Next Step TEST PREP

PCAT SUPER REVIEW

Acid-Base Chemistry and Solubility

Today's Agenda

- Welcome to this Super Review!
- Introduction
- Gen Chem Study Strategy
  - Acid-Base Chemistry
  - Solubility
- What Next?

Introduction

Sophia Stone

PCAT Content Manager

- **Tutored and taught for 8+ years**
- **Score 99th percentile on PCAT**

✓ **Next Step is a team of test prep and educational experts committed to excellence.**

Who Is Next Step?

- Began in 2009 as a tutoring company
- Focus on graduate admissions tests only
- Team of educational experts
- Helped over 50,000 students in Pre-Health admissions preparation

✓ We never stop improving our materials!

STUDENTS HAVE A CHOICE

Introduction to Super Reviews

Thanks for coming to today's review!

These sessions are meant to be:

- Interactive
- Problem-focused

✓ Think of a question after this review? Post in our forums at forum-nextsteptestprep.com

Getting Started:

1. Turn on your mic
2. Locate the hand-raise button
3. Locate the Question and Chat boxes
4. Let me know if you're having at tech issues!

Gen Chem Study Strategy

Next Step TEST PREP

Today we're going to focus on maximizing your gen chem performance. Let's reflect on our experiences with chemistry:

- *How do you typically study?*
- *What concepts have been difficult to master?*
- *What formulas and equations give you trouble?*
- *Have you found strategies that work for you?*

Gen Chem Study Strategy

Next Step TEST PREP

Connecting the dots

- *How does each topic relate to other gen chem concepts?*
- *What's the big picture?*

Start with the basics

- *Understanding periodic trends, stoichiometry, etc. helps build toward "harder" material*
- *Many students miss questions on "easy" topics*

Review, review, review!

Topic #1: Acid-Base Chemistry

Next Step TEST PREP

Strong acids to know

p prefix = –log

Acid-Base Chemistry

Next Step TEST PREP

How do you find the pH of a strong acid solution?

- *What is the pH of a 1 M solution of H_2SO_4?*

How do you find the pH of a weak acid solution?

- *The K_a of acetic acid is 1.8×10^{-5}. What is the pOH of a 0.05 M solution of acetic acid?*

$$HAc + H_2O \rightarrow Ac^- + H_3O^+$$

Acid-Base Chemistry

K_a = acid dissociation constant

K_b = base dissociation constant

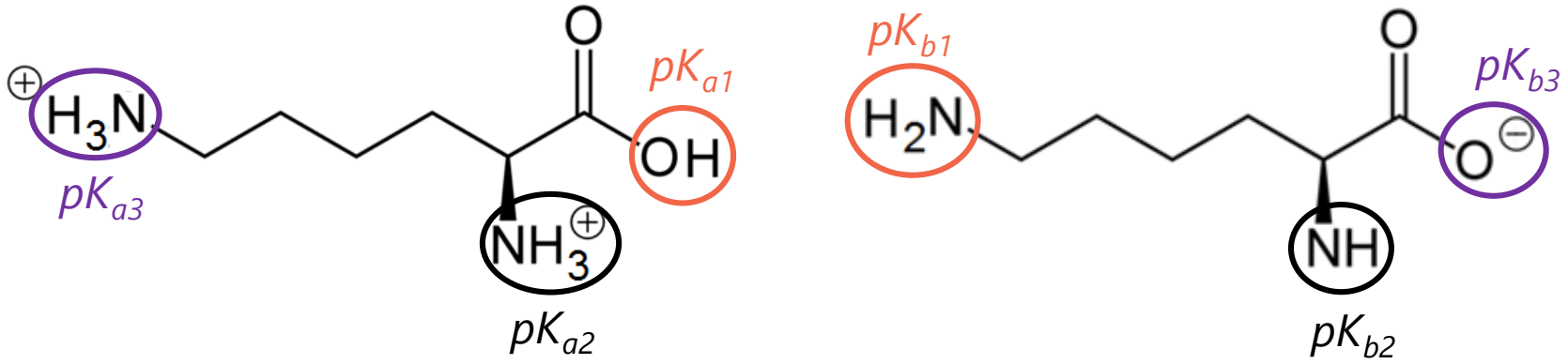
K_w = water ionization constant

What is the expression for the K_b of NH_3?

$K_w = K_a \times K_b$

of acid

of conjugate base



Acid-Base Chemistry

A student combines 50 mL of 0.80 M HF with 40 mL of 0.75 M KOH. The student predicts that the final pH of the solution will be greater than 7. What best explains the observation that a piece of blue litmus paper dipped into the beaker immediately turns red?

A. HF is a strong acid, making the pH of this solution lower than expected.

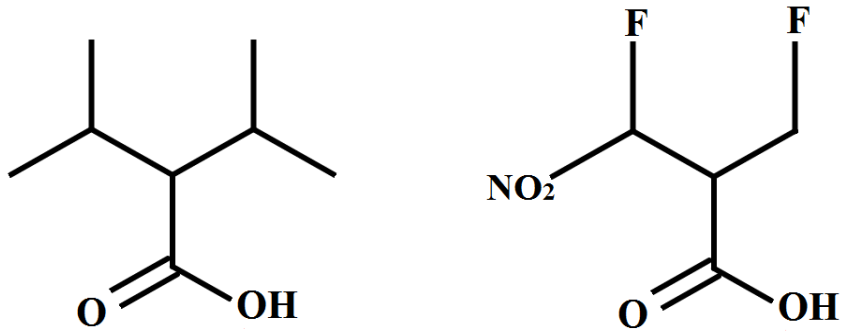
B. Since KOH is strong, it is the pOH of the solution that will be greater than 7, not the pH.

C. pH depends on the concentrations of H^+ and OH^-, regardless of acid and base strength, and the final solution contains more moles of H^+ than OH^-.

D. Blue litmus paper becomes red in basic solution.

Acid-Base Chemistry

The figure below shows two carboxylic acids. The acid with the lower pK_a is:



A. the acid on the left, due to the presence of additional alkyl groups.

B. the acid on the left, due to the stabilizing effects of resonance.

C. the acid on the right, due to the electron-donating substituents.

D. the acid on the right, due to the added inductive effect.

Buffers

Buffers resist changes in pH. How?

$$pH = pK_a + \log\frac{[A^-]}{[HA]}$$

- Imagine adding 1 mol HNO_3 to 1 L H_2O.

  Initial pH = 7

  Final pH = –log(1 M) = –log(10^0)

- Now imagine adding 1 mol HNO_3 to a 10 L solution containing 10 mol HCN and 10 mol CN^-.

  1 mol H^+ → protonates 1 mol CN^-

  pH hardly changes!

weak acid

conjugate base of the SAME weak acid

- When $[A^-] > [HA]$:
- When $[A^-] < [HA]$:
- When $[A^-] = [HA]$:

Buffers

Next Step TEST PREP

For carbonic acid, $K_{a1} = 4.3 \times 10^{-7}$ and $K_{a2} = 5.6 \times 10^{-11}$. What is the pH of a solution made with equimolar amounts of sodium bicarbonate and potassium carbonate?

A. 5.6

B. 6.37

C. 10.25

D. 11.44

Buffers

The pK_a of hydrofluoric acid is 3.14. What is the pH of a solution made by mixing 3 L of a 1.5 M solution of HF with 1 L of a 2.25 M solution of NaOH?

A. 1.50

B. 2.14

C. 3.14

D. 4.14

$$(3\ \text{L})(1.5\ \text{M}) = 4.5\ \text{mol HF}$$

$$(1\ \text{L})(2.25\ \text{M}) = 2.25\ \text{mol NaOH}$$

$$\text{HF} \rightleftharpoons \text{H}^+ + \text{F}^-$$

I

C

E

Titrations

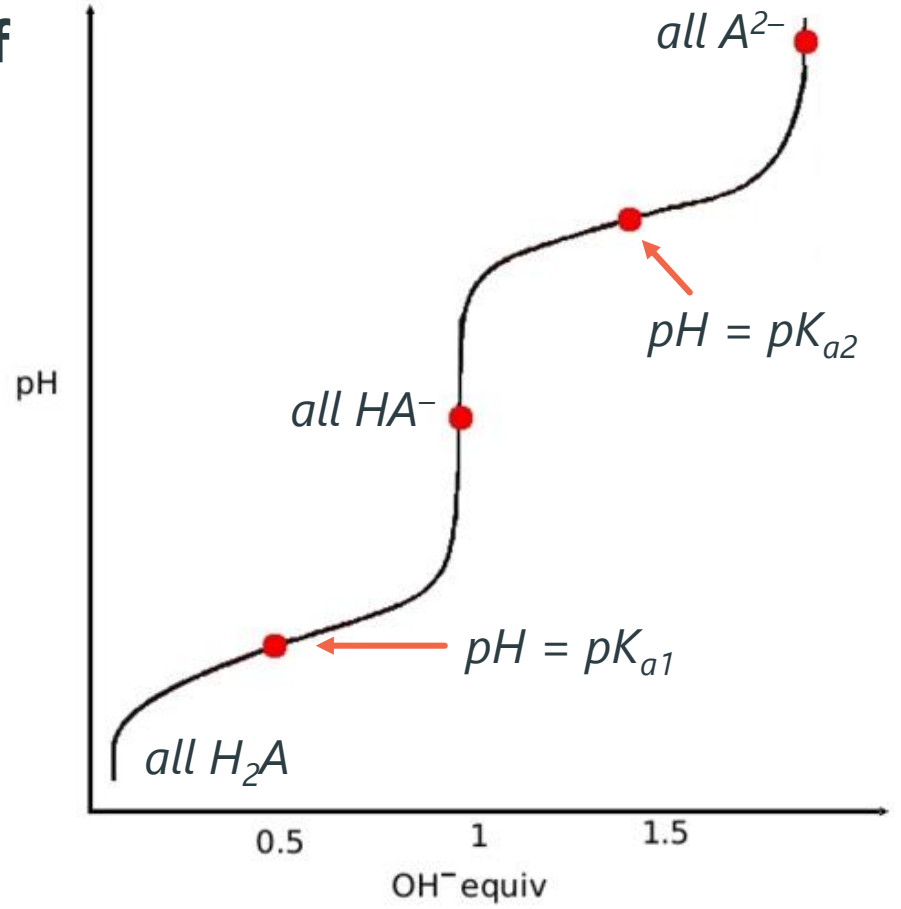
Titrations are used to measure the concentration of an unknown acid or base.

- Analyte = solution of unknown concentration
- Titrant = acid or base of known concentration

Understand the difference between an equivalence point and a half-equivalence point!

- mol original acid = mol conjugate base at…
- mol original acid = mol base added at…

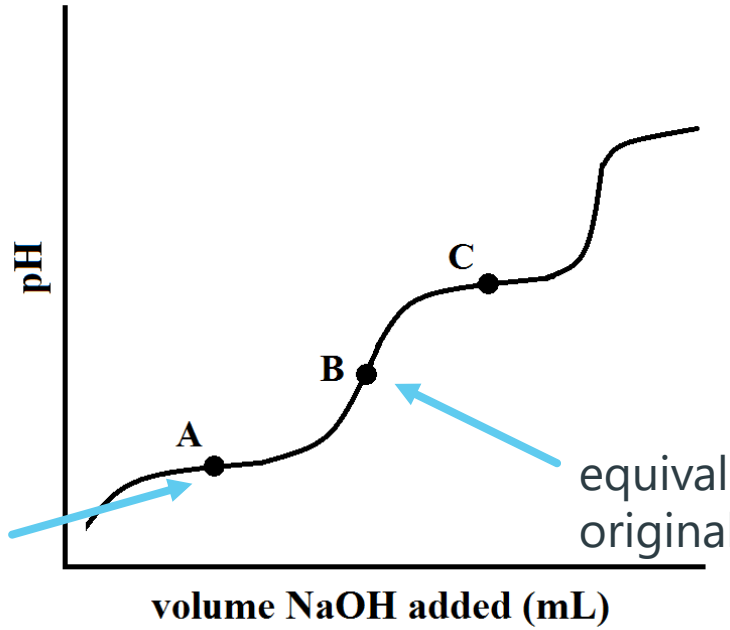
Imagine beginning with 1 L of 1 M H_2SO_4.



Titrations

Suppose 0.75 M H_2CO_3 is titrated with 2.25 M NaOH to generate the following titration curve. If the initial volume of H_2CO_3 was 500 mL, what volume of NaOH is required to reach point A on the curve?

A. 84 mL
B. 167 mL
C. 333 mL
D. 1000 mL



half-equivalence point
$pH = pK_a$

equivalence point
original moles of acid = moles of base added

$(0.75\ M)(0.5\ L) = 0.375\ mol\ H_2CO_3$

$(2.25\ M)(x) = 0.375\ mol\ NaOH$

$0.375 = (2.25\ M)(x)$

$x = 0.167\ L$ or 167 mL (at equiv. pt)

84 mL at half-equiv. point

Topic #2: Solubility

K_{sp} = solubility product

- *What factors affect K_{sp}?*
- *What factors do not change K_{sp}?*

Q = ion product (NOT at equilibrium)

- If Q < K_{sp}, solid will dissolve more
- If Q = K_{sp}, at equilibrium
- If Q > K_{sp}, solid will precipitate

Molar solubility = moles of solute that can dissolve in 1 L solvent

- Suppose AgCl dissolves in water.

$$AgCl\ (s) \rightarrow Ag^+\ (aq) + Cl^-\ (aq)$$

$$K_{sp} = [Ag^+][Cl^-]$$

Solubility

The K_{sp} of zinc phosphate is 9.0×10^{-33}. What is the molar solubility?

A. 1.5×10^{-7}

B. 4.6×10^{-9}

C. 3.0×10^{-11}

D. 2.1×10^{-11}

$$Zn_3(PO_4)_2 \rightarrow 3\ Zn^{2+} + 2\ PO_4^{3-}$$

$$K_{sp} = [Zn^{2+}]^3[PO_4^{3-}]^2 = 9.0 \times 10^{-33}$$

$$K_{sp} = (3x)^3(2x)^2 = 9.0 \times 10^{-33}$$

$$K_{sp} = (27x^3)(4x^2)$$

$$x^5 \approx 8.3 \times 10^{-35}$$

$$x \approx 1.5 \times 10^{-7}$$

Solubility

Next Step TEST PREP

Calcium oxalate, a salt found in large amounts in kidney stones, dissociates according to the equilibrium below.

$$CaC_2O_{4\,(s)} \leftrightarrow Ca^{2+} + C_2O_4^{2-}$$
$$K_{sp} = 2.7 \times 10^{-9}$$

If 5 moles of calcium oxalate are added to 1 L of distilled water, what concentration of oxalate ion will exist in solution?

A. 2.7×10^{-9} M
B. 5.2×10^{-5} M
C. 2.6×10^{-4} M
D. 1.7×10^{-3} M

$$K_{sp} = [Ca^{2+}][C_2O_4^{2-}] = 2.7 \times 10^{-9}$$

$$x^2 = 2.7 \times 10^{-9}$$

$$x = 5.2 \times 10^{-5}\ \text{M}$$

Next Step
TEST PREP

Q&A

Next Step Core Values

Educate Daily

Approachability

Authenticity

Professionalism

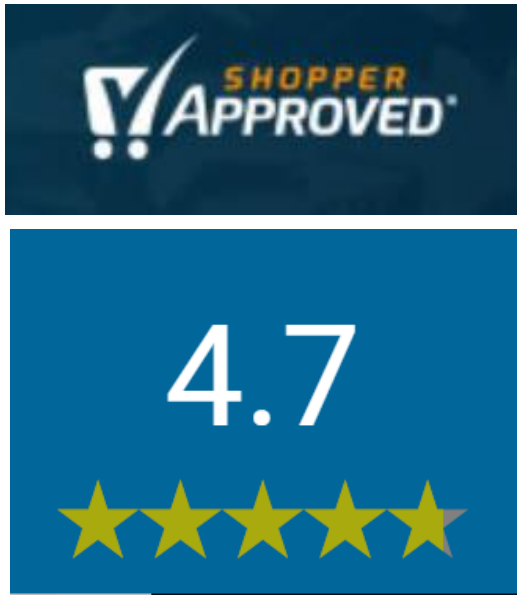
Ownership

We are dedicated to providing personalized support, advice, and prep options that match each student's individual needs.

Student Have a Choice

✓ Over 50,000 students have used Next Step Test Prep in their prep journey

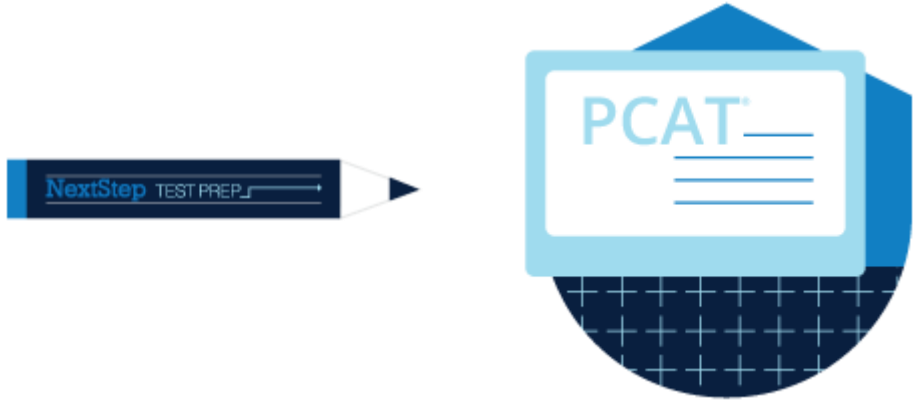
- Always up-to-date content, strategy and tests
- Guaranteed Satisfaction
- No call center – Academic Managers guide you all the way!
- Always updating our content based on announced changes and student feedback
- Are ensured the most up-to-date, realistic experience…always
- Access to Online Forum for additional live support from fellow students and NSTP Content Team



Personalized Options

- ✓ **No matter your study style, subject expertise, or PCAT goal, Next Step has an option for your personal needs and lifestyle.**

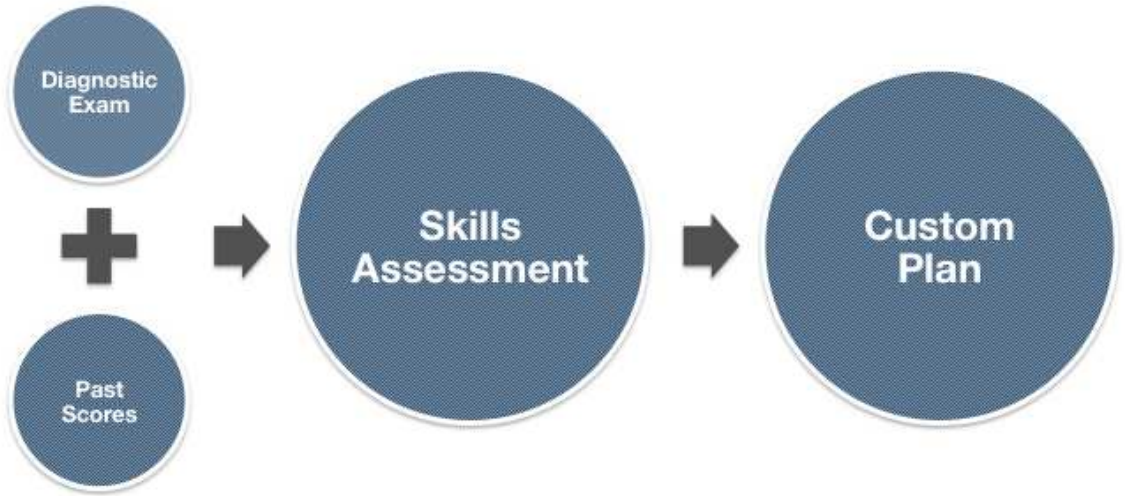
- **Free Practice Bundle Materials**
- **Self-Prep Materials and Planning**
- **Guided Online Study with Free Extra Help**
- **One-on-One Tutoring**



One-on-One Tutoring

- ✓ **No matter your study style, subject expertise, or PCAT goal, Next Step's Tutoring is personalized for YOU**

- **Tailored Study Plan**
- **Flexible Online Tutor Sessions**
- **Top-Scoring, Expert PCAT Tutors**

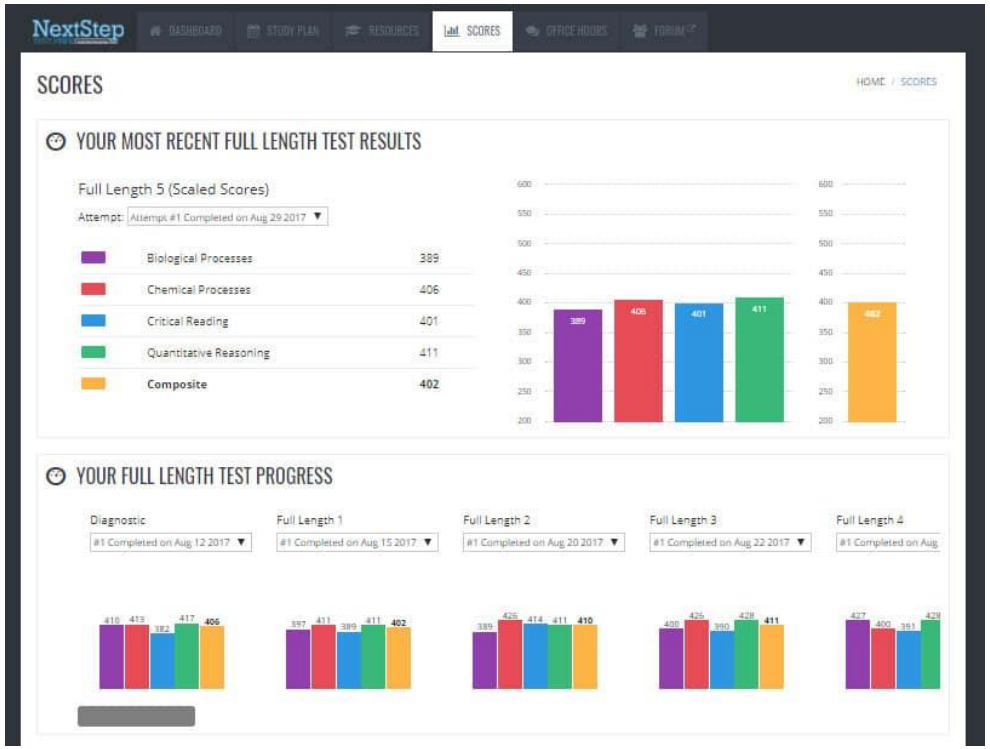


Unmatched Online Course

Next Step TEST PREP

✓ **Finally, a high-quality PCAT prep choice delivering personalization, flexibility, and affordability in an easy-to-understand platform and a score guarantee.**

- **One-On-One Orientation**
- **Exclusive Study Plan Generator**
- **Ongoing Live-Online Office Hours (2x/week)**
- **5 Full-Length PCAT Exams + Full-Length Diagnostic**
- **Review Book: 500+ pages**
- **Lesson Book: 200+ pages**
- **Lesson Videos: over 30 hours**
- **Content Videos: 50 videos with interactive quizzes**
- **11 QBanks with over 450 questions**
- **Expertise Built & Supported by 99th %ile instructors**
- **Best value – only $599**



Most Realistic Practice Exams

Next Step TEST PREP

✓ **Your testing experience matters. Practice with the most representative PCAT exam platform available.**

- **Free Full-Length Diagnostic**
- **5 Full-Length PCAT Exams**
- **Exclusive Study Plan Generator**
- **Lesson Book (print + online PDF)**
- **Review Book (print + online PDF)**
- **All 17 Lesson Videos**
- **All 50 Content Review Videos**
- **All Test Review Videos**
- **All Sections Exams**
- **Live Online Q&A Office Hours (2x/week)**
- **Online Forum Access**
- **Full Exam Bundle– only $99**

Next Step: Educate Every Day

✓ Get the ONLY FREE PCAT Practice Bundle

- Full-Length PCAT Diagnostic Test
- Diagnostic Test Review Video (4 segments)
- Lesson 1 from PCAT Online Course
- PDF Sample: Lesson Book for Lesson 1
- PDF Sample: Review Book for Chapters 1-3
- Content Review Videos
  - Scientific Method and Data Interpretation
  - Quantitative Reasoning: Math Skills I
  - Chemistry: Substitution and Elimination
  - Biology: Kidney Structure and Function
- Exclusive Study Plan Generator
- Free Public Q&A Office Hours & Webinars

Access your FREE PCAT Practice now!

nextsteptestprep.com/free-pcat-practice-bundle

Take the Best Next Step

Meet with an Academic Manager and build a strategy

- Discuss what works for you, from self-study to tutoring
- Personalize a Study Plan for YOU
- Plan around your study style and class/work schedule
- Speak with educational pros, not a call center

Attend free webinars

- Download the FREE PCAT BUNDLE and take the Diagnostic
- Take advantage of the free webinars and open Office Hours with a focus on PCAT subject reviews and strategy sessions

Let's Get Social

- Follow us on Facebook, Instagram and YouTube

Contact an Academic Manager for a free PCAT Consultation and plan your prep today!

nextsteptestprep.com/pcat-tutoring

Next Step
TEST PREP

Get Solid Advice for Your Next Step

CALL 888-530-6398 FOR A FREE CONSULT