

University of Canterbury

End-of-year Examinations 2008

Prescription Number(s): CHEM 224

Paper Title: Analytical & Environmental Chemistry

Time Allowed: Two hours

Number of pages: Five

Answer **ALL** questions.

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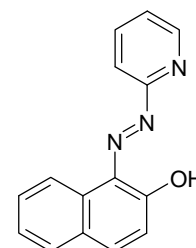
1. (30 marks)

Answer **TWO** of the following (a) – (c):

- (a) (i) A solution of $[\text{Fe}(\text{SCN})]^{2+}$ has an absorbance of 0.917 at 575 nm in a cell with a 2.00-cm pathlength. If the molar absorptivity of $[\text{Fe}(\text{SCN})]^{2+}$ is $7.00 \times 10^3 \text{ M}^{-1} \text{ cm}^{-1}$, calculate the molar concentration of $[\text{Fe}(\text{SCN})]^{2+}$.

State, with reasoning, the type of electronic transition from which this absorption arises. Describe the electron transition.

- (ii) The molar absorptivity of the complex formed between Bi(III) and 1-(2-pyridylazo)-2-naphthol (shown) is $2.10 \times 10^4 \text{ M}^{-1} \text{ cm}^{-1}$ at 580 nm. What concentration of the complex is needed to produce a 20% transmittance in a cell with 1.0 cm pathlength?



- (iii) Explain how normally colourless ions, such as Bi(III), can give rise to strong absorption, as in (ii).

- (b) (i) Describe the processes that lead to emission of radiation from a hollow-cathode lamp, as used for atomic absorption spectroscopy measurements.
- (ii) Explain why it is necessary to modulate the light that passes through the flame in an atomic absorption spectrometer. Indicate how this modulation is achieved.
- (iii) Starting with the dissolved analyte $\text{MX}(\text{aq})$, use a diagram or scheme to show the sequence of reactions, and side reactions, that occurs when an aqueous sample is converted to atoms for atomic absorption measurements in a flame. Indicate the elapsed time in which these reactions must occur.

- (c) A dietary supplement capsule weighing 4.84 g was ground into a fine powder. Two portions of the solid, both weighing 0.137 g, were dissolved in dilute acid and transferred to 50 mL volumetric flasks. To one of these, 5.00 mL of 40.0 ppm Mn(II) standard solution was added, then both flasks were diluted to the mark with distilled water. When aspirated into the flame of an atomic absorption spectrometer set at a manganese absorption wavelength, the absorbance of the unknown and the unknown plus standard were 0.374 and 0.641, respectively.

Showing your full workings, calculate the percentage of Mn in the capsule. What assumptions are required?

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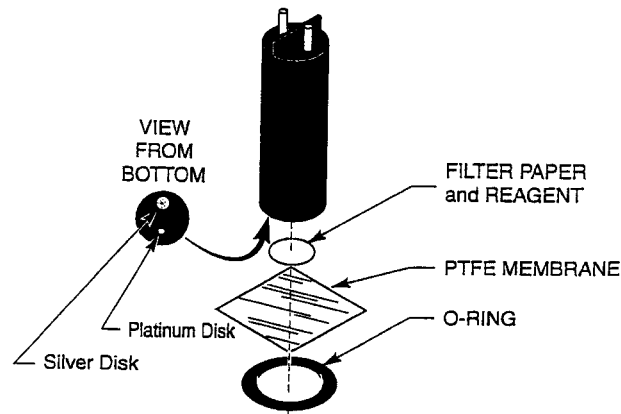
2. (30 marks)

Answer **TWO** of the following, (a) - (c)

(a) Describe the essential components of a glass electrode for pH measurement.

Explain, in detail, how the glass electrode, in conjunction with an external reference electrode, enables the pH of a sample to be determined.

(b) An expanded view of a typical amperometric oxygen electrode is shown below.



(i) Explain the role of each labelled component when the electrode is used to measure dissolved oxygen. Your answer should include equations for the reactions occurring at each electrode.

(ii) Outline advantages and limitations of the amperometric oxygen electrode for measurement of dissolved oxygen in the field.

(c) The 5-day biochemical oxygen demand (BOD_5) test is used internationally to measure water quality.

Describe the principle of the test, and how the test is carried out. Your answer should include an explanation of the following aspects of the procedure:

- the sample bottles are filled to overflowing;
- a seed may be added to the sample;
- samples should be chlorine-free;
- five dilutions of the sample are recommended;
- the dilution water contains buffer and metal salts;
- a glutamic acid test should be included periodically;
- the BOD_5 of the unseeded dilution water should be measured periodically.

3. (20 marks)

Answer **TWO** of the following (a) – (c):

- (a)
- (i) Describe the three general types of chemical species of mercury found in the environment.
 - (ii) Explain how the major mercury species found in fish is formed.
 - (ii) Discuss the human health effects associated with exposure to mercury. As part of your answer, include a description of the uptake of each type of mercury species.
- (b) Lead is a common contaminant in urban soils.
- (i) Describe the significant anthropogenic sources of Pb.
 - (ii) Discuss the human health effects associated with Pb exposure.
 - (iii) Give details for an appropriate method for analysis of total Pb in urban soils.
- (c)
- (i) Define the term speciation. As part of your answer, explain why understanding the speciation of trace elements in water is important.
 - (ii) Explain why the concentration and speciation of trace elements can vary between freshwater and seawater.

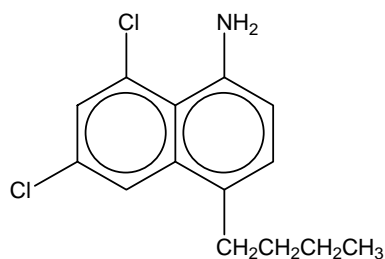
4. (40 marks)

Either

Define EC_{50} , LC_{50} , LogP_{OW} and NOAEL and discuss how they are used to assess the environmental risk of a new pesticide

Or

Predict the environmental fate and behaviour of the following compound:



END OF PAPER