

## Some Assumptions from the Play

- The secretary was neither gnawed by rats nor clawed by cats.
- If a person smelled like Limburger, then that person was clawed by cats.
- If a person was in the faculty lounge, then that person would smell like Limburger.
- A person either didn't change his socks or he was in the faculty lounge at some point.
- A person with dry socks either didn't get his or her feet wet or changed his or her socks.
- Either the secretary's feet got wet or she was wearing shoes the whole time.
- Either the secretary took off her shoes or she entered the principal's office for a while.

# Statements

## Definition:

A *statement* is a sentence which is unambiguously true or false

For Example:

## Statements:

- George Bush is the president of the USA
- Jacques Chirac is the president of Thailand
- Mrs. Kerry is richer than Mr. Kerry
- All line segments have two endpoints
- All angles are less than 45 degrees
- Michael Andrew Flit of Parsons Ln is 5' 11"

## Non-Statements:

- Mike is tall
- $x = 13$
- Angle A is 22 degrees
- Segment X is longer than segment Y
- $p$  is prime

# Predicates

A *predicate* is an assertion involving an unknown quantity, called a *propositional variable*.

## Examples:

- $x = 13$
- Angle A is 22 degrees
- Segment X is longer than segment Y
- $p$  is prime

For every propositional variable mentioned in a problem, a *universe of discourse* must be given for that variable, indicating the set of values under consideration for that variable.

## Examples:

- $x$  is a real number
- A is an angle of some triangle
- X and Y are segments in the plane
- $p$  is a positive integer

# Predicates can Become Propositions

We can turn predicates into propositions by assigning a value to its variable(s).

## Examples:

“ $p$  is prime”

becomes a proposition if we let  $p = 20$ .

“The man is a millionaire”

becomes a proposition if we let “the man” be

“Mike Tyson, the famous boxer.”

# Quantification of Propositional Variables

We can also turn a predicate into a proposition by “quantifying” its variables with either “there exists” or “for all.”

## Examples:

“ $p$  is prime”

becomes a proposition if we say:

“For every value of  $p$ ,  $p$  is prime,” or

“There exists a value of  $p$  such that  $p$  is prime.”

“The man is a millionaire”

becomes a proposition if we say:

“Every man is a millionaire,” or

“Some man is a millionaire.”

Notice how in each case the resulting assertion is unambiguously true or unambiguously false.

Also note that there is, in each case, an underlying universe of discourse for the variables.

# Disjunctions

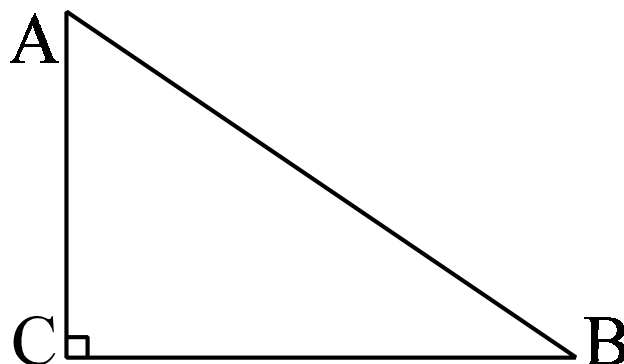
## Definition:

A *disjunction* is the assertion that at least one of two given statements is true.

Notice that disjunctions are statements, because the truth values of the two given statements determines the truth value of the disjunction.

## For example:

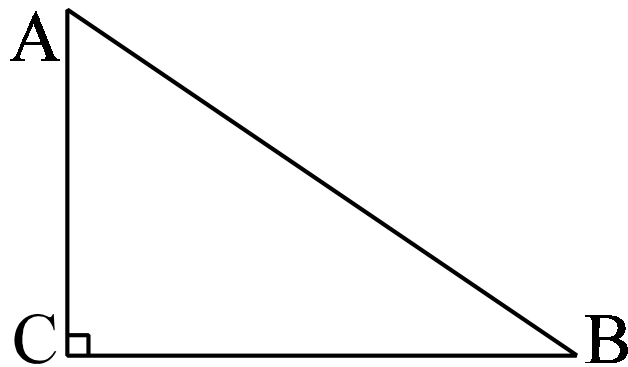
Angle A is at least 45 degrees	True
Angle B is at least 45 degrees	False
Angle A is at least 45 degrees or Angle B is at least 45 degrees	True



# Disjunctions

## Another Example:

Angle A is 90 degrees	False
Angle B 120 degrees	False
Angle A is 90 degrees or Angle B is 120 degrees	False



In this case the disjunction is false because each of its component statements is false.

# Conjunctions

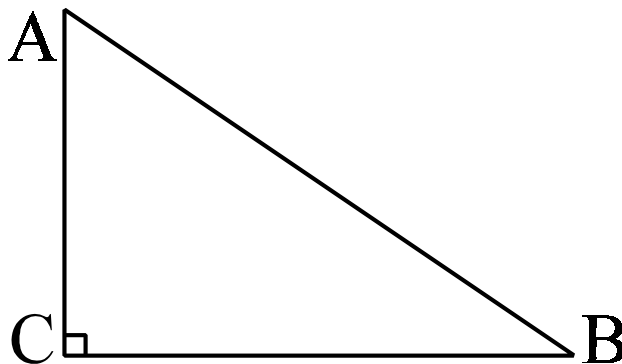
## Definition:

A *conjunction* is the assertion that both of two given statements are true.

Notice that conjunctions are statements, because the truth values of the two given statements determines the truth value of the conjunction.

## For example:

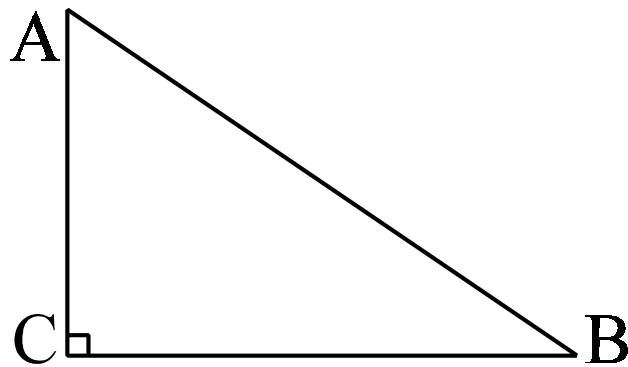
Angle A is at least 45 degrees	True
Angle B is at least 45 degrees	False
Angle A is at least 45 degrees and Angle B is at least 45 degrees	False



# Conjunctions

## Another Example:

Angle A is less than 100 degrees	True
Angle C is 90 degrees	True
Angle A is less than 100 degrees and Angle C is 90 degrees	True



In this case the conjunction is true because each of its component statements is true.

# Implications

## Definition:

An *implication* involves two statements, called the *premise*, or *hypothesis*, and the *conclusion*. It is the assertion that if the premise is true, then the conclusion must be true. It makes no claim in the case that the premise is false.

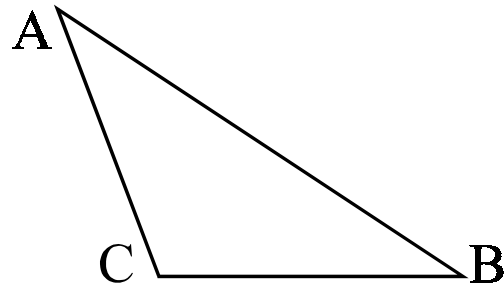
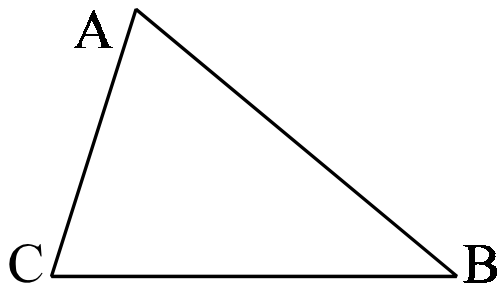
## Examples:

- If  $1 + 2 = 3$ , then  $1 > 0$

This is true, because the premise is true and the conclusion is true

- If  $\triangle ABC$  is acute, then  $\angle CAB$  is less than  $90^\circ$ .

Here are two different triangles ABC:



The implication is true in both cases. In the second case, we say it is “vacuously” true.

# Implications

We rig implications to be propositions by calling them “true” whenever the premise is false. This turns out to be the natural thing to do.

## Better Way to Think of it

An implication is false if the premise is true but the conclusion is not. That is, if “a promise is made, but not kept.”

### Example:

What would make the following implication false:

- If you give me \$100, then I will make sure you pass this class

It is demonstrably false only when the premise is true but the conclusion is false.

Otherwise we say the implication is true.

# Negations

The negation of a statement is the assertion that the statement is false.

Note that the negation of a statement is another statement, having the opposite truth value of the original statement.

## **Example:**

Statement: John is tall.

Negation: John is not tall.

In English you can always form the negation of a statement by putting the phrase “It is not the case that” at the beginning. There are often more natural ways to negate a statement, though.

Statement: John is rich or John is handsome.

Negation: It is not the case that John is rich or  
John is handsome

Better: John is neither rich nor handsome

# Syllogisms

A syllogism is an abstract logical argument.

## Examples:

1. If an implication is true and its premise is true, then its conclusion must be true.
2. If the disjunction of two statements is true and the first statement is false, then the second statement must be true.
3. If an implication is true and its conclusion is false, then its premise must be false.
4. If two implications are true, and the conclusion of the first is the premise of the second, then the premise of the first implies the conclusion of the second.
5. If the conjunction of two statements is true, then each of the statements is true.

# Syllogisms in Action

Here are two statements:

- The secretary was neither gnawed by rats nor clawed by cats.
- If a person smelled like Limburger, then that person was clawed by cats.

What can we conclude?

Observe that “nor” means “and also not,” so that the first statement is really a conjunction of “The secretary was not gnawed by rats,” and “The secretary was not clawed by cats.”

Since the conjunction is true, we can conclude that each component statement is true. In particular, we can conclude that the secretary was not clawed by cats.

Then by syllogism “3” on the previous slide, we can conclude that the secretary did not smell like Limburger.

# Syllogisms in Action

Here are two statements:

- The secretary did not smell like Limburger.
- If a person was in the faculty lounge, then that person would smell like Limburger.

What can we conclude?

By the same reasoning, we can conclude that the secretary had not been in the faculty lounge.

Here are two statements:

- The secretary was not in the faculty lounge.
- A person either didn't change his socks or he was in the faculty lounge at some point.

By rule "2" on that slide, we can conclude that the secretary did not change her socks at any point.

## And So On...

- The secretary had dry socks and had not changed her socks.
  - A person with dry socks either didn't get his or her feet wet or changed his or her socks.
- 
- ∴ The secretary did not get her feet wet
- The secretary did not get her feet wet
  - Either the secretary's feet got wet or she was wearing shoes the whole time.
- 
- ∴ The secretary was wearing shoes the whole time
- The secretary was wearing shoes the whole time
  - Either the secretary took off her shoes or she entered the principal's office for a while.
- 
- ∴ The secretary entered the principal's office.
- If the secretary was in the principal's office during the blackout, then she is the guilty party
  - The secretary was in the principal's office
- 
- ∴ The secretary is the guilty party

# The Symbols of Logic

We've already seen “ $\therefore$ ” used to mean “therefore,” signifying the conclusion of our argument.

It is also customary to express:

- Propositions with capital letters:  $P, Q, R, \dots$
- Propositional variables with lowercase letters in italics:  $x, y, z, \dots$
- Predicates as functions:  $P(x), R(y, z), \dots$
- Implications with arrows:  $P \rightarrow Q$
- Disjunctions with this symbol: “ $P \vee Q$ ”
- Conjunctions with this symbol: “ $P \wedge Q$ ”
- Negation with this symbol: “ $\neg P$ ”
- “For all” with “ $\forall$ ” and “there exists” with “ $\exists$ ”

# Symbolic Form of Syllogisms

<p>If an implication is true and its premise is true, then its conclusion must be true.</p>	$\frac{P \rightarrow Q \quad P}{\therefore Q}$
<p>If the disjunction of two statements is true and the first statement is false, then the second statement must be true.</p>	$\frac{P \vee Q \quad \neg P}{\therefore Q}$
<p>If an implication is true and its conclusion is false, then its premise must be false.</p>	$\frac{P \rightarrow Q \quad \neg Q}{\therefore \neg P}$
<p>If two implications are true, and the conclusion of the first is the premise of the second, then the premise of the first implies the conclusion of the second.</p>	$\frac{P \rightarrow Q \quad Q \rightarrow R}{\therefore P \rightarrow R}$
<p>If the conjunction of two statements is true, then each of the statements is true.</p>	$\frac{P \wedge Q}{\therefore P, Q}$

# Names of Syllogisms

Modus Ponens	$P \rightarrow Q$ $P$ <hr style="width: 100%;"/> $\therefore Q$
Disjunctive Syllogism	$P \vee Q$ $\neg P$ <hr style="width: 100%;"/> $\therefore Q$
Modus Tollens	$P \rightarrow Q$ $\neg Q$ <hr style="width: 100%;"/> $\therefore \neg P$
Hypothetical Syllogism	$P \rightarrow Q$ $Q \rightarrow R$ <hr style="width: 100%;"/> $\therefore P \rightarrow R$
Simplification	$P \wedge Q$ <hr style="width: 100%;"/> $\therefore P, Q$

Note: In some books, “Hypothetical Syllogism” is called “The Law of Syllogism,” and what we are calling “syllogisms,” they call “arguments.”

# Resolution

Resolution	$P \vee Q$
	$\neg P \vee R$
	<hr/>
	$\therefore Q \vee R$

The ‘resolution’ syllogism is commonly used in artificial intelligence systems to help draw conclusions.

Notice that the conclusion of this syllogism is a compound proposition, as is the case for hypothetical syllogism.

## Handout #1 — The Mystery

Narrator: It was a typical but stormy school day in western Nebraska when Mr. Heinz, the principal of Central Private, received what all the school's teachers agreed was a much-needed and well-deserved wedgie. Here's the story:

It was about 9am when the sky started to turn dark and the rain began to fall. By 10 the rain had become a deluge and the thunder from the clouds was shaking the chalk from the blackboards. The usual holes in the roof had performed well this storm, and there was not a dry spot of floor in the entire school. Nobody was surprised when the big oak tree blew down in the playground behind the school. And nobody was surprised when the lights went out at Central Private. But some eyebrows were definitely raised when about a hundred medium-sized white lab rats came running down the main hallway toward the teachers' lounge. Everyone figured they were heading toward the teachers' lounge. That part was not surprising. Nor was the fact that they were lab rats and over a hundred in number. The school had kept them for years to accommodate the brilliant but peculiar chemistry teacher with her chromomorphism theories. But white? That surprised everyone. Had she finally succeeded in her chromodepletion experiments? It was probably because of the several dozen stray cats that came next that nobody immediately realized how interesting it was to be able to see lab rats, even white ones, in the pitch black. That should have been surprising.

But our story does not concern cats, rats or wet floors. What we're here to talk about is the piercing scream that came from room 299 precisely 20 seconds before the lights came back on. No fingerprints were found. No witnesses were there. Someone, it seemed, had pulled the perfect crime.

*(In what follows, "Everyone" means "all characters in the play except for Mr. Hero.")*

Everyone: Who are you?

Hero: My name is Poicule. Hero Poicule. I am here to uncover the identity of the perpetrator of this foul crime. After lengthy discussions with the bulk of the staff I have determined that the perpetrator is to be found among the seven of you. Although there does not seem to be a person in this school who feels the crime was undeserved, you seven were mentioned as people particularly interested in seeing this happen. So I have assembled you here and soon I shall know the identity of our cheeky criminal. Everyone has denied being in the principal's office during the blackout, but clearly somebody was in there. I will therefore assume that if I can find the person who was in the principal's office, I will have found the guilty party. Let us begin with you, Ms. Acorn. Where were you when the crime was committed?

Ms. Acorn: I was at the desk in my classroom, thank you very much.

Hero: And how far is that from the principal's office, room 299?

Ms. Acorn: It is clear at the other end of the school. About five minutes before the lights went out I was in Mr. Heinz' office discussing a problem student. That took only a minute or two, and then I went straight to my room. Well, as straight as possible. The whole school was covered in water you know, and I was trying not to get my feet wet. Well, that was just impossible since

I was wearing penny loafers, so I had to trudge through the puddles and try not to think about the damage.

Hero: I don't mean to imply anything. But Ms. Acorn, your socks are dry.

Ms. Acorn: Well aren't you just a regular Sherlock Holmes. Maybe you've noticed that the seven of us *all* have dry socks.

Hero: In fact, I have noticed that, and I was hoping you'd tell me how you managed this little feat?

Mr. Brass: It was in 1988 that our fair school first sprang a leak in its roof and dripped water down onto the floor. The administration always placed a higher priority on education than maintenance, proudly told anyone who asked, and so the leak was simply dealt with instead of repaired until the end of the school year. Well, administration was so happy with the money they had saved that they made it official building policy not to make repairs as long as there was some book that needed to be bought or some teacher needing a manipulative. Except for the principal's office, which got carpet two years ago. Did you know his office was the only carpeted room in the entire building? But that's off topic, what was I talking about? Repairs! Right. That's why our school floods every time it rains now. Well, there was a time back in '97 when some teachers got together and...

Hero: (ahem) thank you Mr. Brass for the, uh, history. But about your socks...

Mr. Brass: What? Oh, yes. That. We all keep spares in a big locker in the faculty lounge.

Hero: Thank you. And may I assume that you all put on spare socks from the faculty lounge before I got here?

Ms. Acorn: Certainly not. Take little Miss Totty here (*points to the Secretary*). She wears high shoes so her feet won't get wet.

Hero: So if I have this right, I can assume that everyone either changed their socks or never got their feet wet.

Everyone: Right!

Hero: And I may assume that the flooding was complete enough that everybody either had high shoes on or got wet feet?

Everyone: Yes!

Hero: Mr. Brass.

Mr. Brass: Yes, Mr. Hero?

Hero: Mr. Brass. Where else do faculty keep their spare socks?

Mr. Brass: Oh. Now that is a very interesting question. We had a meeting about this back when I

started working here. It seems that at first, faculty were keeping their spare socks all over this school. A few in this desk, a few in that locker. Some in the principal's office, some in his secretary's office...

Secretary: Oh, thank goodness those days are gone!

Mr. Brass: ...some in the bathrooms. It was very disorganized. It was suggested by some of the gym teachers that...

Hero: Today! Where do the faculty keep spare socks *today*?

Mr. Brass: Only in the faculty lounge. It's the rule. Never broken.

Hero: So if I have this right, I can assume that either a person didn't change his or her socks, or he or she was in the faculty lounge.

Everyone: Right!

Hero: Mr. Brass, what happened to your pants?

Mr. Brass: I was clawed by cats. Because I smelled like Limburger.

Hero: Does this happen often?

Mr. Flit: To those of us who smell like Limburger. There were these cats today...

Hero: I heard about the cats. Okay. Can I assume that anyone who smells like Limburger today was clawed by cats?

Everyone: Yes!

Hero: Thank you. (*Turning to the secretary*) And you are the secretary to the principal?

Secretary: That's correct. If you can call him that. He doesn't *have* any.

Hero: Any what?

Secretary: The man has no people skills, no sense of what makes a good teacher; he wouldn't recognize a good policy if it slapped him in the face. Or a good secretary.

Hero: Perhaps he hasn't had the chance... Mr. Dimple, I see your socks are dry. May I assume that you changed yours in the faculty lounge?

Mr. Dimple: Certainly not! I avoid that room like the principal avoids parents. Ever since Ms. Acorn let her Limburger go bad in that room I've been unable to go anywhere near it.

Ms. Acorn: One pound! One *little* pound!

Ms. Gable: You can't go into that room without smelling like Limburger the rest of the day. No. I like to wear high shoes so that I never get my socks wet, and I never have to go near that faculty lounge. See what happened today, with the cats and the rats. Look at their clothes (*gestures to those standing around her*).

Hero: Yes, I'd like to come back to that. But first, may I assume that anyone who entered the faculty lounge today smells like Limburger?

Everyone: Yes!

Hero: Mr. Eagle.

Mr. Eagle: Mr. Hero.

Hero: What are those marks on your shoes. They don't look like claw marks.

Mr. Eagle: They are bite marks.

Hero: You were not clawed by cats?

Mr. Eagle: No. I was gnawed by rats.

Hero: Were all of you "gnawed by rats?"

Acorn, Brass, Dimple, Eagle, Flit: Yes.  
Gable, Secretary: No.

Hero: Ms. Gable?

Ms. Gable: I managed to avoid the cats, thank goodness. This pant suit would surely have been torn to shreds if I hadn't. I was out in the hallway near the principal's office when the cats went charging by. I was just able to get out of their way; and thank goodness I didn't smell like Limburger.

Hero: May I ask how you dodged the cats?

Ms. Gable: Strangest thing. Luckiest thing, really. Little miss Secretary's chair was out in the hallway, so I climbed onto it.

Secretary: Yeah! And the whole time this cat and rat thing was going on I was looking all over the place for my chair.

Mr. Dimple: No you weren't!

Secretary: What do you mean?

Hero: Yes. Please. What do you mean?

Mr. Dimple: Your shoes, lady! You've been driving me nuts for years with those shoes. (*Turns to Hero.*)  
Mr. Hero... I have the office across the hall from the principal and his secretary here, and every day my patience, (and I'm a patient guy — ask my therapist), my patience is sorely challenged with this “clip, clop, clip, clop, clip, clop, clip, clop” from Ms. Secretary here. And if she was walking around looking for her chair, I would have heard it. I would have *felt* it. I would not have this very distinct and very real memory of a minute of peace while those shoes were *not* making noise, just before the lights came back on.

Hero: Ms. Secretary. Will you please walk around a bit for us?

Secretary: *clip, clop, clip, clop, ...*

Hero: And would you mind doing the same thing in the principal's office, please?

Secretary: What a silly idea. But I'll do it just to humor you. *no clip, no clop, no clip, no clop...*

Mr. Eagle: Oh, this proves nothing! She may have taken off her shoes (they are rather expensive) so they wouldn't get wet.

Hero: Indeed! Indeed, indeed, indeed. So I can assume that during the time of the crime, Ms. Secretary was either in the Principal's office or she was walking around with no shoes on.

Everyone: Right!

Hero: Okay. Thank you very much everyone for your cooperation. You are all free to go about your business. I will see that the person who committed this wedgie is brought to justice. Good day!

Narrator: Mr. Hero thanks everyone, and they disperse. Minutes later a loud shriek is heard coming from one of their offices, followed by the emergence of a stern-faced Mr. Hero. Some workplace crimes merit suspension, a reprimand or termination, according to a well-defined code. But for those that fall through the cracks, justice must be taken into our own hands.

Mr. Flit: There's something I still don't understand. How did the rats get out, how did they turn white, and how were we able to see them in the dark? Ms. Acorn?

Ms. Acorn: Hey, if you're looking for closure, take a literature class...



## Exercises — Syllogisms

### Presentation Problems:

1. Find two examples of the “resolution” syllogism in the play. The conclusions should be disjunctions of terms which are not negated. Identify the propositions in each case, and represent the syllogism symbolically.
2. Identify two instances of modus tollens in today’s play.
3. Identify an instance of hypothetical syllogism in today’s play.
4. Suppose that  $P \rightarrow Q$ ,  $Q \rightarrow R$  and  $R \rightarrow S$  are all true. What assertion about  $S$  would lead us to conclude that  $P$  is false? How do you prove your claim?
5. Assuming that  $\neg A \rightarrow B$ ,  $A \rightarrow (C \rightarrow D)$  and  $E \rightarrow \neg B$  are all true, show that  $E \rightarrow (C \rightarrow D)$  is true, or find values for each of the variables so that the premises are true but the conclusion is false.
6. Assuming that  $(A \rightarrow B) \rightarrow C$ ,  $D \rightarrow E$ ,  $\neg D \rightarrow \neg C$  and  $\neg E$  are all true, show that  $\neg(A \rightarrow E)$  is true.
7. Assume that “If I love you, then I will give you flowers” is true. Which of the following must also be true:
  - a. If I give you flowers, then I love you.
  - b. If I don’t give you flowers, then I don’t love you.
  - c. If I don’t love you, then I don’t give you flowers.If you say that an assertion must be true, justify your answer. If not, explain circumstances under which the assertion might be false.

### Extension Problem:

Here are some axioms of geometry:

- A straight line segment can be drawn joining any two points.
  - Any straight line segment can be extended indefinitely in a straight line.
  - Given any straight line segment, a circle can be drawn having the segment as radius and one endpoint as center.
  - All right angles are congruent.
  - If two lines are drawn which intersect a third in such a way that the sum of the inner angles on one side is less than two right angles, then the two lines inevitably must intersect each other on that side if extended far enough.
8. Use these to prove that it is possible to construct an equilateral triangle given a segment which is one of its sides.
  9. Prove that given two lines  $l$  and  $m$  which intersect at point  $A$ , and another point  $B$  on  $l$ , that it is possible to construct a third line through  $B$  which makes the same angle with  $l$  as  $m$  does.

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# Discrete Math Resource Book

## on

# Syllogisms

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### Workshop Outline — Syllogisms

#### I. The Play

- A. Introduction to Syllogisms
  - 1. Rules for drawing conclusions from premises
  - 2. In words, not symbols
- B. The proof requires a chain of deductions beginning with the testimony of seven witnesses, whose accounts are assumed to be true, and concluding with the assertion that the secretary did it.
- C. Each step in the proof requires a formally valid argument.
  - 1. An argument is a logical structure for drawing conclusions from premises.
  - 2. It is independent of the actual semantic content of either the premises or the conclusion, which may change from argument to argument, while the argument remains the same
  - 3. These arguments are called “syllogisms.”

#### II. Formalism

- A. Some definitions
  - 1. A *statement* (also called a *proposition*) is an assertion which is unambiguously true or false
  - 2. A *predicate* (also called a *propositional function*) is an assertion involving some unknown quantity or quantities
    - a. The unknowns are called *propositional variables*
    - b. Each propositional variable must have an associated, and explicitly stated or implicitly understood *universe of discourse*, which is the set of values under consideration for that variable
  - 3. A *syllogism* is an assertion that a particular conclusion must be true as long as some particular premises are true
    - a. For example, if we assume “Bill is tall” and “If Bill is tall, then Bill is rich” are both true, then the law (syllogism) called “modus ponens” allows us to conclude that “Bill is rich” is true.
- B. We can turn predicates into propositions in two ways
  - 1. By substituting a value in for the variable
  - 2. By quantifying, universally with “for all” or existentially with “there exists”

#### III. Letters

- A. Finally, we use letters to stand for our propositions, predicates and variables
- B. To get expressions such as  $(P \wedge Q) \rightarrow (P \rightarrow R)$

# The Mystery

Narrator:

It was a typical but stormy school day in western Nebraska when Mr. Heinz, the principal of Central Private, received what all the school's teachers agreed was a much-needed and well-deserved wedgie. Here's the story:

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Ms. Acorn: I was at the desk in my classroom, thank you very much.

Hero: And how far is that from the principal's office, room 299?

Ms. Acorn: It is clear at the other end of the school. About five minutes before the lights went out I was in Mr. Heinz' office discussing a problem student. That took only a minute or two, and then I went straight to my room. Well, as straight as possible. The whole school was covered in water you know, and I was trying not to get my feet wet. Well, that was just impossible since I was wearing penny loafers, so I had to trudge through the puddles and try not to think about the damage.

Hero: I don't mean to imply anything. But Ms. Acorn, your socks are dry.

Ms. Acorn: Well aren't you just a regular Sherlock Holmes. Maybe you've noticed that the seven of us *all* have dry socks.

Hero: In fact, I have noticed that, and I was hoping you'd tell me how you managed this little feet?

Mr. Brass: It was in 1988 that our fair school first sprang a leak in its roof and dripped water down onto the floor. The administration always placed a higher priority on education than maintenance, proudly told anyone who asked, and so the leak was simply dealt with instead of repaired until the end of the school year. Well, administration was so happy with the money they had saved that they made it official building policy not to make repairs as long as there was some book that needed to be bought or some teacher needing a manipulative. Except for the principal's office, which got carpet two years ago. Did you know his office was the only carpeted room in the entire building? But that's off topic, what was I talking about? Repairs! Right. That's why our school floods every time it rains now. Well, there was a time back in '97 when some teachers got together and...

Hero: (ahem) thank you Mr. Brass for the, uh, history. But about your socks...

Mr. Brass: What? Oh, yes. That. We all keep spares in a big locker in the faculty lounge.

Hero: Thank you. And may I assume that you all put on spare socks from the faculty lounge before I got here?

Ms. Acorn: Certainly not. Take little Miss Totty here (*points to the Secretary*). She wears high shoes so her feet won't get wet.

Hero: So if I have this right, I can assume that everyone either changed their socks or never got their feet wet.

Everyone: Right!

Hero: And I may assume that the flooding was complete enough that everybody either had high shoes on or got wet feet?

Everyone: Yes!

Hero: Mr. Brass.

Mr. Brass: Yes, Mr. Hero?

Hero: Mr. Brass. Where else do faculty keep their spare socks?

Mr. Brass: Oh. Now that is a very interesting question. We had a meeting about this back when I started working here. It seems that at first, faculty were keeping their spare socks all over this school. A few in this desk, a few in that locker. Some in the principal's office, some in his secretary's office...

Secretary: Oh, thank goodness those days are gone!

Mr. Brass: ...some in the bathrooms. It was very disorganized. It was suggested by some of the gym teachers that...

Hero: Today! Where do the faculty keep spare socks *today*?

Mr. Brass: Only in the faculty lounge. It's the rule. Never broken.

Hero: So if I have this right, I can assume that either a person didn't change his or her socks, or he or she was in the faculty lounge.

Everyone: Right!

Hero: Mr. Brass, what happened to your pants?

Mr. Brass: I was clawed by cats. Because I smelled like Limburger.

Hero: Does this happen often?

Mr. Flit: To those of us who smell like Limburger. There were these cats today...

Hero: I heard about the cats. Okay. Can I assume that anyone who smells like Limburger today was clawed by cats?

Everyone: Yes!

Hero: Thank you. (*Turning to the secretary*) And you are the secretary to the principal?

Secretary: That's correct. If you can call him that. He doesn't *have* any.

Hero: Any what?

Secretary: The man has no people skills, no sense of what makes a good teacher; he wouldn't recognize a good policy if it slapped him in the face. Or a good secretary.

Hero: Perhaps he hasn't had the chance... Mr. Dimple, I see your socks are dry. May I assume that you changed yours in the faculty lounge?

Mr. Dimple: Certainly not! I avoid that room like the principal avoids parents. Ever since Ms. Acorn let her Limburger go bad in that room I've been unable to go anywhere near it.

Ms. Acorn: One pound! One *little* pound!

Ms. Gable: You can't go into that room without smelling like Limburger the rest of the day. No. I like to wear high shoes so that I never get my socks wet, and I never have to go near that faculty lounge. See what happened today, with the cats and the rats. Look at their clothes (*gestures to those standing around her*).

Hero: Yes, I'd like to come back to that. But first, may I assume that anyone who entered the faculty lounge today smells like Limburger?

Everyone: Yes!

Hero: Mr. Eagle.

Mr. Eagle: Mr. Hero.

Hero: What are those marks on your shoes. They don't look like claw marks.

Mr. Eagle: They are bite marks.

Hero: You were not clawed by cats?

Mr. Eagle: No. I was gnawed by rats.

Hero: Were all of you "gnawed by rats?"

Acorn, Brass, Dimple, Eagle, Flit: Yes.  
Gable, Secretary: No.

Hero: Ms. Gable?

Ms. Gable: I managed to avoid the cats, thank goodness. This pant suit would surely have been torn to shreds if I hadn't. I was out in the hallway near the principal's office when the cats went charging by. I was just able to get out of their way; and thank goodness I didn't smell like Limburger.

Hero: May I ask how you dodged the cats?

Ms. Gable: Strangest thing. Luckiest thing, really. Little miss Secretary's chair was out in the hallway, so I climbed onto it.

Secretary: Yeah! And the whole time this cat and rat thing was going on I was looking all over the place for my chair.

Mr. Dimple: No you weren't!

Secretary: What do you mean?

Hero: Yes. Please. What do you mean?

Mr. Dimple: Your shoes, lady! You've been driving me nuts for years with those shoes. *(Turns to Hero.)* Mr. Hero... I have the office across the hall from the principal and his secretary here, and every day my patience, (and I'm a patient guy — ask my therapist), my patience is sorely challenged with this "clip, clop, clip, clop, clip, clop, clip, clop" from Ms. Secretary here. And if she was walking around looking for her chair, I would have heard it. I would have *felt* it. I would not have this very distinct and very real memory of a minute of peace while those shoes were *not* making noise, just before the lights came back on.

Hero: Ms. Secretary. Will you please walk around a bit for us?

Secretary: *clip, clop, clip, clop, ...*

Hero: And would you mind doing the same thing in the principal's office, please?

Secretary: What a silly idea. But I'll do it just to humor you. *no clip, no clop, no clip, no clop...*

Mr. Eagle: Oh, this proves nothing! She may have taken off her shoes (they are rather expensive) so they wouldn't get wet.

Hero: Indeed! Indeed, indeed, indeed. So I can assume that during the time of the crime, Ms. Secretary was either in the Principal's office or she was walking around with no shoes on.

Everyone: Right!

Hero: Okay. Thank you very much everyone for your cooperation. It seems that the perpetrator of this crime is not among us after all. You are all free to go about your business. Good day!

Narrator: Mr. Hero thanks everyone, and they disperse. Minutes later a loud shriek is heard coming from one of their offices, followed by the emergence of a stern-faced Mr. Hero. Some workplace crimes merit suspension, a reprimand or termination, according to a well-defined code. But for those that fall through the cracks, justice must be taken into our own hands.

Mr. Flit: There's something I still don't understand. How did the rats get out, how did they turn white, and how were we able to see them in the dark? Ms. Acorn?

Ms. Acorn: Hey, if you're looking for closure, take a literature class...

## A Symbolic Summary of the Play

### Statements and Predicates:

$P(x)$	Person $x$ never got his or her feet wet.
$Q(x)$	Person $x$ was in the faculty lounge
R	The secretary was in the office
$S(x)$	Person $x$ was gnawed by rats
$T(x)$	Person $x$ smelled like Limburger
$U(x)$	Person $x$ had changed his or her socks
W	The secretary was wearing shoes
$Z(x)$	Person $x$ was clawed by cats

### Assertions and their logical expressions

$P(x) \vee U(x)$	Person $x$ either changed his or her socks or never got his or her feet wet.
$Q(x) \vee \neg U(x)$	either didn't change his or her socks or was in the faculty lounge
$\neg W \vee R$	Either the secretary was not wearing shoes or she was in the principal's office
$T(x) \rightarrow Z(x)$	If person $x$ smelled like Limburger, then person $x$ was clawed by cats
$Q(x) \rightarrow T(x)$	If person $x$ was in the faculty lounge, then person $x$ smells like Limburger
$W \vee \neg P(\text{secretary})$	Either the secretary was wearing shoes or her feet got wet
$\neg(S(\text{secretary}) \vee Z(\text{secretary}))$	The Secretary was neither gnawed by rats nor clawed by cats.