# Web-based Proficiency Exams and Mastery Learning in Mathematics

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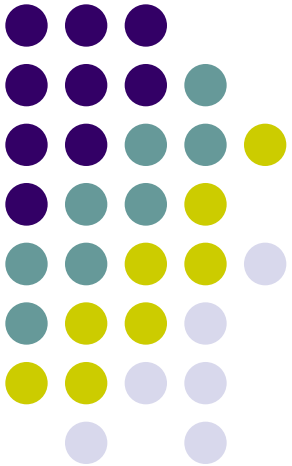
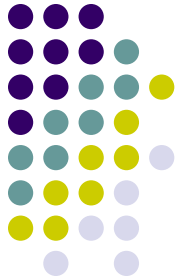
University of Nebraska - Lincoln

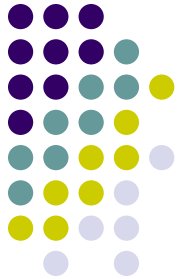


# Slides



http://www.math.unl.edu/~jorr/presentations

# Goal



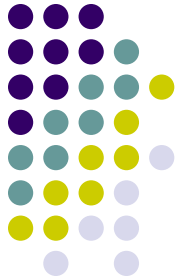
Answer the question:

What is an **Online Assessment Management System** and why use it?

- Definitions
- Examples
- Core Features
- Five practical problems

# Who Am I and Why Am I Here?

# What is an OAMS?



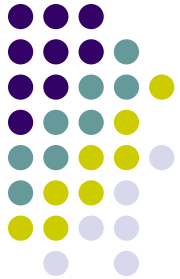
An Online Assessment Management System is web-based software to manage student assessment:

**Student:** Step through questions, answer questions, get grade report and feedback

**Instructor:** Write questions, assemble assignments, review grades

Varied question types and assignment types

# Examples



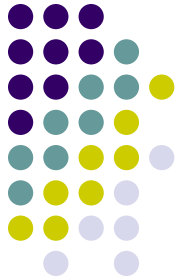
Some Online Assessment Management Systems include:

- Maplesoft's **MapleTA**
- Horizon Wimba's **EDU**

- **WebAssign** from North Carolina State U
- **WebWork** from Rochester U

- Wiley's **WileyPlus**
- Prentice Hall's **PHGradeAssist**

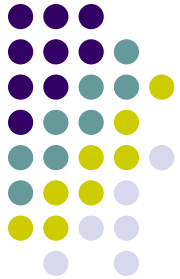
# Core Features



The core features of an OAMS are:

- Automated grading, immediate feedback
- Range of question types
- Range of assignment policies (quiz, homework, test, etc.)
- Web interface for students to browse questions
- Grade reporting for student and instructor (grade book)
- Tools to create new questions
- Administrative tools (user management)
- Interface with other web applications (CMS)

# Five Practical Problems



1. Students don't always remember all the material from previous courses.

2. Some students scrape through on partial credit who shouldn't.

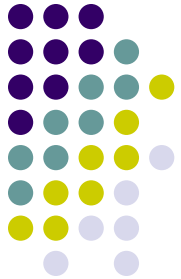
3. I have some students in my class who shouldn't be there.

4. I know what I said but I don't know what they heard.

5. My students don't all study as hard as I'd like them to.

# Five Practical Problems

# Five Practical Problems



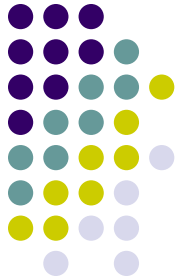
"Students don't always remember all the material from previous courses"

Practice more the first time

Learn it until you've mastered it

Review it until you're as good as you were (or better)

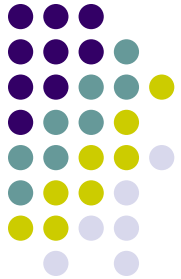
# Five Practical Problems



"Some students scrape through on partial credit who shouldn't"

Only award credit once they've mastered it

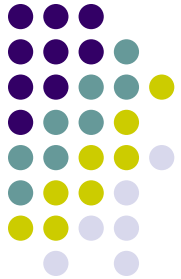
# Five Practical Problems



"I have some students in my class who shouldn't be there"

Placement testing

# Five Practical Problems

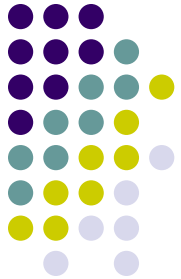


"I know what I said but I don't know what they heard"

"Just in time teaching" (www.jitt.org)

Pre-class warm-ups – with feedback loop

# Five Practical Problems

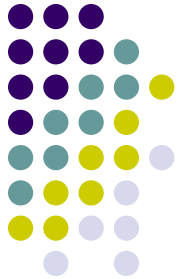


"My students don't all study as hard as I'd like them to"

"No pay/no play"

Increased time-on-task

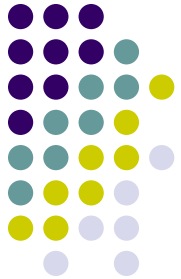
# Some Pedagogical Strategies



1. Mastery Learning
2. Just-in-time Learning
3. Adaptive Learning
4. Increased time-on-task

# A False Choice

# How Technology Can Help



In addition to

**Automated grading** and **Immediate feedback**

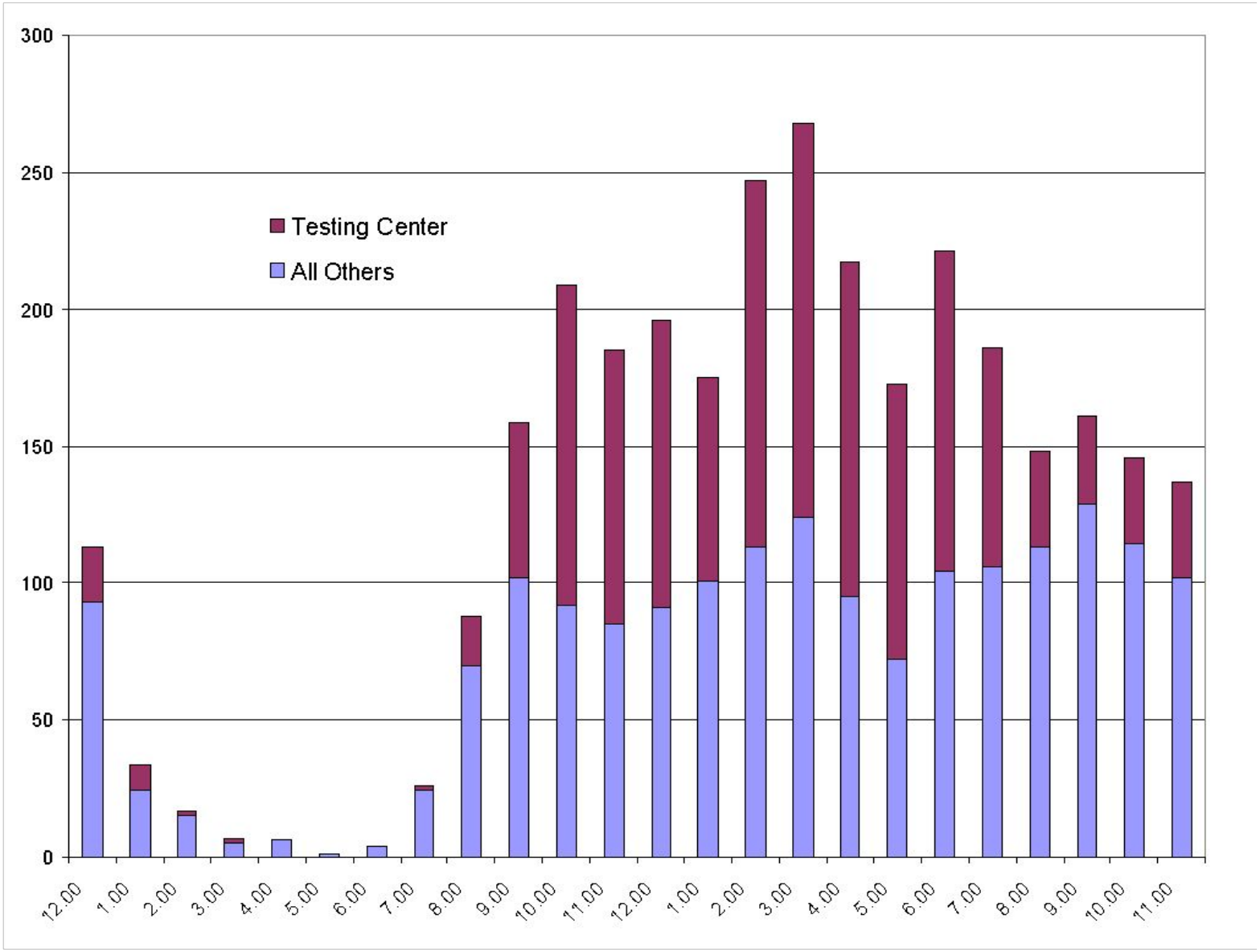
an OAMS can provide

**24/7 Access**

and

**Repeatable assignments**

# 24/7 Access


300
250
200
150
100
50
0
Testing Center
All Others
12.00
1.00
2.00
3.00
4.00
5.00
6.00
7.00
8.00
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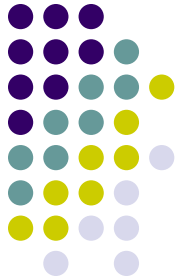
11.00

# Repeatable Assignments

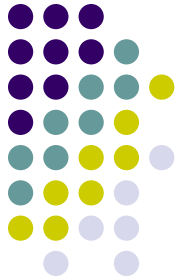


Each student on each attempt gets a different set of questions.

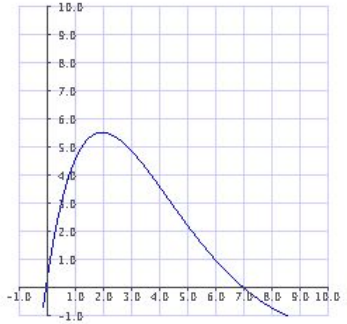
1. Permuted questions

2. Algorithmic questions

# Algorithmic Questions



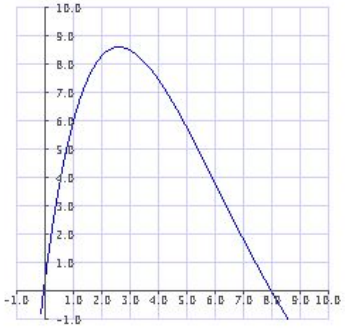
The graph below shows the function $f\left(x\right)=x\left(7-x\right)e^{-0.30x}$



Use Riemann sums on the graph to estimate $\int_0^7 f(x)\mathrm{dx}$

This question accepts numbers and formulas with units.
Help | Change Math Entry Mode | Preview

The graph below shows the function $f\left(x\right)=x\left(8-x\right)e^{-0.19x}$

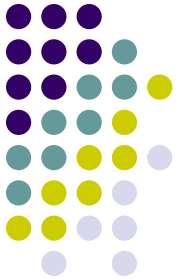


Use Riemann sums on the graph to estimate $\int_0^8 f(x)\mathrm{dx}$

This question accepts numbers and formulas with units.
Help | Change Math Entry Mode | Preview

```
$a = range(4, 9); $k = decimal(2, rand(1, 2));
$right = sum(x, 1, $a, x($a-x)e^(-$k x));
$low = $right - 3; $high = $right + 3;
```

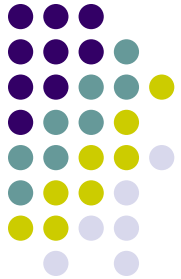
# Case Studies



Some ways we've used OAMS at Nebraska:

1. Gateway Exams
2. Placement Testing
3. Keller Plan
4. Homework

# Gateway Exams



Precalculus, Calculus 1, Calculus 2

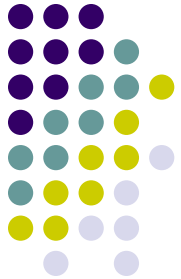
Require 80% fully correct for credit

Credit is 5% of course total

Daily retakes allowed for two weeks

Proctored exams and unlimited practice

# Placement Testing



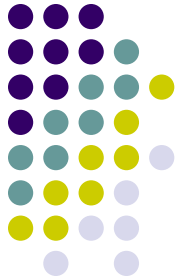
All incoming students take diagnostic test

Proctored from UNL or high school

Diagnostic assessment algorithm

(Maplesoft + MAA product)

# Keller Plan



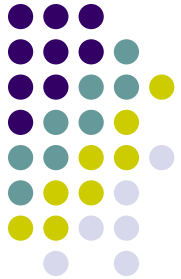
Self-paced introductory psychology course

Students progress through units by mastering tests

Tests mix multiple choice and essay

Both machine and human feedback available

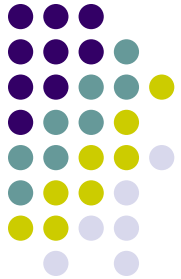
# Homework



Increased time-on-task

Publisher and home-grown content

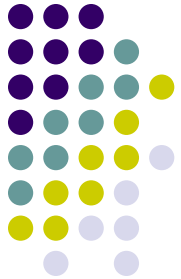
# Advantages/Disadvantages



Standardizes courses
+ Reduces grading work
+ Reduces grading budget
+ Enhances limited classroom time

- Administration
- Question creation

# EDU at UNL



Began project in 1996 at UNL

Developed **Wiley Webtests** and then **eGrade 1.0** for John Wiley & Sons

Developed **EDU** for Brownstone Learning (now Horizon Wimba)

Became core of Maplesoft's **MapleTA**

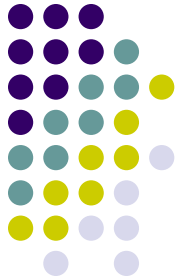
# EDU at UNL > Courses

| Fall 1996 | Spring 1997 | Fall 1997 | Spring 1998 | Fall 1998 | Spring 1999 | Fall 1999 | Spring 2000 |
|---|---|---|---|---|---|---|---|
| Math 106 | Math 106 | Math 103 | EdPs 860 | Curr 359 | Chem 110 | Astr 103 | Astr 103 |
| | Math 107 | Math 106 | Hist 201 | EdPs 859 | EdPs 860 | BioSci 230(X) | Bios 202 |
| | | Math 107 | Math 102 | Hist 201 | Hist 171 | BioSci 301 | Chem 109 |
| | | | Math 103 | Math 102 | Hist 201 | BioSci 418/818 | Chem 110 |
| | | | Math 106 | Math 103 | Hist 220 | Chem 109 | EdPs 860 |
| | | | Math 107 | Math 106 | Math 102 | Chem 110 | Geol 100 |
| | | | Phys 211 | Math 107 | Math 103 | EdPs 859 | Geol 101 |
| | | | | Math 208 | Math 106 | Geol 101 | Hist 120 |
| | | | | Phys 211 | Math 107 | Hist 100 | Hist 171 |
| | | | | Phys 211H | Math 208 | Hist 171 | Hist 201 |
| | | | | Psyc 296 | Phys 141 | Hist 201 | Lib 110 |
| | | | | Psyc 350 | Phys 151 | Math 102 | Math 102 |
| | | | | Psyc 461 | Phys 212H | Math 103 | Math 103 |
| | | | | | Psyc 296 | Math 104 | Math 104 |
| | | | | | Psyc 461 | Math 106 | Math 106 |
| | | | | | | Math 106H | Math 107 |
| | | | | | | Math 107 | Math 107H |
| | | | | | | Math 203 | Math 203 |
| | | | | | | Math 208 | Math 208 |
| | | | | | | Phys 141 | Math 208H |
| | | | | | | Phys 151 | Phys 212 |
| | | | | | | Phys 212 | Phys 212H |
| | | | | | | Phys 212H | Pols 100 |
| | | | | | | PolS 100 | Psyc 181 |
| | | | | | | Psyc 181 | Psyc 350 |
| | | | | | | Psyc 268 | Psyc 463 |
| | | | | | | Psyc 350 | Psyc 910 |
| | | | | | | Psyc 463 | Stat 180 |
| | | | | | | Psyc 975 | Stat 380 |
| | | | | | | | Thtr. Stud. |

*Fall 2003*

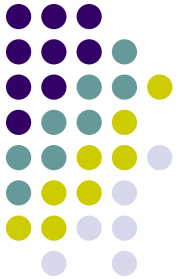
170 active classes set up

# EDU at UNL > Disciplines



Accounting
Ag. Marketing
Agro. & Hort.
Anthropology
Architecture
Astronomy
Biochemistry
Biological Sciences
Bio Systems Eng.
Children, Family & Law
Chemistry
Civil Engineering
Communication Studies
Computer Science
Const. Management
Curr & Instruction
Educational Psych.
Electrical Eng.
Entomology
Family & Consumer Science
Geography
Geosciences
History
Industrial Eng.
Libraries
Mathematics
Modern Languages
Natural Resource Sciences
Physics
Political Science
Psychology
School of Music
Veterinary Science
Lincoln High School

# EDU at UNL > Students



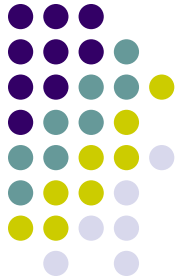
*Fall 2003*

| | |
|---|---|
| Student accounts: | 10,650 |
| Active (5+ sess.): | 7,075 |

*Spring 2004*

| | |
|---|---|
| Student accounts: | 8,863 |
| Active (5+ sess.): | 5,310 |

# EDU at UNL > Assignments



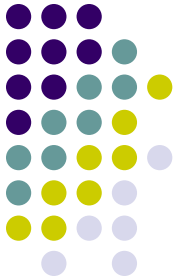
*Fall 2003*

Total assignments: 277,148
Daily average: 2,500

*Spring 2004*

Total assignments: 292,888
Daily average: 2,650

# EDU at UNL > Value Added

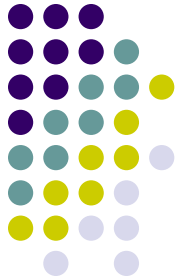


*Fall 2003*

Total assignments: 277,148
GTA hourly rate: $20
GTA assignments/hour: 10

Cost of human grading: $554,296

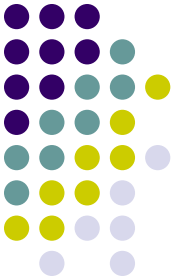
# OAMS for *Maths*



What's specific to math for online assessment?

- Grading formulas and expression on **content**; CAS
  - Powerful question types
- Mathematical **notation** in display and entry
- LaTeX or WYSIWG **question creation**
- Sophisticated algorithms (" `x+-2` ")

# Questions

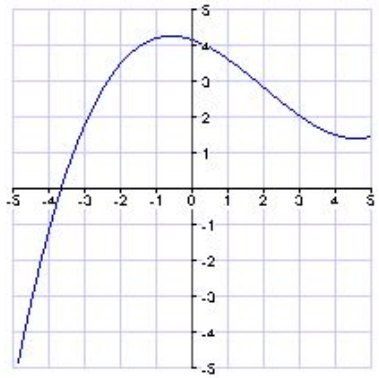


A dog is running at 3ft/sec for 20 seconds. How far does it run?

| | |
|---|---|
| | |
| Number | Units |

# Questions

Mark all those statements that are true for the function $f$ whose graph is depicted below.

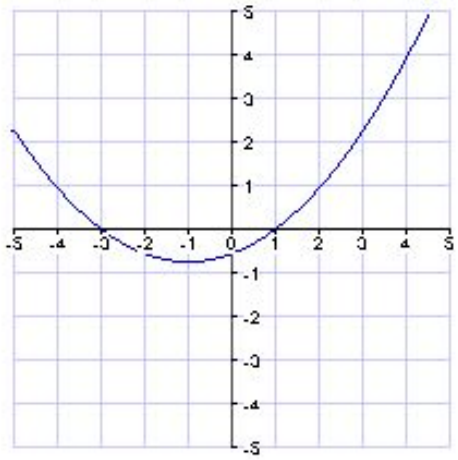



- ☐ $f''$ is negative at $x = 0$
- ☐ $f'$ is positive at $x = -4$
- ☐ $f$ is increasing at $x = 0$
- ☐ $f'$ is negative at $x = -2$
- ☐ $f'$ is decreasing at $x = -2$

Partial Grading Explained

# Questions

Use the graph of $f'$ shown below to determine the local extrema of $f$.

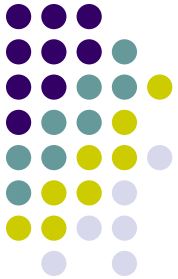



Find the local **maxima** of $f$.

Find the local **minima** of $f$.

[If there is more than one answer, separate them with semicolons.
If there are no answers, enter "-10".]

# Questions

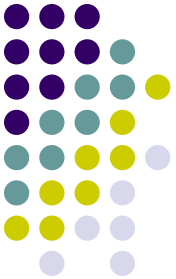


Find the derivative of $\left(7v^3 - v\right)(\cos(5v))$.

(21v^2 - 1)cos(5v) + (

This question accepts numbers or formulas.
Help | Change Entry Style | Preview

# Questions



Compute $\int \frac{e^x}{\sqrt{3-6e^x}}\,dx.$

(-1/3)(3-6e^x)^(1/2)

This question accepts numbers or formulas.Do not include a constant of integration in your answer.
Help | Change Entry Style | Preview

# Questions

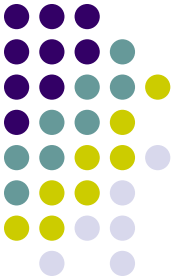
Give an example of a function f(x) which is increasing on the interval [0,10]. Enter only the expression for the function, omitting "f(x) =". Click Plot to verify that your function increases.

**Equation Editor** Help

$x^2 + \sqrt{x+1} +$

This question accepts numbers or formulas.
Plot | Help | Change Math Entry Mode

# Questions



Question:

This question concerns the integral of the function $x^{11}$.

**(a)**

In the first part, use a geometric argument to decide whether $\int_{-7}^{7} x^{11}\,dx$ is:

- ○ negative
- ○ zero
- ○ positive

**(b)**

In the second part, check your response by computing the integral.

**(i)** Evaluate $\int x^{11}\,dx$.

This question accepts numbers or formulas.
Help | Change Entry Style | Preview

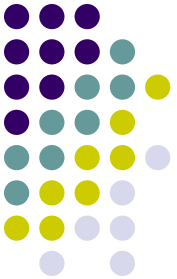
**(ii)** Use the indefinite integral above to compute $\int_{-7}^{7} x^{11}\,dx$

This question accepts numbers or formulas.
Help | Change Entry Style | Preview

**(c)**

The geometric argument in the first part was based on the fact that $x^{11}$ is an (Click for List) function.

# Questions



Find the closest point on the curve $f(x) = x^2 + 17$ to the point $(-37, 0)$.

(Note: you must get all parts right to get credit for this question.)

**(i)** Find a formula for distance squared between the indicated point and an arbitrary point on the curve.

This question accepts numbers or formulas.
Help | Change Entry Style | Preview

**(ii)** Why can we find the minimum of the distance squared instead of just the distance?

- In case the distance is negative, we will still get the correct answer because it is squared.
- A larger $d^2$ means a larger $d$ whenever $d$ is positive.
- Distance squared is simpler than just the distance.
- We want to avoid the square root when using distance.

**(iii)** Let $g(x)$ be the function that gives the distance squared. Find the derivative of $g(x)$.

This question accepts numbers or formulas.
Help | Change Entry Style | Preview

**(iv)** Find the critical number(s).

This question accepts numbers or formulas.
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**(v)** How do we know without additional calculation that the critical point is a minimum?

- It has to be a minimum otherwise this problem wouldn't work.
- g(x) is continuous and increases as $x \to \infty$ and $x \to -\infty$.
- g(x) is not continuous but increases as $x \to \infty$ and $x \to -\infty$.
- g'(x) is continuous and is always increasing.

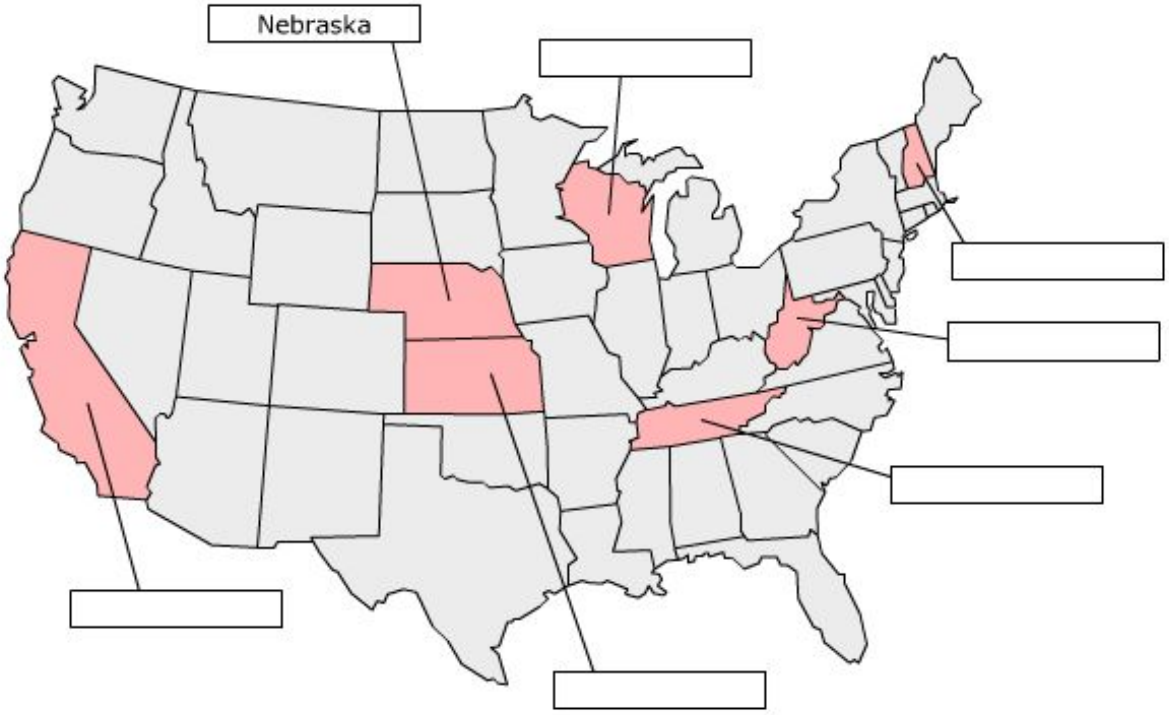
**(vi)** What are the coordinates of the point on the curve closest to the given point?

This question accepts answers that are in a form like "(-1,3)" or "(3,7,3z)".
The entries can be numbers or formulas.
Help | Preview

# Questions

**Question 10: (1 point)**

Identify the states in the diagram below.



# Questions

Question 7: (1 point)

Directions: Put the phases of the moon in reverse chronological order, from latest to earliest, starting with new moon.

Click here for background information on this problem

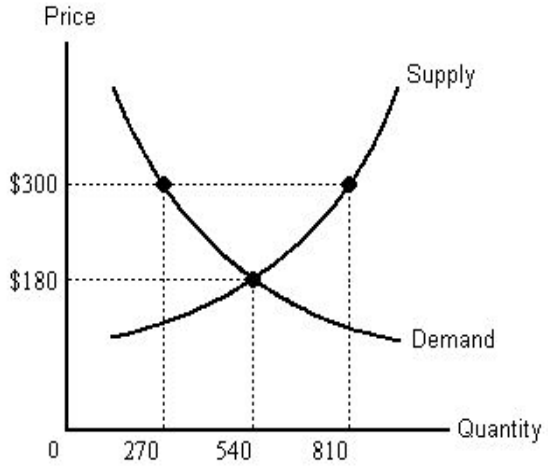
latest earliest

Grading Info

# Questions

**Question:**

Assume that the equilibrium price of corn is $180 as shown in the graph below.




**(a)** If a law is passed that forces the sales price of corn to be $300, how many units will be sold?

**(b)** What will be the total revenue generated by the sale of corn after the price increase? Do not include the dollar sign ($) in your response.

**(a)**

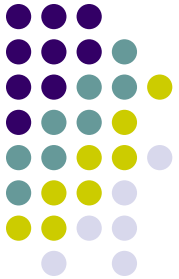
Preview

**(b)**

Preview

This question accepts numbers and formulas with units.
Help

# Demos



MapleTA 2.51

MapleTA 3.0 (Beta)

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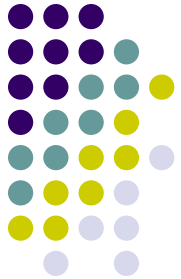
# Goal



**http://www.math.unl.edu/~jorr/presentations**