

Titration Probe – Scoring Sheet

Student Name: _____

Place a score (1-4) in each row corresponding to the student's college readiness level.

Exceeding College Ready (4): Substantially exceeds the performance expectations**College Ready (3):** Shows proficiency in all of the performance expectations**Approaching College Ready (2):** Meets only some of the performance expectations**Initiating College Ready (1):** Does not yet meet the performance expectations

KEY COGNITIVE SKILLS	Student's Self-Assessment	Instructor's Score
Intellectual Curiosity (engages in scholarly inquiry and dialogue)		
Reasoning (considers arguments and conclusions of self and others; constructs well-reasoned arguments; supports or modifies claims based on the results of an inquiry)		
Academic Behaviors (self-monitors learning needs and seeks assistance when needed; strives for accuracy and precision; perseveres to complete and master tasks)		
Work Habits (works independently; works collaboratively)		
FOUNDATIONAL SKILLS	Student's Self-Assessment	Instructor's Score
Writing Across the Curriculum (writes clearly and coherently using standard writing conventions)		
Research Across the Curriculum (synthesizes and organizes information effectively)		
Use of Data (identifies patterns or departures from patterns among data; presents analyzed data and communicates findings in a variety of formats)		
Technology (uses technology to gather, organize, manage, and analyze information and to communicate, display findings in a clear and coherent manner; uses technology appropriately)		
SCIENCE STANDARDS	Student's Self-Assessment	Instructor's Score
Nature of Science: Scientific Ways of Learning and Thinking (exercises cognitive skills in science; demonstrates collaborative, safe practices; demonstrates understanding of current lab practices; effectively communicates scientific info)		
Foundational Skills: Scientific Applications of Mathematics (uses basic mathematical properties, relationships, and symbols; uses SI units and significant digits appropriately)		
Foundational Skills: Scientific Applications of Communication (demonstrates appropriate reading and writing practices for science; presents scientific information accurately)		
Chemistry (describes and classifies chemical reactions; understands the mole concept and molar relationships; recognizes and describes the properties of solutions)		

See reverse for
comments.

Score	College Readiness Level
42-48	Exceeding College Ready
35-41	College Ready
18-34	Approaching College Ready
0-17	Initiating College Ready

Total Score: _____

Grade: _____

See Scoring Guide for grade
conversion chart.

Titration Probe – Scoring Guide

Note: The letters and numbers of the skills below refer to their designation in the College and Career Readiness Standards.

KEY COGNITIVE SKILLS

A. Intellectual Curiosity

1. Engage in scholarly inquiry and dialogue.

College Ready Description: Student engages fellow classmates in discussion, correcting their misconceptions as well as considering their reasoning and arguments. Student attempts to answer questions informally posed by the instructor.

Evidence for Scoring: Student explains what reactions and changes are expected to occur during titration and is able to justify each step of the titration if asked by the instructor.

B. Reasoning

1. Consider arguments and conclusions of self and others.

College Ready Description: Student listens attentively to fellow classmates' arguments, weighing what is presented against what they think.

Evidence for Scoring: Student is open to changing his or her views when unable to refute classmates' views and logic.

2. Construct well-reasoned arguments to explain phenomena, validate conjectures, or support positions.

College Ready Description: Student uses logical responses to support his or her opinions. Student should be able to explain his or her reasoning in a step-by-step manner, citing sound logic at each step.

Evidence for Scoring: Rather than jumping from one topic to the next, the student states his or her arguments in a linear manner.

4. Support or modify claims based on the results of an inquiry.

College Ready Description: Student is open to re-examining and changing his or her arguments when other data or situations are presented.

Evidence for Scoring: Student addresses and reconsiders his or her prediction about the conductivity of the solution after performing the experiment that may or may not agree with the initial prediction.

D. Academic Behaviors

1. Self-monitor learning needs and seek assistance when needed.

College Ready Description: Student keeps a mindful eye on his or her integration of knowledge as it progresses and is able to ask fellow students and the instructor for help.

Evidence for Scoring: Student is comfortable admitting he or she does not know an answer and is willing to re-examine the material to relearn.

3. Strive for accuracy and precision.

College Ready Description: Student carefully and correctly collects and reports experimental data throughout the inquiry.

Evidence for Scoring: Student accurately records values for the volumes of barium hydroxide and sulfuric acid solutions used, conductivity values, and pH values during the investigation.

4. Persevere to complete and master tasks.

College Ready Description: Student submits a report that reflects thorough understanding of each element of the task and meets all requirements of the assignment.

Evidence for Scoring: Student's report presents a complete and thorough answer for every question and a clear and correct analysis of the graphs of conductivity and pH data.

E. Work Habits**1. Work independently.**

College Ready Description: Student can work though the problems by themselves.

Evidence for Scoring: Student does not wait until the group work to start thinking about the activity.

2. Work collaboratively.

College Ready Description: Student actively and equally works with others on the problem at hand. Student recognizes different people have different skills and knowledge and tries to use the best everyone has for the betterment of the group.

Evidence for Scoring: One student does not do all the work while the other students just sit passively.

FOUNDATIONAL SKILLS**B. Writing Across the Curriculum****1. Write clearly and coherently using standard writing conventions.**

College Ready Description: Student uses appropriate terminology and data expression to communicate information in a concise manner. Student uses proper citation conventions, grammar, mechanics, punctuation, and spelling.

Evidence for Scoring: Student uses clearly titled and labeled data tables and graphs to present the measured volumes of the barium hydroxide and sulfuric acid solutions for each trial as well as the pH and conductivity data. Student correctly uses the terms *conductivity*, *equivalence point*, and *titration* to present the results of the investigation.

C. Research Across the Curriculum**5. Synthesize and organize information effectively.**

College Ready Description: Student collects and organizes experimental data in an orderly and strategic manner. Student effectively sequences the presentation of experimental data to support the final conclusion(s).

Evidence for Scoring: Student organizes titration data using tables and graphs. Student includes in his or her laboratory report both the collected data (presented in a clear, organized manner) and a clear statement of what these data demonstrate pertaining to the primary research question.

D. Use of Data

1. Identify patterns or departures from patterns among data.

College Ready Description: Student adequately identifies relevant patterns in the data in order to be able to identify the equivalence point of the titration.

Evidence for Scoring: Student correctly identifies and marks the equivalence point on the graphs of conductivity data and of pH data based on the patterns visible in each and compares the points between the two graphs.

3. Present analyzed data and communicate findings in a variety of formats.

College Ready Description: Student composes a written report that adequately details the data analysis and all findings related to the titration of a base with an acid.

Evidence for Scoring: Student's report displays the data collected (with appropriate units) in tables, presents the data (with appropriate labels) in graphs, and summarizes the findings in paragraph form.

E. Technology

1. Use technology to gather information.

College Ready Description: Student uses appropriate devices to accurately measure volume, conductivity, and pH.

Evidence for Scoring: Student accurately uses a graduated cylinder and buret to measure the volumes of barium hydroxide and sulfuric acid solutions respectively, a pH sensor to measure the pH of the reaction mixture, and a conductivity probe to measure the conductivity of the reaction mixture.

2. Use technology to organize, manage, and analyze information.

College Ready Description: Student uses appropriate devices to organize and analyze data associated with the titration of barium hydroxide with sulfuric acid.

Evidence for Scoring: Student uses a graphing calculator to list data, plot data on a graph, and to analyze plotted data to determine the equivalence point of the titration.

3. Use technology to communicate and display.

College Ready Description: Student utilizes technology to effectively present information and data graphically, textually, and mathematically.

Evidence for Scoring: Student's report is prepared using word-processing software and includes data tables and graphs that were generated from a graphing calculator or other graphing software.

4. Use technology appropriately.

College Ready Description: Student thoughtfully identifies when technology may or may not be necessary or appropriate to communicate findings.

Evidence for Scoring: Student makes a careful hand drawing of each apparatus used in the Investigating trials, with all dimensions/aspects labeled clearly and consistently but using a spreadsheet to present the graphical and analytical results/conclusions and using a word processor for the report/discussion itself.

SCIENCE STANDARDS

I. Nature of Science: Scientific Ways of Learning and Thinking

A.1, 2, 4. Cognitive skills in science.

College Ready Description: Student utilizes skepticism, logic, and professional ethics in science. Student uses creativity and insight to recognize and describe patterns in natural phenomena. Student relies on reproducible observations of empirical evidence when constructing, analyzing, and evaluating explanations of natural events and processes.

Evidence for Scoring: Student critically thinks about the ideas that are being addressed and logically come to a conclusion. Student does not blindly believe their fellow classmates claim but questions the validity of it.

C.1, 2, 3. Collaborative and safe working practices.

College Ready Description: Student collaborates on joint projects. Student understands and applies safe procedures in the laboratory and field, including chemical, electrical, and fire safety and safe handling of live or preserved organisms. Student demonstrates skill in the safe use of a wide variety of apparatuses, equipment, techniques, and procedures.

Evidence for Scoring: Student actively participates in the discussions with their fellow classmate as well as with their instructor. Student shares responsibilities in doing the lab activity. Student uses safe procedures when working with chemicals.

D.3. Current scientific technology.

College Ready Description: Student demonstrates appropriate use of a wide variety of apparatuses, equipment, techniques, and procedures for collecting quantitative and qualitative data.

Evidence for Scoring: Student uses a computer or graphing calculator to collect and analyze data, and lab equipment to conduct scientific experiments.

E.1, 2. Effective communication of scientific information.

College Ready Description: Student uses several modes of expression to describe or characterize natural patterns and phenomena. These models of expression include narrative, numerical, graphical, pictorial, symbolic, and kinesthetic. Student uses essential vocabulary of the discipline being studied.

Evidence for Scoring: Student can converse with fellow classmates about the activity. Student prepares a formal laboratory report where the student communicates his or her findings in a variety of modes, including narrative, numerical, and graphical.

II. Foundation Skills: Scientific Applications of Mathematics

A.3, 4, 7. Basic mathematics conventions.

College Ready Description: Student understands ratios, proportions, percentages, and decimal fractions, and translates from any form to any other. Student uses proportional reasoning to solve problems. Student uses calculators, spreadsheets, computers, etc. in data analysis.

Evidence for Scoring: Student can rearrange equations to solve for useful quantities. Student can balance chemical equations.

B.1, 2. Mathematics as a symbolic language.

College Ready Description: Student carries out formal operations using standard algebraic symbols and formulae. Student represents natural events, processes, and relationships with algebraic expressions and algorithms.

Evidence for Scoring: Student writes a net ionic equation for a reaction.

F.1, 2. Scientific measurement.

College Ready Description: Student selects and uses appropriate Standard International (SI) units and prefixes to express measurements for real world problems. Student uses appropriate significant digits.

Evidence for Scoring: Student makes measurements with various devices and records the data with the correct number of significant digits. Student uses probes and a graphing calculator to take the pH measurement of a solution.

III. Foundation Skills: Scientific Applications of Communication

A.1. Scientific writing.

College Ready Description: Student uses correct applications of writing practices in scientific communication.

Evidence for Scoring: Student presents their knowledge in the form of a lab report. Student is able to communicate the experiment with narrative, graphs, and symbols, and using the appropriate scientific vocabulary.

B.2, 3. Scientific reading.

College Ready Description: Student sets up apparatuses, carries out procedures, and collects specified data from a given set of appropriate instructions. Student recognizes scientific and technical vocabulary in the field of study and uses this vocabulary to enhance clarity of communication.

Evidence for Scoring: Student follows the instructions in the Student Notes for setting up the experiment.

C.1. Presentation of scientific/technical information.

College Ready Description: Student prepares and presents scientific/technical information in appropriate formats for various audiences.

Evidence for Scoring: Student presents his or her results from an experiment. Student presents his or her conclusions and explains how collected evidence supports those conclusions.

VII. Chemistry

E.1, 2, 4. Chemical reactions.

College Ready Description: Student classifies chemical reactions by type and describes the evidence that a chemical reaction has occurred. Student describes the properties of acids and bases, and identifies the products of a neutralization reaction.

Evidence for Scoring: Student uses hydrogen ion or hydroxide ion concentrations to determine the pH of an acid or base solution. Student describes how titration is performed and how this process can be used to determine the concentration of an unknown acid or base solution.

G.1, 2. The mole and stoichiometry.

College Ready Description: Student understands the mole concept as well as molar relationships in reactions, stoichiometric calculations, and percent yield.

Evidence for Scoring: Student calculates percent yield, theoretical yield, or actual yield for a reaction.

I.2. Properties and behavior of gases, liquids, and solids.

College Ready Description: Student understands properties of solutions.

Evidence for Scoring: Student calculates the molarity of a solution.

Titration Probe – Scoring Instructions

Place a score (1-4) in each row of the scoring sheet corresponding to the student's college readiness level.

Exceeding College Ready (4): Substantially exceeds the performance expectations

College Ready (3): Shows proficiency in all of the performance expectations

Approaching College Ready (2): Meets only some of the performance expectations

Initiating College Ready (1): Does not yet meet the performance expectations

Suggested Grade Conversion:

This chart reflects equal weight given to each skill. As key cognitive skills, foundational skills, and discipline content knowledge are all important elements of college readiness, we recommend this grading approach. However, you may certainly choose to implement different weights to particular scales and assign a grade at your discretion.

Score	Grade		Score	Grade		Score	Grade		Score	Grade
48	100		39	89		30	80		21	73
47	99.5		38	87		29	79.5		20	72
46	99		37	86		28	79		19	71
45	98		36	85		27	78.5		18	70
44	97		35	84.5		26	78		17	68
43	96		34	84		25	77		16	66
42	95		33	83		24	76		15	64
41	93		32	82		23	75		14	62
40	91		31	81		22	74		13	60