Chem 210 Final Exam

May 4, 2001

______________________ Name

Equations:

$S = mC + S_{bl}$ $\quad$ $LOD = 3s_{bl}/m$ $\quad$ $LOQ = 10s_{bl}/m$ $\quad$ $S/N = k\sqrt{N}$

$\lambda = 2dn/m$ $\quad$ $\delta\lambda^* = 1/(2\cdot d_m)$ $\quad$ $f = 2\cdot v\cdot\lambda^*$ $\quad$ $Q/nF = CV$ $\quad$ $i = i_o\cdot e^{-t/\tau}$

$\lambda = (d/m)(\sin i + \sin r)$ $\quad$ $A.D. = m/d$ $\quad$ $D = (A.D.)(f.l.)$ $\quad$ $\Delta\lambda = (W)(D^{-1})$

$R = mN$ $\quad$ $A = \log(1/T) = \epsilon bC$ $\quad$ $A_t = b\Sigma\epsilon_i C_i$ $\quad$ $S = k'P_o\Phi_f\epsilon bC$

$\Delta E = K + S\cdot\log(a_A)$ $\quad$ % rel. error $= \pm 100\%\cdot(10^X - 1)$ $\quad$ $X = z\cdot E_{err}/0.05916$

$k' = t_R'/t_M$ $\quad$ $\alpha = t_R'(B)/t_R'(A)$ $\quad$ $N = L/H = 16(t_R/W)^2$ $\quad$ $R = k\sqrt{N} = k\sqrt{L}$

$H = A + B/u + Cu$ $\quad$ $R = m/\delta m$

Useful constants: F = 96485 coul/mol; 2.3RT/F = 0.05916 V at 25°C.

The following questions have one and only one correct answer. Mark the answer on the test itself. Each question is worth 4 points.

Calculations:

1. A solution containing 6.9×10^{-5} M dye was placed in a cuvet and its transmittance at 620 nm measured on a Spectronic 20 spectrometer. The pathlength of the cuvet is 0.80 cm. Calculate the molar absorptivity of the dye if the measured transmittance is 36.6%.

(a) 6600 $M^{-1}cm^{-1}$
(b) 7900 $M^{-1}cm^{-1}$
(c) 530000 $M^{-1}cm^{-1}$
(d) 28000 $M^{-1}cm^{-1}$
(e) 6300 $M^{-1}cm^{-1}$

2. A compound with the formula $C_2H_2N_3O$ has a mass of 84.0198, while a compound with the formula of $C_2H_4N_4$ has a mass of 84.0437. What is the minimum resolution of the mass analyzer needed to separate the two molecular ions?

(a) 7000
(b) 42
(c) 100
(d) 2000
(e) 3500

3. A solid catalyst was analyzed by atomic absorption spectroscopy for its platinum content. A standard containing 190 ppm Pt yielded an absorbance of 0.317, while a second standard containing 410 ppm Pt yielded an absorbance of 0.601. Calculate the concentration of a sample that yielded an absorbance of 0.451.

(a) 270 ppm
(b) 100 ppm
(c) 290 ppm
(d) 180 ppm
(e) 310 ppm

4. Atomic emission spectroscopy was used to determine the concentration of iridium ions in waste water. A 20.0 mL sample of waste water was placed in a 50.0 mL volumetric flask (flask **A**), diluted to the mark, and mixed. A 20.0 mL sample of waste water and 10.0 mL sample of 5.5 ppb iridium standard was placed in a second 50.0 mL volumetric flask (flask **B**), diluted to the mark, and mixed. The AES signal for flask **A** was 0.23, and the signal for flask **B** was 0.37. Calculate the concentration of iridium in the waste water.

(a) 4.1 ppb
(b) 1.4 ppb
(c) 0.91 ppb
(d) 0.68 ppb
(e) 4.5 ppb

5. Shark meat was analyzed for lead by anodic stripping voltammetry. The meat was digested to destroy the organic matter and get the lead into solution. After further processing, the sample was converted to an electrolyte suitable for stripping analysis. The ASV cell was filled with 20.0 mL of sample and analyzed using a MFE. The stripping peak was 21.0 nA. To the electrolyte was added 5.00 mL of 10.0 ppb Pb standard. After mixing, the new stripping peak was 56.0 nA. Calculate the Pb concentration in the sample.

(a) 19.6 ppb
(b) 1.20 ppb
(c) 0.75 ppb
(d) 1.07 ppb
(e) 3.75 ppb

6. Bromide ISE's are used in the photographic industry to monitor bromide concentrations in the film manufacturing process. A bromide ISE + ref. electrode (designed not to leak bromide or chloride) were standardized in a solution containing 2.5×10^{-3} M bromide. The cell voltage was -0.217 V. Calculate the concentration of a bromide solution if the measured cell voltage was -0.254 V.

(a) 1.1×10^{-2} M
(b) 5.9×10^{-4} M
(c) 4.4×10^{-6} M
(d) 1.6 M
(e) 8.4×10^{-4} M

7. A CV of a solution containing 1.0 mM $Ru(NH_3)_6^{3+}$ recorded at 100 mV/s yielded a peak current of 206 μA. Calculate the expected peak current if the sweep rate is 1000 mV/s and the $Ru(NH_3)_6^{3+}$ is 0.50 mM.

(a) 130 μA
(b) 651 μA
(c) 10.3 μA
(d) 1030 μA
(e) 326 μA

8. Two substance were injected into a HPLC system (25.0 cm column length). The first peak had a retention time of 25.7 min and a base width of 2.3 min. The second peak had a retention time of 29.6 min and a base width of 2.8 min. The dead time was 1.7 min. Calculate the capacity factor for the first peak and the selectivity factor for the two peaks.

	capacity factor	selectivity factor
(a)	14.1	0.860
(b)	15.1	0.860
(c)	15.1	1.16
(d)	14.1	1.16
(e)	10.2	1.16

9. For the HPLC system and data in the previous question, calculate the number of theoretical plates for the first peak and the plate height.

	# theoretical plates	plate height
(a)	2000	0.0125 cm
(b)	180	0.14 cm
(c)	32000	0.0125 cm
(d)	3700	0.0068 cm
(e)	2000	0.00050 cm

10. A diffraction grating with 1000 lines/mm is part of a 0.25 meter monochromator. Calculate the linear reciprocal dispersion at the focal plane for first-order wavelengths.

(a) 4 nm/mm
(b) 4×10^{3} nm/mm
(c) 4×10^{-6} nm/mm
(d) 2.5 nm/mm
(e) 0.25 nm/mm

Concepts:
In the next 6 questions, give the correct acronym (2 points) and then write the words represented by the acronym (2 points). Ex. LOD limit-of-detection

11. This device converts voltage signals into numbers that can be used by a computer.

____________________ ____

acronym name

12. This light detector measures light intensity as a function of position in an XY plane. It is very sensitive and very expensive.

____________________ ____

acronym name

13. This device is the preferred source in atomic emission spectroscopy. It uses a powerful radio transmitter and lots of argon gas.

____________________ ____

acronym name

14. In this electrochemical method, the electrolyte is stirred. The resulting currents are independent of time.

____________________ ____

acronym name

15. This device detects the presence of an analyte in a gas stream by the ability of the gas stream to cool a hot wire. It is used in a gas chromatograph.

____________________ ____

acronym name

16. This technique is a common method for interfacing a HPLC and a mass spectrometer. Molecules in the liquid eluant are converted to ions in the gas phase.

____________________ ____

acronym name

The following questions are worth 3 points each.

17. An electron impact ion source is characterized as a ________ source and a ________ source.

(a) desorption, hard
(b) gas-phase, hard
(c) gas-phase, soft
(d) desorption, soft

18. A quadrupole mass analyzer has ______ speed, ______ transmittance, and has a_______ resolution.

(a) high, high, moderate
(b) high, high, very high
(c) low, high, low
(d) high, low, very high
(e) low, low, moderate

19. In tandem mass spectrometry, what happens in the second quadrupole unit?

(a) The daughter ions of the molecular ion are detected.
(b) The selected molecular ions collide with He gas atoms.
(c) The molecules are ionized by a stream of electrons.
(d) Molecular ions of one m/z are selected for further analysis.
(e) The ions are allowed to drift in a field-free tube.

20. In reverse phase HPLC, molecules with ______ polarity elute first, and molecules with _______ polarity elute last. For molecules with similar polarity, molecules with the ________ molecular weight elute first.

(a) lower, higher, higher
(b) higher, lower, higher
(c) lower, higher, lower
(d) higher, lower, lower

21. Choose the true statements. In gas chromatography, capillary columns provide better resolution than packed columns because:

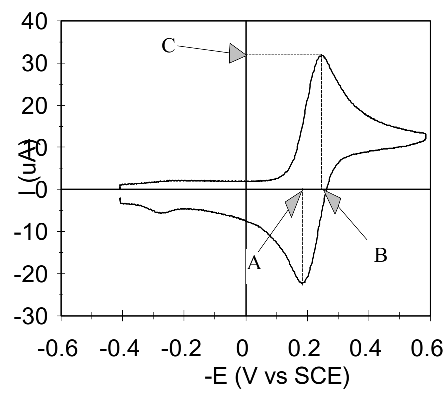
A. they are much longer than packed columns.
B. they don't have band broadening due to the multipath process.

(a) A only.
(b) B only.
(c) Both A and B.
(d) Neither A nor B.

22. In controlled potential coulometry, 99.9% of the analyte is converted to product when:

(a) the analyte is preconcentrated onto the WKG electrode.
(b) the applied potential is equal to the formal potential of the half-reaction.
(c) the current decays to 0.1% of its initial value.
(d) the switching potential is set well negative of the formal potential.
(e) oxygen is removed by sparging with argon.

23. In the CV (American convention), point A is the _____ peak potential and point B is the _____ peak potential. From point C, one can obtain the ______________. (Note that the horizontal axis is the negative of the potential)



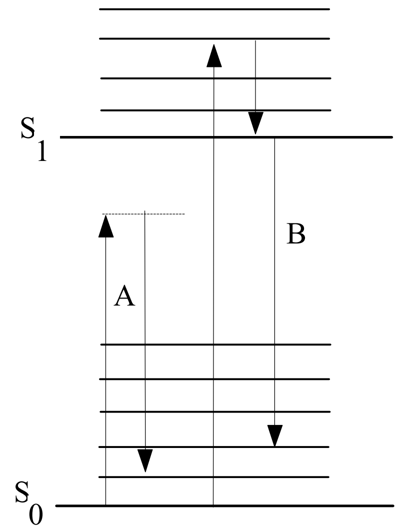
(a) cathodic, anodic, analyte concentration
(b) formal potential, standard potential, # of electrons
(c) anodic, cathodic, analyte concentration
(d) cathodic, formal potential, # of electrons
(e) oxidation state, zero crossing, formal potential

24. Choose the true statements. The two roles of the supporting electrolyte in voltammetry are:

A. To suppress diffusion of the analyte.
B. To increase the resistance of the solution.

(a) A only
(b) B only
(c) Both A and B
(d) Neither A nor B

25. In the energy state diagram on the right, the process indicated by the arrows surrounding **A** corresponds to:



(a) fluorescence
(b) phosphorescence
(c) intersystem crossing
(d) Raman scattering
(e) Raleigh scattering

26. In the same diagram, the process corresponding to arrow **B** is:

(a) phosphorescence
(b) Raleigh scattering
(c) fluorescence
(d) excitation
(e) Raman scattering

27. Which of the following is a spectroscopic interference in flame atomic absorption spectroscopy?

(a) light absorption by OH species in the flame
(b) formation of refractory compounds in the flame
(c) ionization of the gaseous atoms in the flame
(d) excitation of the gaseous atoms in the flame

28. What is Jacquinot's advantage in FT-IR spectroscopy?

(a) constant bandwidth over the entire spectrum
(b) detection of all wavelengths simultaneously
(c) high precision in peak positions
(d) stray light is not a problem
(e) high throughput to the detector