Annual Departmental Plan Report

Program Information

Program/Department: Chemistry/Department of Biology and Chemistry
Department Chair: Meledath Govindan
Department Assessment Committee Contact: Steven Fiedler

Please be as detailed as possible in your responses. We will use this information to fulfill our NECHE requirements and this report will help with your next Program Review or aid with your external accreditation. This file is to be kept in the department and an electronic file is due to the Director of Assessment by May 31 each academic year.

Program Learning Outcomes (PLOs) (Educational Objectives)

I. List all PLOs and the timeline for assessment.

PLO #	PLO – Stated in assessable terms.	Timing of assessment (annual, semester, bi-annual, etc.)	When was the last assessment of the PLO completed?
1.	Chemical Literature and Information Management Skills and Communication Skills: Outcomes delineated in Appendix A, sections 1, 3, 5, and 7	Annual	Spring 2019
2.	Disciplinary Knowledge and Skills: Outcomes delineated in Appendix A, section 2.	Annual	Spring 2019

II. <u>PLO Assessment</u> (Please report on the PLOs assessed and/or reviewed this year, programs should be assessing at least one each year.)

Using the table below, list and briefly describe the **direct method(s)** used to collect information assessing whether students are learning the core sets of knowledge (K), skills (S) and attitudes (A) identified as essential.

PLO #	Assessment description (exam, observation, national standardized exam, oral presentation with rubric, etc.)	When assessment was administered in student program (internship, 4th year, 1st year, etc.)	To which students were assessments administered (all, only a sample, etc.)	What is the target set for the PLO? (criteria for success)	Reflection on the results: How was the "loop closed"?
1	Oral presentation assessed by rubric (Appendix B) with analysis provided in Appendix C.	4th year	All students in capstone course	Iterative development of the oral assessment rubric to capture PLO 1 attributes	Rubric revisions to be discussed (Fall 2019 Departmental Retreat).
2	Exam (Appendices D, E)	4th year	All students in capstone course	Performance baseline (Appendix D) established	Results to serve as a foundation to prioritize PLO rank within the program with respect to curricular emphasis.

III. **Summary of Findings:** Briefly summarize the results of the PLO assessments reported in Section II above combined with other relevant evidence gathered and show how these are being reviewed/discussed. How are you "closing the loop"?

Other than GPA, what data/ evidence is used to determine that graduates have achieved the stated outcomes for the degree? (e.g., capstone course, portfolio review, licensure examination)	Who interprets the evidence? What is the process? (e.g. annually by the curriculum committee)	What changes have been made as a result of using the data/evidence? (close the loop)
Oral presentation with rubric (Appendix B), with results summarized in Appendix C	Spring 2019 observation by assessment committee	Recommendation adopted from the AY 2017 annual report for the removal of an irreverent category from the assessment rubric.
Disciplinary knowledge and skills exam	Results reviewed by the Chemistry program faculty and the department assessment committee	Concepts that highlight proficiency deficiencies to be reinforced in the curriculum.

Assessment Plan for Program/Department

Development of components in the Department Assessment Plan is scheduled to continue within the Fall 2019 Departmental Retreat.

I. Insert the program or department Assessment Plan
II. Explain any changes in the assessment plan including new or revised PLOs, new assessments that the program/department plans to implement and new targets or goals set for student success.
III. If you do not have a plan, would you like help in developing one?

☐ Yes

University Data

I. SSC Data

Indicate **at least one** Student Success Performance Measure that the department/program has identified for planned change or improvement.
Freshman retention, bottleneck courses, graduation rates, at risk student retention etc.

a. What was the focus this year?

Student Success Measure (data point from SSC)	**Implemented Intervention**	**Update on Implemented Intervention (i.e. change in target, satisfied with outcome, not satisfied, will continue or not)**
Gateway course performance	There is no SSC data yet for the Chemistry major. However, General Chemistry II (CHEM 1400) was identified as a good predictor of success for student success in upper level chemistry courses. To encourage students to master the content in CHEM 1400, the department developed AUC proposal 139 in S19, which stipulates that chemistry majors must attain a minimum 2.0 grade threshold in the course to continue in the program.	Data is not yet available for this intervention as AUC 139 passed through governance AY 2018-2019 and has not yet been applied.

b. What will your focus be for the upcoming year?*

Student Success Measure (data point from SSC)	**Rationale for selection**	**Planned or Implemented Intervention**	**Current score/ Target Score**	**This measure was selected because of last Program Review or Accreditation (yes/ no)**
Gateway course performance	There is no SSC data yet for the Chemistry major. However, General Chemistry II (CHEM 1400) was identified as a good predictor of success for student success in upper level chemistry courses.	Chemistry faculty considered options to assist struggling students in the major and to encourage students with a low probability of success to switch their major at an earlier point.	N/A	yes

*Note: Programs may wish to monitor or review the same data point over multiple years.

II. Trend Data

Indicate **at least one** Department Performance Measure that the program/department identified for change or improvement. Number of graduates, number of majors, credit production, substitutions etc.

a. What was the focus this year?

Department Performance Measure (data point from Trend Data)	**Implemented Intervention**	**Update on Implemented Intervention (i.e. change in target, satisfied with outcome, not satisfied, will continue or not)**
Enrollment	The Department hosted a Chemistry Career Panel Discussion for Upward Bound students on December 4, 2018.	The Career Panel members were distinguished educators and professionals from industry in the region. Thirty-two Upper Bound students attended the event and were actively engaged in the lively and informative discussion. Written feedback from the students indicated that some of the students were considering the Chemistry major based on the event.
Enrollment	The Department co-sponsored a local-section dinner meeting of the American Chemical Society on April 23, 2019. Announcements and invitations were sent to students attending Mount Wachusett and Quinsigamond Community Colleges. The cost to students for the dinner was covered by the section.	Although the meeting was attended by three undergraduate students from Worcester State and Fitchburg State University, no community college students attended the event. Similar outreach efforts may need to be redesigned in the future to increase participation within this target demographic.

b. What will be the focus next year?*

Department Performance Measure (data point from Trend Data)	Rationale for selection	Planned or Implemented Intervention	Current score/ Target Score	This measure was selected because of last Program Review or Accreditation (yes/ no)
Enrollment	Benchmarks for program enrollment were set in section E-2 of the 2013 New Academic Program proposal to the Board of Higher Education on the reinstatement of the Chemistry major at Fitchburg State University. These values are tracked due to the importance of growing enrollment to the health of the major.	The Department plans to continue coordination with the Office of Admissions to assist with outreach and marketing efforts of this major.	AY 2014/2015 Current 10/Target 8 AY 2015-2016 15/18 AY 2016-2017 28/30 AY 2017-2018 29/42 AY 2018-2019 26/50	no

*Note: Programs may wish to monitor or review the same data point over multiple years.

Campus Climate

Each department was asked to review the Campus Climate Survey information distributed by the Leading for Change Committee and determine what your department has been doing to contribute to the positive outcomes identified.

The survey data may be found through this link: https://www.fitchburgstate.edu/offices-services-directory/institutional-research-and-planning/office-of-assessment/campus-climate-survey/

Please list the feedback and recommendations that your department provided to the Leading for Change Committee, along with any additional plans that you might have to further explore this data.

The Department plans to implement the following actions to address the campus climate issues and help our under-represented students feel more welcome and be more successful in our programs.

- *Personal Outreach- Instructors will be cognizant about reaching out to under-represented student groups and inviting them to do research with us in both independent students and in introduction to research courses. Additionally, faculty will highlight our approachability and previous activities in this regard at the departmental annual fall advising meeting with incoming Biology and Chemistry majors.*

- *An inclusiveness charge has been added to the Departmental Student Affairs committee. The committee will discuss the campus climate data and our student survey data and create goals to improve inclusiveness, increase retention and develop opportunities for our minority students. This can include items like working on the HHMI grant to include imbedded tutors in our STEM courses or add a STEM success center on campus.*

- *Collaboration with the Center for Diversity and Inclusiveness- Our department plans to develop ideas and strategies for making our minority students feel welcomed and successful in our programs with the LASO (Latin American Student Organization) and the BSA (Black Student Association).*

Appendix A: Chemistry Learning Goals/Outcomes (Adapted from the American Chemical Society Standards)

1. Problem Solving Skills. Students should be able to define problems clearly, develop testable hypotheses, design and execute experiments, analyze data using appropriate statistical methods, understand the fundamental uncertainties in experimental measurements, and draw appropriate conclusions.

2. Disciplinary knowledge and skills

Students should understand and be able to apply their understanding of all chemistry sub-disciplines and use appropriate laboratory skills and instrumentation to solve problems. These areas of knowledge and skills include:

- Basic chemical concepts such as stoichiometry, states of matter, atomic structure, molecular structure and bonding, thermodynamics, equilibria, and kinetics.
- Basic laboratory skills such as keeping a notebook, use of electronic balances and volumetric glassware, preparation of solutions, chemical measurements using pH electrodes and spectrophotometers
- Foundational knowledge and skills in analytical chemistry, biochemistry, inorganic chemistry, organic chemistry, and physical chemistry.
- Foundational laboratory skills including synthesis of molecules, measurement of chemical properties, determination of structures, use of modern instrumentation and computational modeling.

3. Chemical Literature and Information Management Skills. Students should be able to retrieve information efficiently and effectively by searching the chemical literature, evaluate technical articles critically, and manage many types of chemical information.

4. Laboratory Safety Skills. Students should be able to demonstrate and apply their understanding of the concepts of safe laboratory practices. They should be able to evaluate and assess safety risks associated with laboratory experiences. Students must be able to:

- Carry out responsible disposal techniques
- Comply with safety regulations
- Properly use personal protective equipment to minimize exposure to hazards
- Recognize chemical and physical hazards in laboratories, assess the risks from these hazards, know how to minimize the risks, and prepare for emergencies.
- Understand the categories of hazards associated with chemicals (health, physical, and environmental)
- Use Safety Data Sheets (SDSs) and other standard printed and online safety reference materials

5. Communication Skills. Students should be able to present information in a clear and organized manner, write well-organized and concise reports in a scientifically appropriate style, and use relevant technology in their communications.

6. Team Skills. Students should be able to interact effectively in a group to solve scientific problems and work productively with a diverse group of peers.

7. Ethics. Students should understand and demonstrate responsible treatment of data, proper citation of others' work, and the standards related to plagiarism and the publication of scientific results. Students should also be able to explain the role of chemistry in contemporary societal and global issues, including areas such as sustainability and green chemistry.

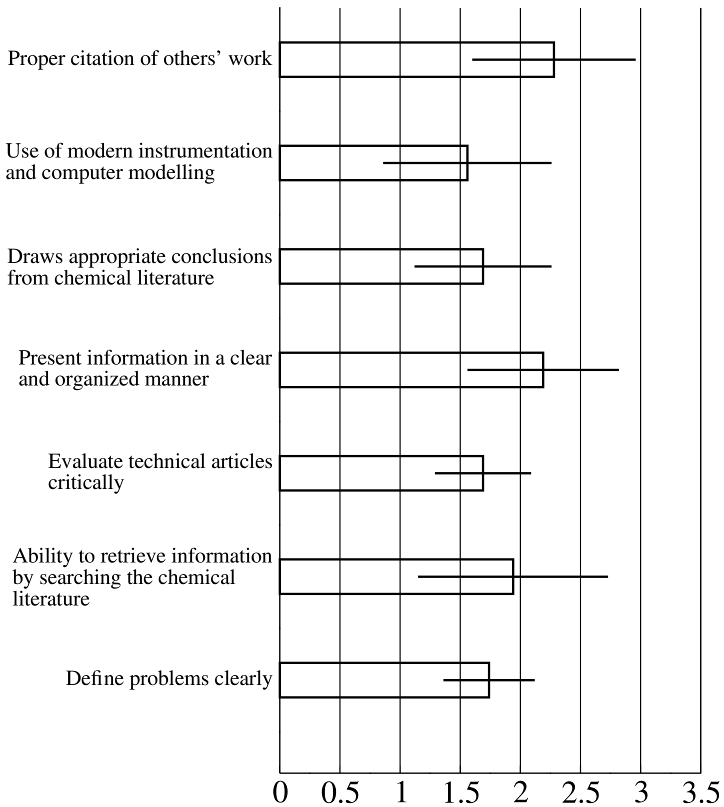
Appendix B: Chemistry Seminar Presentation Assessment (Spring 2019)

Presenter Name: ______________________ **Presentation Title: ____**

	Proficient 3	**Sufficient** 2	**Deficient** 1	**Rating (1, 2, 3 or N/A)**
Define problems clearly	Identifies a creative, focused, and manageable topic that addresses potentially significant yet previously less-explored aspects of the topic.	Identifies a focused and manageable/doable topic that appropriately addresses relevant aspects of the topic.	Identifies a topic that is far too general and wide-ranging as to be manageable and doable.	
Ability to retrieve information by searching the chemical literature	8 – 12 journal articles from the primary literature.	8 – 12 journal articles from the primary literature, some review articles included.	<8 journal articles from the primary literature, other sources such as web articles.	
Evaluate technical articles critically	Synthesizes in-depth information from relevant sources representing various points of view/approaches.	Presents information from relevant sources representing limited points of view/approaches.	Presents information from irrelevant sources representing limited points of view/approaches.	
Students present information in a clear and organized manner	Delivery of presentation is well-organized, professional, and coherent. Images and text are clearly readable to the audience.	Delivery of presentation is organized, professional, and coherent. Images and text are mostly readable to the audience.	Delivery of presentation lacks organization or is not always coherent. Images and text not always easily read by audience.	
Draws appropriate conclusions from chemical literature	Presentation interprets, connects and expands on results and conclusions from the different sources, and formulates a coherent argument about a topic.	Results from different sources are compared and contrasted but does not formulate a coherent argument about a topic.	Presentation mainly reports results and conclusions of journal articles from the primary literature.	
Use of modern instrumentation and computational modeling	Able to clearly express an understanding of basic principles of analytical instrumentation or computational modeling applied in the presentation. *For example: if the presentation deals with NMR, the student is able to explain the principle*	Able to express an understanding of basic principles of analytical instrumentation or computational modeling applied in the presentation.	Unable to clearly express an understanding of basic principles of analytical instrumentation or computational modeling applied in the presentation	

	behind NMR techniques.			
Proper citation of others' work	Properly cites sources in text and for images used in the presentation	Mostly cite sources in text or for images used in the presentation	Does not properly cite sources in text or for images used in the presentation	

Appendix C. Chemistry Seminar Presentation Assessment: Summary of Results.



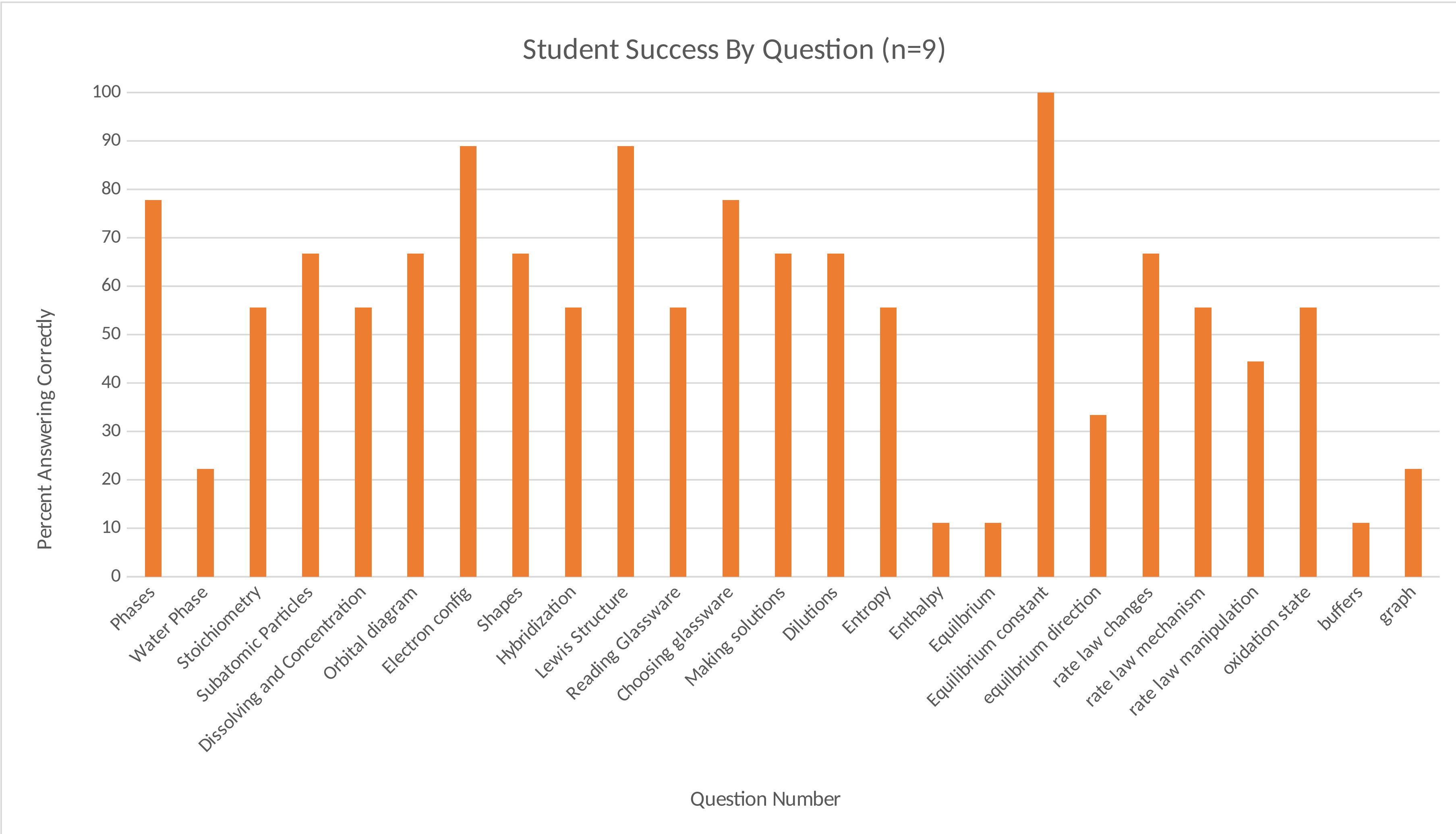
Two members of the Departmental Assessment Committee (one chemist and one biologist) evaluated oral presentations in the Chemistry Seminar Capstone Course on April 30 and May 7, 2019. In total, nine students presented on individual semester length literature review projects on topics of their own choosing. This is the third graduating cohort of chemistry majors in the program.

All of the eight learning outcomes were considered met (i.e., ranked sufficient (2.0) or better, all outcomes ranked at least 1.5) within the uncertainty of the assessment, however, only two of the eight outcomes scored an average that exceeded 2.0. The highest ranked learning outcomes were “Proper citation of others' work" and “Present information in a clear and organized manner”. The lowest ranked learning outcomes were “Draws appropriate conclusions from chemical literature” and “Use of modern instrumentation and computational modeling”. Proficiency in these two latter categories are an important component for graduates in the program and these results will be passed along to the the Chemistry faculty for consideration.

In future years alternative modes of assessment should be considered for “Ability to retrieve information by searching the chemical literature” and “Use of modern instrumentation and computational modeling”.

Figure 1. Results of assessment of oral presentation with rubric (Appendix A).

Appendix D. Chemistry Seminar Exit Exam: Result Summary



Appendix E. Chemistry Seminar Exit Exam

1. Identify the characteristics of a liquid.
   (A) indefinite shape and volume
   (B) indefinite shape, but definite volume
   (C) definite shape and volume
   (D) none of the above
   (E) all of the above

2. Identify the phase in which the water molecules are closest together.
   (A) gas
   (B) dry ice
   (C) solid
   (D) liquid

3. How many grams of Li_3N can be formed from 1.75 moles of Li? Assume an excess of nitrogen.
   $6\ Li(s) + N_2(g) \rightarrow 2\ Li_3N(s)$

   (A) 18.3 g Li_3N
   (B) 20.3 g Li_3N
   (C) 58.3 g Li_3N
   (D) 61.0 g Li_3N
   (E) 15.1 g Li_3N

4. What species is represented by the following information?

$p^+ = 47$ $n^\circ = 62$ $e^- = 46$

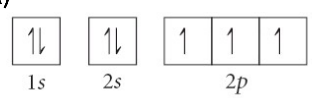
(A) Ag^+
(B) Nd
(C) Pd
(D) Ag
(E) Pd^+

5. If 30.2 g of $BaCl_2$ is dissolved in 1.0 L of water, what is the resultant chloride (Cl^-) ion concentration?

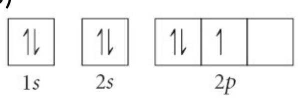
(A) Less than 0.10 M
(B) 0.11 - 0.20 M
(C) 0.21 - 0.50 M
(D) 0.51 - 1.0 M
(E) More than 1.1 M

6. Choose the orbital diagram that represents the ground state of N.

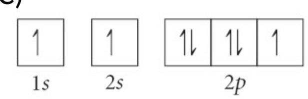
(A)



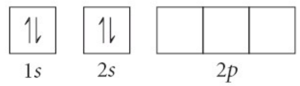
(B)



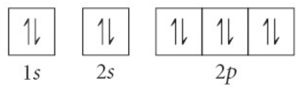
(C)



(D)



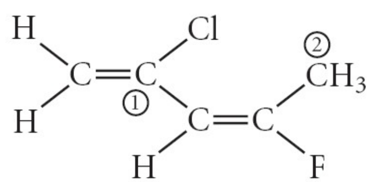
(E)



7. Identify the element that has a ground state electronic configuration of $[Ar]\ 4s^2\ 3d^{10}\ 4p^1$.

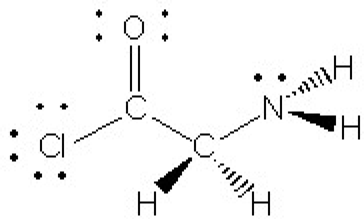
(A) Al
(B) In
(C) Ga
(D) B

8. Consider the molecule below. Determine the molecular geometry at each of the 2 labeled carbons.



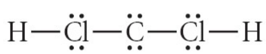
(A) C1 = tetrahedral, C2 = linear
(B) C1 = trigonal planar, C2 = bent
(C) C1 = bent, C2 = trigonal planar
(D) C1 = trigonal planar, C2 = tetrahedral
(E) C1 = trigonal pyramidal, C2 = see-saw

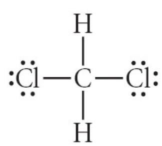
9. Consider the molecule below. Determine the hybridization at each of the three atoms (C,C, N) from left to right

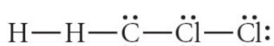


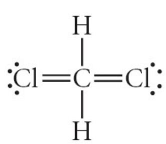
(A) 1 = sp^2, 2 = sp^3, 3 =sp^2
(B) 1 = sp^2, 2 = sp^3, 3 = sp^3
(C) 1 = sp^3, 2 = sp^3, 3 = sp^3
(D) 1 = sp^3, 2 = sp^3, 3 = sp^2
(E) 1 = sp, 2 = sp^2, 3 = sp^2

10. Choose the best Lewis structure for CH_2Cl_2.

(A) 

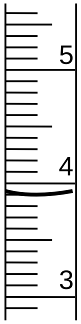
(B) 

(C) 

(D) 

11. Report the volume of the liquid contained in the graduated cylinder to the correct number of digits.

(A) 3 mL
(B) 3.9 mL
(C) 3.88 mL
(D) 3.887 mL
(E) 4.1 mL



12. Which glassware is best to measure 10.5 mL of a liquid?

(A) a graduated buret (with marking every 0.1 mL)
(B) a graduated cylinder (with marking every 1 mL)
(C) a fixed volume pipet (with only one marking)
(D) a graduated beaker (with marking every 10 mL)

13. How many grams of KBr are required to make 350. mL of a 0.115 M KBr solution?
(A) 0.338 g
(B) 3.04 g
(C) 4.79 g
(D) 40.3 g

14. How many milliliters of a stock solution of 11.1 M HNO_3 would be needed to prepare 0.500 L of 0.500 M HNO_3?
(A) 0.0444 mL
(B) 22.5 mL
(C) 2.78 mL
(D) 44.4 mL

(E) 0.0225 mL

15. Which of the following reactions is most likely to have a positive change in entropy ($\Delta S_{rxn} > 0$)?

$2LiOH(aq) + CO_2(g) \rightarrow Li_2CO_3(aq) + H_2O(l)$

A. $2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$
B. $CO(g) + 2H_2(g) \rightarrow CH_3OH(l)$
C. $P_4(g) \rightarrow P_4(s)$
D. $2IBr(g) \rightarrow I_2(s) + Br_2(l)$

16. The thermodynamic equation for the formation of water is:

$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)\ \Delta H_{rxn} = -241.8$ kJ

What is the ΔH_{rxn} for the decomposition of 1 mole of water?

A. -241.8 kJ
B. -120.9 kJ
C. 120.9 kJ
D. 241.8 kJ
E. 483.6 kJ

17. We use coal to generate hydrogen gas (a possible fuel) by the **endothermic** reaction

$$C(s) + H_2O(g) \rightleftharpoons CO(g) + H_2(g)$$

If this reaction is at equilibrium, predict which of the following changes will result in an increased yield of hydrogen gas (H_2).

(A) Adding more C to the reaction mixture.
(B) Removing H_2O from the reaction mixture.
(C) Raising the temperature of the reaction mixture.
(D) Lowering the volume of the reaction mixture.
(E) Adding a catalyst to the reaction mixture.

18. Express the equilibrium constant for the following reaction:

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

(A) $K = \dfrac{[N_2][H_2]^{1/3}}{[NH_3]^{1/2}}$

(B) $K = \dfrac{[NH_3]^6}{[N_2]^3[H_2]^9}$

(C) $K = \dfrac{[NH_3]^2}{[N_2][H_2]^3}$

(D) $K = \dfrac{[N_2][H_2]^3}{[NH_3]^2}$

(E) $K = \dfrac{[NH_3]^{1/2}}{[N_2][H_2]^{1/3}}$

19. For the reaction $2A(g) \rightleftharpoons B(g)$, the equilibrium constant is $K_c = 0.76$. A reaction mixture initially contains 0.20 M of each gas. Which statement is true of the reaction mixture?

a. The reaction mixture is at equilibrium.
b. The reaction mixture will proceed towards products.
c. The reaction mixture will proceed towards reactants.
d. There is not enough information to determine the direction of the mixture.
e. The mixture will never reach equilibrium.

20. For the reaction A + B → C, the rate law is rate = $k[A][B]^2$. If the concentration of A is doubled, what will be the effect on the rate of the reaction?

a. Rate is unchanged.
b. Rate is doubled.
c. Rate is quadrupled.
d. Rate decreases to ½.
e. Rate decreases to ¼.

21. Given the mechanism below for the overall reaction AB + C → A + BC, what is the rate law for the reaction?

$AB + AB \rightarrow AB_2 + A$ *slow*
$AB_2 + C \rightarrow AB + BC$ *fast*

a. Rate = k[2AB]
b. Rate = $k[AB]^2$
c. Rate = $k[AB_2][A]$
d. Rate = $k[AB_2][C]$
e. Rate = k[AB][BC]

22. For the reaction $2\ NO_2 \rightarrow 2\ NO + O_2$, the rate of decomposition of NO_2 is – 0.20 M/s. What is the rate of appearance of O_2?

a. – 0.10 M/s
b. – 0.40 M/s
c. 0.10 M/s
d. 0.20 M/s
e. 0.40 M/s

23. Which of the following represents the oxidation states of the individual atoms in CaC_2O_4?

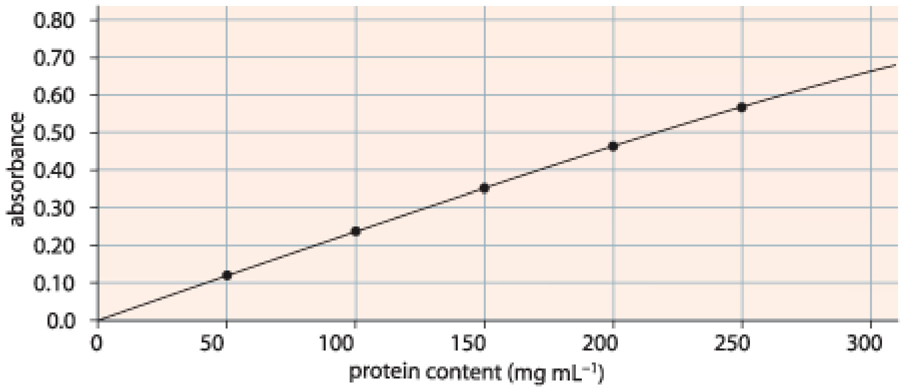
(A) Ca = +2; C = +3; O = -2
(B) Ca = +3; C = +2; O = -2
(C) Ca = +3; C = +4; O = -2
(D) Ca = -2; C = +3; O = -1
(E) Ca = -2; C = +2; O = -1

24. Equimolar 0.5 L solution of each of the following solutions were mixed, which choices below are buffers?

(1) NH_4Cl (*aq*) and NH_3(*aq*)
(2) HCl (*aq*) and NH_3 (*aq*)
(3) KF (*aq*) and HF (*aq*)
(4) NaOH (*aq*) and HCl (*aq*)
(5) $NaHCO_3$ (*aq*) and Na_2CO_3 (*aq*)

(A) 1 and 3
(B) 1, 3 and 5
(C) 1 and 5
(D) 2 and 5
(E) 2, 3, and 4

25. The protein content of a sample was determined using a reagent to convert the protein into a coloured complex. The absorbance of the complex was measured using a UV-visible spectrophotometer set at an appropriate wavelength. Using standard protein solutions, the calibration curve shown below was obtained. A sample containing protein was diluted 50 fold. The diluted solution was found to have an absorbance of 0.30. The protein content of the sample was



a. 125 mg mL^{-1}
b. 0.125 g mL^{-1}
c. 2.5 mg mL^{-1}
d. 6.25 g mL^{-1}