the part of this apparatus labelled X.

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(ii) Evaluate the appropriateness of using reflux in the preparation of an ester. 3

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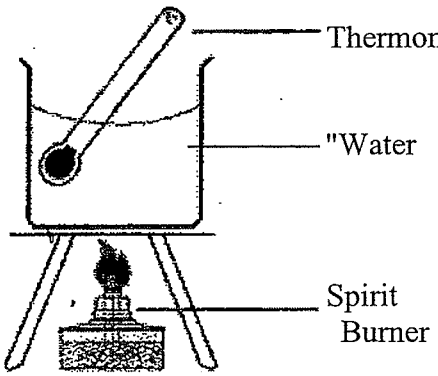
Marks

Question 25 (4 marks)

A student was asked to compare the heats of combustion of ethanol and 1-butanol.

She selected her apparatus and set it up as shown in the diagram below:



(a) Write a suitable hypothesis for this experiment. 1

(b) Identify TWO variables which should be controlled in this experiment. 1

(c) In industry, combustion reactions are monitored to ascertain whether complete combustion is occurring. Identify ONE problem associated with incomplete combustion and outline ONE way the reaction can be managed to overcome the problem. 2

Marks

Question 26 (3 marks)

Justify the need for monitoring the temperature of the reaction. vessel during the industrial production of ammonia by the Haber process: 3

$$N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$$

$$\triangle H = -92 \text{ kJ mol}^{-1}$$

Marks

Question 27 (4 marks)

A student wanted to determine the phosphorus content in a certain brand of washing powder. The phosphorus was precipitated as $Ca_2P_2O_7$ and then filtered. A 4.42 g sample of washing detergent resulted in a precipitate of mass 0.232 g.

(a) Identify TWO procedures that the student would need to perform, after filtration and before weighing, in order to increase the accuracy of the experiment. 2

(b) Calculate the percentage of phosphorus, by mass, in the sample. 2

Marks

Question 28 (3 marks)

State 3 reasons as to the limitations of a school laboratory investigation using flame tests to identify ions. 3

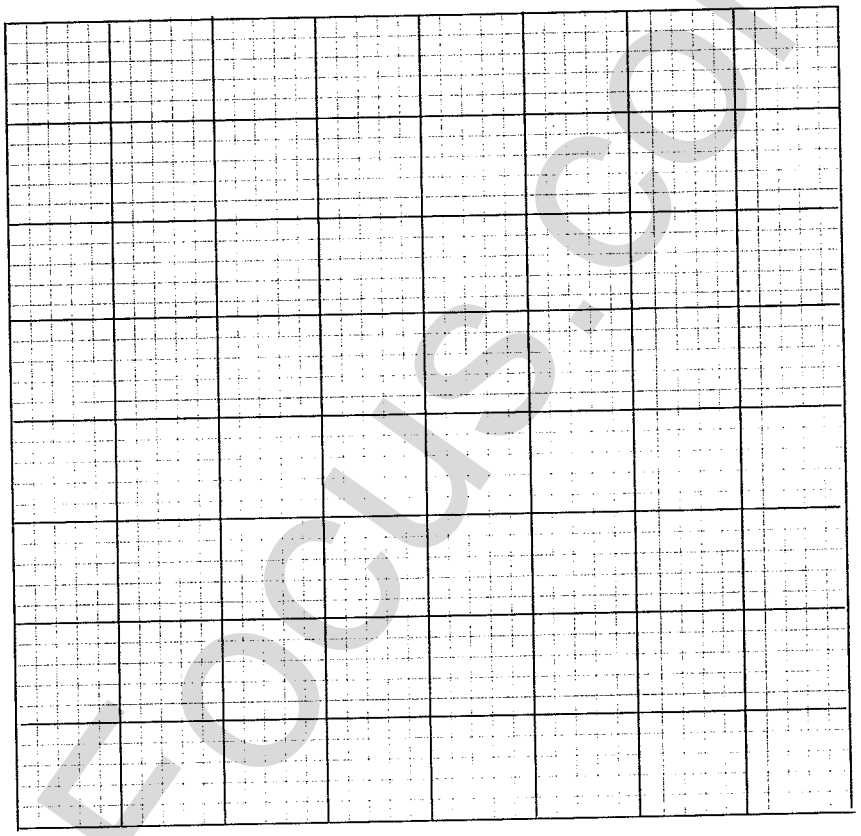
Marks

Question 29 (6 marks)

The results of the analysis of set of standard lead solutions are shown below.

Lead Concentration (ppm)	5	15	25	35
Absorbance	0.2	0.6	1.1	1.4

(a) Draw a line graph of the data for the standard solutions. 4



(b) A soil sample taken from a site near a school, prepared for analysis using the same methods as for the standards, gave an absorbance reading of 0.44. What is the lead concentration in the soil near the school.

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(c) What is the name of the instrument used by scientists to determine the trace concentration of metals, such as Pb, in solution. 1

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