APPENDIX D

Page

Self-administered instructional treatment designed to advantage successive information processing aptitudes.

V

REASONING

These lessons will improve your reasoning skills.

You do not need to have any knowledge of mathematics or any school subjects.

You will not find the material too difficult.

Everything you will need is in these notes - teaching material, examples and exercises. You will therefore be able to work through the material by yourself without the teacher's help. Only ask the teacher if you can't find the answer yourself in the notes. The teacher will then show you where to look in the notes.

You have been given one of the sets of notes on learning to reason. That is, some of you will work through one set of printed lessons while the others will use a different set of material. Because of this, do not talk to each other about your work.

There are a number of practice exercises. You should attempt as many exercises as possible. Check your work with the answers on the last page of these notes as soon as you have completed each one.

PART A - CLASSES AND SETS

ELEMENTS

A set is any collection of objects. Examples of sets are:

1. the days of the week
2. the numbers 1, 2, 3, and 4
3. the students in your class
4. the letters a, b, c.

Capital letters are used to name sets:

A = {2, 4, 6, 8} B = {apples, pears} S = {d, e, f}

The objects or members of a set are called elements of the set. The elements are listed inside braces "{" and "}" as shown above.

A set can contain a collection of letters, numbers, or a collection of things or people, or any mix of these elements.

A set can have its elements listed in any order and can have any number of elements.

In the set P = {7, 23, 12}

Set P has 3 elements.

Sets that have the same elements are said to be equal. For example:

If Set P = {1, 2, 3} and Set Q = {2, 1, 3} then Set P = Set Q.

Remember, the order of the elements does not matter.

In the set P = {7, 12, 23}, 7 is a member of the set P. **The symbol $\in$ is used to show "is a member of" or "is an element of":**

$7 \in P$

Note also: $12 \in P$ and $23 \in P$

EXERCISE 1

Do this exercise now. Write your answers on this page in the boxes underneath each question. Immediately you finish this exercise, check with the answers on the last page of these notes and re-do those questions where your answers were incorrect.

1. List the elements of each of the following sets **in braces**:

   (a) The set of letters in the word FROG

   (b) The set of letters in the word BANANA

   [Elements of a set are not repeated when defining a set's members.]

   (c) The set of counting numbers from 1 to 7

1(a):	1(b):	1(c):

2. Is 3 a member of the set A = {1, 2, 3, 4}? [Answer Yes or No]

2:

3. Is a triangle an element in the set of shapes? [Answer Yes or No]

3:

4. **(a)** How many elements in the set A = {@, #, %, ^, *}?

   (b) Look at Set A in 4 (a) above. Is * ∈ A ? [Answer Yes or No]

4(a):	4(b):

5. **(a)** How many elements in the set W, the set of letters in the word "sections"?

   (b) In Set W in 5 (a) above, is z ∈ W ? [Answer Yes or No]

5(a):	5(b):

REMEMBER: CHECK YOUR ANSWERS NOW!

SUBSETS

If A = {Tom, Harry, Bill, Sarah, Cathy} and B = {Tom, Cathy}

Set B is a subset of set A because every element of set B is also an element of set A.

To save time, this is written: B ⊂ A **The symbol ⊂ means "is a subset of".**

In the same way, if P = {4, 23, 45, 56} and Q = {23}, set Q is a subset of set P.

This is written: Q ⊂ P

If a set has no elements at all, it is called the empty set. **The empty set is written showing empty braces { }.** Example: if set C = { }, set C is an empty set, and contains no elements.

The empty set is a subset of any set! For example:

If A = {3, 4}, its subsets are {3, 4}, {3}, {4} and { }.

Summary:

The symbol $\in$ means "is a member of" or "is an element of".

The symbol $\subset$ means "is a subset of".

The empty set is written showing empty braces { }.

EXERCISE 2

If you cannot remember how to do a question, look back in these notes for help.

1. Write set P is a subset of set Q, using the symbol meaning "is a subset of".

1:

2. In each of the following answer "Yes" if A is a subset of B, or answer "No" if not.

(a) A = {1} and B = {1, 3} **(b)** A = {2, 3} and B = {1, 3, 4}

2(a):	2(b):

3. Let A = {1, 2, 3, 4, 5}, B = {1, 3, 4} and C = {0, 1, 4}. If the following statements are correct, write Yes, and if they are not correct write No.

(a) $A \subset B$ **(b)** $B \subset A$ **(c)** $C \subset A$ **(d)** $C \subset B$

3(a):	3(b):	3(c):	3(d):

4. Think about the different coins we use in Australia.

(a) Write the set of coins under 10 cents as set B.

(b) Set E = { }. Is set E a subset of set B? [Answer Yes or No]

4(a):	4(b):

REMEMBER: CHECK YOUR ANSWERS NOW!

INTERSECTION OF SETS

Suppose A = {Lisa, Lila, Monique, Cathy, Kristen} is the set of girls in your class with blue eyes,

and B = {Lila, Cathy, Sheridan, Amanda} is the set of girls in your class with fair hair.

Then, {Lila, Cathy} is the set of all girls in your class with both blue eyes and fair hair.

This new set is called the intersection of A and B and is written using the ∩ symbol, meaning "in intersection with":

$A \cap B$

So $A \cap B = \{Lila, Cathy\}$

The intersection $A \cap B$ of two sets A and B is the set of all elements which belong to both A and B. You can remember this by thinking of an intersection as containing the elements that are common to both sets.

For example:

if $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6, 7\}$

then $A \cap B = \{3, 4\}$.

Another example:

if A = {black, brown, blue} and B = {orange, blue}

then $A \cap B = \{blue\}$.

UNION OF SETS

Suppose A = {Lisa, Lila, Monique, Cathy, Kristen} is the set of girls in your class with blue eyes,

and B = {Lila, Cathy, Sheridan, Amanda} is the set of girls in your class with fair hair.

Then, {Lisa, Lila, Monique, Cathy, Kristen, Sheridan, Amanda} is the set of all girls in your class with blue eyes or fair hair.

This new set is called the union of A and B and is written using the $\cup$ symbol, meaning "in union with":

$A \cup B$

So $A \cup B$ = {Lisa, Lila, Monique, Cathy, Kristen, Sheridan, Amanda}

The union $A \cup B$ of two sets A and B is the set of all elements which belong to A and B (to both A and B). You can remember this by thinking of a union as a joining together.

For example:

if A = {1, 2, 3, 4} and B = {3, 4, 5, 6, 7}

then $A \cup B$ = {1, 2, 3, 4, 5, 6, 7}.

Note that the same set element is not repeated.

Another example:

if A = {black, brown, blue} and B = {orange, blue}

then $A \cup B$ = {black, brown, blue, orange}.

Summary:

The symbol $\in$ means "is a member of" or "is an element of".

The symbol $\subset$ means "is a subset of".

The empty set is written showing empty braces { }.

The $\cap$ symbol means "in intersection with".

The $\cup$ symbol means "in union with":

EXERCISE 3

1. If A = {1, 3, 5}, B = {2, 5, 7} and C = {4, 6, 10} find:

   (a) $B \cup C$ **(b)** $A \cap B$

1(a):	1(b):

2. If A = {a, b, c}, B = {a, b} and C = {c}, write Yes if the following sentences are correct, and write No if they are not.

   (a) $c \in B$ **(b)** $a \in A$ **(c)** $b \in C$

   (d) $A \cup B = \{a, b, c\}$ **(e)** $B \cup C = \{a, c\}$ **(f)** $C \cap B = \{\ \}$

2(a):	2(b):	2(c):	2(d):	2(e):	2(f):

3. If J = {Jenny, Joanne} who like to collect jewels, and S = {Sarah, Sharon, Simone} who like to collect shells, find: **(a)** $S \cup J$ **(b)** $S \cap J$

3(a):	3(b):

NEGATION OF SYMBOLS

The symbol = is used to show "contains the elements". **The symbol ≠ means "does not contain the elements of":** If A = {1, 2} and B = {2, 3} then A ≠ B

The symbol ∈ is used to show "is a member of" or "is an element of".

The symbol ∉ means "is not a member of" or "is not an element of":

If A = {1, 2, 3}, then 4 ∉ A

The symbol ⊂ means "is a subset of". **The symbol ⊄ means "is not a subset of":**

If A = {1, 2, 3} and B = {4}, then B ⊄ A

EXERCISE 4

1. If A = {lions, tigers}, B = {tigers, cats} and C = {cats}, write Yes if the following statements are correct, and write No if they are not.

(a) lions ∉ B **(b)** lions ∉ A **(c)** lions ∉ C

(d) A ∪ B ≠ {lions, tigers} **(e)** C ∩ A ≠ {lions} **(f)** C ∩ B ≠ { }

1(a):	1(b):	1(c):	1(d):	1(e):	1(f):

2. If A = {1, 3, 5, 7, 9} and B = {7, 9, 11}, write Yes if the following statements are correct, and write No if they are not.

(a) A ∪ B = {7, 9} **(b)** A ∩ B = {7, 9}

(c) B ⊂ A **(d)** {7, 9, 11} ≠ A ∩ B

2(a):	2(b):	2(c):	2(d):

PART B - SYLLOGISMS

Syllogisms are of the type:

All tigers are animals.

Some animals are koalas.

Therefore some koalas are tigers.

The idea of syllogisms is to decide whether the conclusion, in this example "*Therefore some koalas are tigers*" is "valid" (meaning correct - from the information given in the two lines above it) or "invalid" (meaning not correct - from the information given). In the above example, the conclusion is invalid. The idea of these notes is to teach you rules that will help you find out if the conclusions to certain types of syllogisms are valid or invalid.

THE FIRST TWO LINES OF A SYLLOGISM ARE CALLED PREMISES.

THE FINAL THIRD LINE IS CALLED A CONCLUSION.

THE FIRST TWO STATEMENTS ARE PREMISES AND ARE ALWAYS ASSUMED TO BE TRUE EVEN IF THEY ARE NOT SENSIBLE. WE ONLY NEED TO DECIDE IF THE CONCLUSION IS VALID IN TERMS OF THE PREMISES GIVEN.

For example, in the syllogism:

Some drets are blue.

All quists are drets.

Therefore some quists are blue.

... we do not need to know whether the premises are true or not. These lessons will teach you how to reason and decide whether the conclusion is valid or invalid. For example, in the syllogism above we do not need to know anything about quists or drets!

When solving syllogisms, do not worry about whether the premises are true or false. Just assume that they are true. Then use the reasoning skills you will be taught in these notes to see if the conclusion is valid. ASSUME THE PREMISES ARE TRUE!

For example, in:

All dogs are fish.

All kelpies are dogs.

Therefore all kelpies are fish.

the conclusion is valid!

We know the first premise "All dogs are fish" is not really true, but we are told this and must carry on with the reasoning believing it is a true statement.

EXERCISE 5

1. Answer the questions following from the information given in this syllogism. Answer the questions Yes or No:

   Some dogs are pink.

   All pigs are pink.

   Therefore some pigs are dogs.

   (a) Do you assume all pigs are pink?

   (b) Do you assume that only some dogs are pink?

(c) Do you assume all dogs are not pink?

(d) Do you assume that only some pigs are pink?

(e) "*All pigs are pink*" is a premise.

(f) "*Some dogs are pink*" is a premise.

(g) "*Therefore some pigs are dogs*" is the conclusion.

1(a):	1(b):	1(c):	1(d):	1(e):	1(f):	1(g):

2. "We only need to decide if the conclusion of a syllogism is valid in terms of the premises given, even if the premises and conclusion are not sensible."

   If this is a correct statement write Yes, and write No if it is not.

2:

REMEMBER - CHECK YOUR ANSWERS NOW!

TERMS USED WITH SYLLOGISMS

In the syllogism:

All M are P

All S are M

Therefore all S are P

the letters M, P and S can be used to stand for anything the writer of the syllogism chooses. We will be able to work out if the syllogism is valid or invalid whatever the letters stand for!

The letters could stand for "States of Australia" or "fish" or "shapes" or "prings" or "quints"! The letters can be anything - either real things or make-up things - and the reasoning task is not changed. We can still decide if the conclusion written is "valid" (is a correct conclusion logically).

In the syllogism:

All M are P

All S are M

Therefore all S are P

"*M*" is common to the two premises but is not in the conclusion.

"*M*" is called the middle term.

Remember: THE MIDDLE TERM IS THE TERM THAT IS IN BOTH PREMISES!

"*S*" is the subject of the conclusion.

Remember: THE SUBJECT COMES FIRST IN THE CONCLUSION!

"*P*" is the predicate of the conclusion.

Remember: THE PREDICATE COMES LAST IN THE CONCLUSION!

Therefore, in:

All animals have fur.

All cats are animals.

Therefore all cats have fur.

"*animals*" is called the middle term - (IT IS THE TERM IN BOTH PREMISES)

"*cats*" is the subject of the conclusion - (IT COMES FIRST IN THE CONCLUSION)

"*fur*" is the predicate of the conclusion - (IT COMES LAST IN THE CONCLUSION)

The terms S, P and M can occupy different positions in the premises. However, the positions of S and P are fixed in the conclusion.

Examples of different positions of the S, P and M terms in the premises are:

All M are P

All S are M

Therefore all S are P

and *All P are M*

All M are S

Therefore all S are P

REMEMBER, THE MIDDLE TERM IS COMMON TO BOTH PREMISES BUT IS NOT IN THE CONCLUSION.

ALSO, TO FIND THE SUBJECT AND THE PREDICATE, JUST LOOK AT THE CONCLUSION. THE SUBJECT COMES FIRST, THE PREDICATE LAST.

EXERCISE 6

1. *All boys are footballers.*

   All animals are boys.

   Therefore all animals are footballers.

What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

2. *All dumbos are stupid.*

   Some blips are stupid.

   Therefore some blips are dumbos.

What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

3. *All plants are flowers.*

   Some plants are trees.

   Therefore all trees are flowers.

What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

REMEMBER - CHECK YOUR ANSWERS NOW!

SENTENCE TYPES

In our study of syllogisms in these lessons, we will only be concerned with two (2) sentence types. Some examples of these two types of sentences are:

1. *All S are P*

   e.g., *All politicians are honest.*

2. *Some S are P*

   e.g., *Some politicians are honest.*

Notice either the words *all* or *some* can appear in our sentence types.

DISTRIBUTION

We have seen that a term in a syllogism (such as "politicians", or "girls", or letters like "S") can have the word "*all*" in front of it, meaning that the term is distributed and the whole set is included. "*All*" means every member is included ... ***all* means the term is distributed.**

We have also seen that a term in a syllogism can have the word "*some*" in front of it, meaning that the term is not distributed and the whole set is not included. "*Some*" means every member is not included ... ***some* means the term is not distributed.**

Terms in the premises sometimes do not have a qualifier like "some" or "all" in front of them and we need to study the whole statement:

If the statement says that "*Some S are P*", this means that the term P is not distributed because we only know about some of them. (S is also not distributed.)

Example 1: *All girls are workers.*

The term "*girls*" is distributed. The term "*workers*" is not distributed.

We are saying something about the set of all girls but we have not said anything about the set of all workers. (We have not said that all workers are girls.)

Example 2: *Some soldiers are Australians.*

Both the term "*soldiers*" and the term "*Australians*" are not distributed.

We are only saying something about some and not all of the soldiers. Nor are we saying something about all Australians.

Example 3: *All P are M.*

The term "*P*" is distributed. The term "*M*" is not distributed.

We are saying something about the set of all P but we have not said anything about the set of all M. (We have not said that all M are P.)

Example 4: *Some ziggs are pingles.*

Both the term "*ziggs*" and the term "*pingles*" are not distributed.

We are only saying something about some and not all of the ziggs. Nor are we saying something about all pingles.

Example 5: *Fijians are friendly people.*

The term "*Fijians*" is distributed, because we imply "All Fijians". The term "*friendly people*" is not distributed.

We are saying something about the set of all Fijians but we have not said anything about the set of all friendly people. (We have not said all friendly people are Fijians.)

EXERCISE 7

In each of the following statements, say whether each of the terms listed in each question are distributed or not distributed. Answer **D** for distributed, **ND** for not distributed.

1. *All moons are satellites.*

(a) moons **(b)** satellites

1(a) moons:	1(b) satellites:

2. *Some Victorians are savages.*

(a) Victorians **(b)** savages

2(a) Victorians:	2(b) savages:

3. *Some shoppers are mothers.*

(a) shoppers **(b)** mothers

3(a) shoppers:	3(b) mothers:

4. *All A are B.*

(a) A **(b)** B

4(a) A:	4(b) B:

REMEMBER - CHECK YOUR ANSWERS NOW!

VALIDITY OF SYLLOGISMS

Rules can be used to solve a syllogism and help you decide if it is valid or invalid.

There are two rules, known as the Rules of Distribution, which help to solve the type of syllogisms we are dealing with in these lessons:

RULES OF DISTRIBUTION

1. **The middle term must be distributed in at least one of the two premises.**
2. **If a term is distributed in the conclusion, then it must be distributed in the premise in which it occurs.**

We can use the above rules to determine the validity of a our syllogism types by determining if the syllogism breaks either of these rules. If a syllogism breaks a rule, it is invalid. If a syllogism does not break any rules, it is valid.

SUMMARY OF WHAT YOU NEED TO KNOW TO SOLVE OUR SYLLOGISMS:

The first two lines are premises, the last line a conclusion.

The middle term is the term that occurs in both premises.

A term is distributed if *all* is in front of it, meaning all members.

A term is not distributed if *some* is in front of it, meaning only some members.

and the RULES OF DISTRIBUTION

1. **The middle term must be distributed in at least one of the two premises.**
2. **If a term is distributed in the conclusion, then it must be distributed in the premise in which it occurs.**

To see how these rules work, some examples follow.

EXAMPLE 1

All sailors are men.

All men are people.

Therefore all people are sailors.

The middle term "*men*" is distributed in at least one of the premises (in the first premise). However, the term "*people*" is distributed in the conclusion but not distributed in the premise in which it occurs.

One of our rules has been broken. The given syllogism is invalid.

EXAMPLE 2

All pilots are men.

All sailors are men.

Therefore all sailors are pilots.

The middle term "*men*" is not distributed in either of the premises. Since we have broken one of the rules of distribution, the given syllogism is invalid.

EXAMPLE 3

Girls are human.

All students are girls.

Therefore all students are human.

The middle term "*girls*" is distributed in at least one of the premises (in the first premise ... meaning All girls). The term "*students*" is distributed in the conclusion and in the premise in which it occurs. No rules have been broken. The syllogism is valid.

EXAMPLE 4

All Pobbs are Mibs.

All Sabs are Mibs.

Therefore all Sabs are Pobbs.

The middle term "*Mibs*" is not distributed in either of the premises. Since we have broken one of the rules of distribution, the given syllogism is invalid.

EXAMPLE 5

All M are P.

All M are S.

Therefore all S are P.

The middle term "*M*" is distributed in at least one of the premises (in fact, it is distributed in both). The term "*S*" is distributed in the conclusion but not distributed in the premise in which it occurs. Because we have broken one of the rules of distribution, the given syllogism is invalid.

EXERCISE 8

Using the rules, find out if the following syllogisms are valid or invalid.

1. *All girls are beautiful.*

   All netballers are girls.

   Therefore all netballers are beautiful.

   Your answer: Valid or Invalid? .....

2. *All monkeys are playful.*

   All monkeys are students.

   Therefore all students are playful.

Your answer: Valid or Invalid? .....

3. *All Principals are men.*

   Some men are fathers.

   Therefore all fathers are Principals.

Your answer: Valid or Invalid? .....

[Remember to check your answers now.]

FURTHER EXAMPLES

Remember the two **RULES OF DISTRIBUTION**:

1. **The middle term must be distributed in at least one of the two premises.**
2. **If a term is distributed in the conclusion, then it must be distributed in the premise in which it occurs.**

If a syllogism breaks a rule, it is invalid. If a syllogism does not break any rules, it is valid.

EXAMPLE 6

All men are fighters.

Some astronauts are men.

Therefore some astronauts are fighters.

The middle term "*men*" is distributed in at least one of the premises (in the first premise).

Neither term "*astronauts*" or "*fighters*" is distributed in the conclusion.

Since we have broken none of the rules of distribution, the given syllogism is valid.

EXAMPLE 7

All reptiles are lizards.

Some mice are reptiles.

Therefore all mice are lizards.

The middle term "*reptiles*" is distributed in the first premise. The term "*mice*" is distributed in the conclusion but not in the premise in which it occurs.

Because one of the rules of distribution has been broken, the given syllogism is invalid.

EXAMPLE 8

Some cars are Fords.

Some Fords are vehicles.

Therefore all vehicles are cars.

The middle term "*Fords*" is not distributed in either of the premises. Also, the term "*vehicles*" is distributed in the conclusion but not in the premise in which it occurs, but the first rule has already been broken and therefore we need not be concerned to check whether the second rule has also been broken. (In fact, it has.)

Since the middle term must be distributed in at least one of the premises, and this rule has been broken, the given syllogism is invalid.

EXAMPLE 9

All Z are Q.

All K are Z.

Therefore all K are Q.

The middle term "*Z*" is distributed in the first premise. The term "*K*" is distributed in the conclusion and also in the premise in which it occurs.

Because none of the rules of distribution has been broken, the given syllogism is valid.

EXERCISE 9

Using the rules of distribution, find out if the following syllogism are valid or invalid.

1. *Some frondles are tasty.*

   All frondles are jumpers.

   Therefore some jumpers are tasty.

   Your answer: Valid or Invalid? .....

2. *Some tigers are budgies.*

   All budgies are flowers.

   Therefore some flowers are tigers.

   Your answer: Valid or Invalid? .....

3. *All astronauts are brave.*

   Some husbands are astronauts.

   Therefore all husbands are brave.

   Your answer: Valid or Invalid? .....

[Remember to check your answers now.]

ANSWERS TO EXERCISES

EXERCISE 1

1. **(a)** {F, R, O, G} **(b)** {B, A, N} **(c)** {1, 2, 3, 4, 5, 6, 7} 2. Yes 3. Yes
4. **(a)** 5 **(b)** Yes 5. **(a)** 7 **(b)** No

EXERCISE 2

1. P ⊂ Q 2.**(a)** Yes **(b)** No 3. **(a)** No **(b)** Yes **(c)** No **(d)** No 4. **(a)** B = {1, 2, 5} **(b)** Yes

EXERCISE 3

1. **(a)** {2, 4, 5, 6, 7, 10} **(b)** {5} 2. **(a)** No **(b)** Yes **(c)** No **(d)** Yes **(e)** No **(f)** Yes
3. **(a)** {Jenny, Joanne, Sarah, Sharon, Simone} **(b)** { }

EXERCISE 4

1. **(a)** Yes **(b)** No **(c)** Yes **(d)** Yes **(e)** Yes **(f)** Yes 2. **(a)** No **(b)** Yes **(c)** No **(d)** Yes

EXERCISE 5

1. **(a)** Yes **(b)** Yes **(c)** No **(d)** No **(e)** Yes **(f)** Yes **(g)** Yes 2. Yes

EXERCISE 6

1.	Middle term: "boys"	Subject: "animals"	Predicate: "footballers"
2.	Middle term: "stupid"	Subject: "blips"	Predicate: "dumbos"
3.	Middle term: "plants"	Subject: "trees"	Predicate: "flowers"

EXERCISE 7

1.	"moons":	**D** (distributed)	"satellites":	**ND** (not distributed)
2.	"Victorians":	**ND** (not distributed)	"savages":	**ND** (not distributed)
3.	"shoppers":	**ND** (not distributed)	"mothers":	**ND** (not distributed)
4.	"A":	**D** (distributed)	"B":	**ND** (not distributed)

EXERCISE 8

1. Conclusion valid. No rules broken.
2. Conclusion invalid. The term "students" is distributed in the conclusion but is not distributed in the premise in which it occurs.
3. Conclusion invalid. The term "fathers" is distributed in the conclusion but is not distributed in the premise in which it occurs.

EXERCISE 9

1. Conclusion valid. No rules broken.
2. Conclusion valid. No rules broken.
3. Conclusion invalid. The term "husbands is distributed in the conclusion but is not distributed in the premise in which it occurs.

APPENDIX E

Page

REASONING

These lessons will improve your reasoning skills.

You do not need to have any knowledge of mathematics or any school subjects.

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There are a number of practice exercises. You should attempt as many exercises as possible. Check your work with the answers on the last three pages of these notes as soon as you have completed each one.

PART A - CLASSES AND SETS

ELEMENTS

A set is any collection of objects. Examples of sets are:

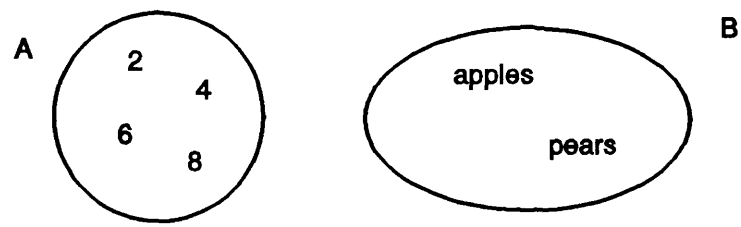
1. the days of the week
2. the numbers 1, 2, 3, and 4
3. the students in your class
4. the letters a, b, c.

Capital letters are used to name sets:

A = {2, 4, 6, 8} B = {apples, pears} S = {d, e, f}

The objects or members of a set are called elements of the set. The elements are listed inside braces "{" and "}" as shown above.

Instead of listing the elements of a set within braces, we can show a set diagrammatically:

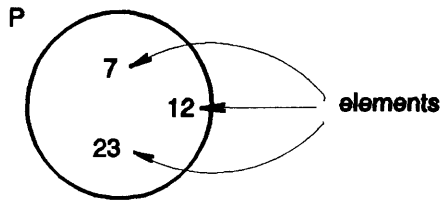


A set can contain a collection of letters, numbers, or a collection of things or people, or any mix of these elements.

A set can have its elements listed in any order and can have any number of elements.

In the set P = {7, 23, 12}

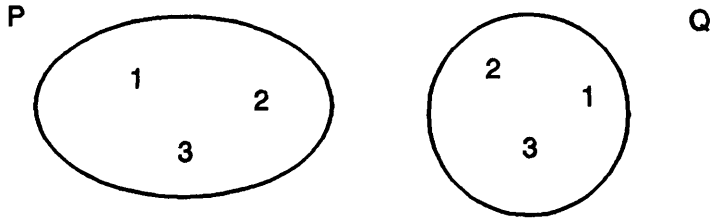
Set P has 3 elements.



Sets that have the same elements are said to be equal. For example:

If Set P = {1, 2, 3} and Set Q = {2, 1, 3} then Set P = Set Q.

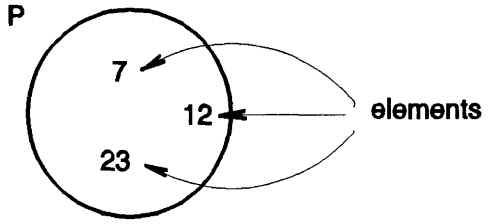
Remember, the order of the elements does not matter.



In the set P = {7, 12, 23}, 7 is a member of the set P. **The symbol $\in$ is used to show "is a member of" or "is an element of":**

$7 \in P$

Note also: $12 \in P$ and $23 \in P$



EXERCISE 1

Do this exercise now. Write your answers on this page in the boxes underneath each question. Immediately you finish this exercise, check with the answers at the end of these notes and re-do those questions where your answers were incorrect.

1. List the elements of each of the following sets **in braces**:

   (a) The set of letters in the word FROG

   (b) The set of letters in the word BANANA

   [Elements of a set are not repeated when defining a set's members.]

   (c) The set of counting numbers from 1 to 7

1(a):	1(b):	1(c):

2. Is 3 a member of the set A = {1, 2, 3, 4}? [Answer Yes or No]

2:

3. Is a triangle an element in the set of shapes? [Answer Yes or No]

3:

4. **(a)** How many elements in the set A = {@, #, %, ^, *}?

   (b) Look at Set A in 4 (a) above. Is * $\in$ A ? [Answer Yes or No]

4(a):	4(b):

5. **(a)** How many elements in the set W, the set of letters in the word "sections"?

   (b) In Set W in 5 (a) above, is z $\in$ W ? [Answer Yes or No]

5(a):	5(b):

Before your proceed, please check your answers to Exercise 1.

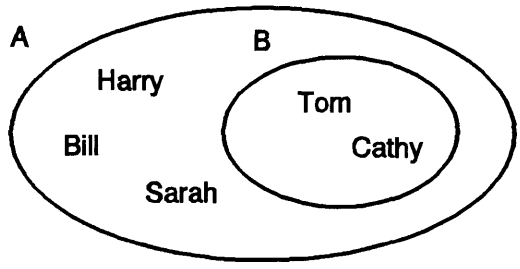
SUBSETS

If A = {Tom, Harry, Bill, Sarah, Cathy} and B = {Tom, Cathy}

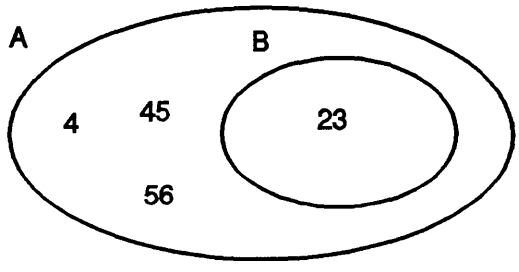
Set B is a subset of set A because every element of set B is also an element of set A.

To save time, this is written: B ⊂ A **The symbol ⊂ means "is a subset of".**

This diagram shows B is a subset of A:



In the same way, if A = {4, 23, 45, 56} and B = {23}, set B is a subset of set A.



This is written: B ⊂ A

If a set has no elements at all, it is called the empty set. **The empty set is written showing empty braces { }.** Example: if set C = { }, set C is an empty set, and contains no elements.

The empty set is a subset of any set! For example:

If A = {3, 4}, its subsets are {3, 4}, {3}, {4} and { }.

Summary:

The symbol $\in$ means "is a member of" or "is an element of".

The symbol $\subset$ means "is a subset of".

The empty set is written showing empty braces { }.

EXERCISE 2

If you cannot remember how to do a question, look back in these notes for help.

1. Write set P is a subset of set Q, using the symbol meaning "is a subset of".

1:

2. In each of the following answer "Yes" if A is a subset of B, or answer "No" if not.

(a) A = {1} and B = {1, 3} **(b)** A = {2, 3} and B = {1, 3, 4}

2(a):	2(b):

3. Let A = {1, 2, 3, 4, 5}, B = {1, 3, 4} and C = {0, 1, 4}. If the following statements are correct, write Yes, and if they are not correct write No.

(a) $A \subset B$ **(b)** $B \subset A$ **(c)** $C \subset A$ **(d)** $C \subset B$

3(a):	3(b):	3(c):	3(d):

4. Think about the different coins we use in Australia.

(a) Write the set of coins under 10 cents as set B.

(b) Set E = { }. Is set E a subset of set B? [Answer Yes or No]

4(a):	4(b):

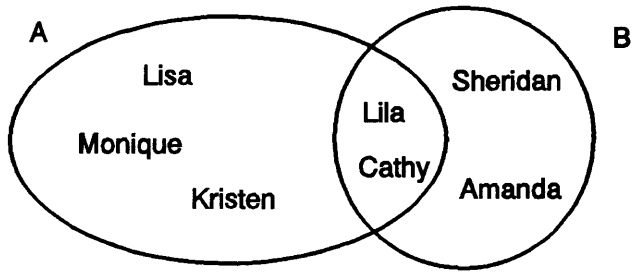
REMEMBER: CHECK YOUR ANSWERS NOW!

INTERSECTION OF SETS

Suppose A = {Lisa, Lila, Monique, Cathy, Kristen} is the set of girls in your class with blue eyes,

and B = {Lila, Cathy, Sheridan, Amanda} is the set of girls in your class with fair hair.

Then, {Lila, Cathy} is the set of all girls in your class with both blue eyes and fair hair.

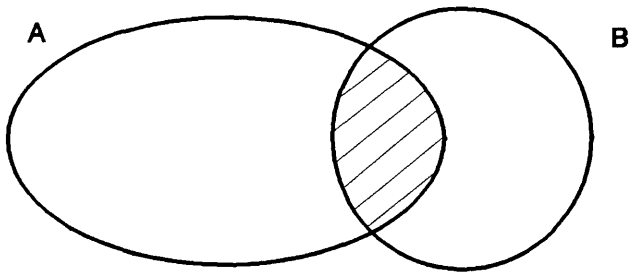


This new set is called the intersection of A and B and is written using the ∩ symbol, meaning "in intersection with":

$A \cap B$

So $A \cap B = \{Lila, Cathy\}$

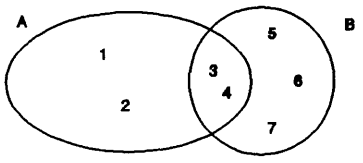
The intersection $A \cap B$ of two sets A and B is the set of all elements which belong to both A and B (as shown in the hatched area below). You can remember this by thinking of an intersection as containing the elements that are common to both sets.



For example:

if A = {1, 2, 3, 4} and B = {3, 4, 5, 6, 7}

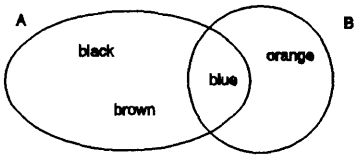
then A ∩ B = {3, 4}.



Another example:

if A = {black, brown, blue} and B = {orange, blue}

then A ∩ B = {blue}.

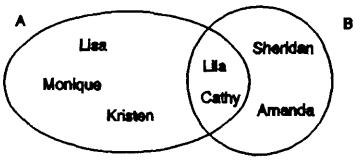


UNION OF SETS

Suppose A = {Lisa, Lila, Monique, Cathy, Kristen} is the set of girls in your class with blue eyes,

and B = {Lila, Cathy, Sheridan, Amanda} is the set of girls in your class with fair hair.

Then, {Lisa, Lila, Monique, Cathy, Kristen, Sheridan, Amanda} is the set of all girls in your class with blue eyes or fair hair.



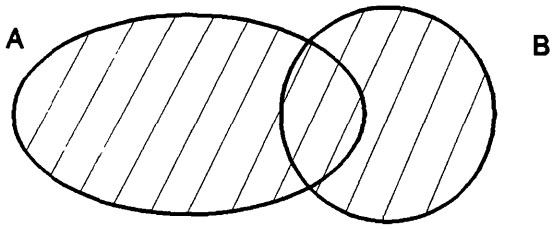
The union of Sets A and B is all the elements of both A and B.

This new set is called the union of A and B and is written using the ∪ symbol, meaning "in union with":

$A \cup B$

So $A \cup B = \{Lisa, Lila, Monique, Cathy, Kristen, Sheridan, Amanda\}$

The union $A \cup B$ of two sets A and B is the set of all elements which belong to A and B (to both A and B). You can remember this by thinking of a union as a joining together. This can be pictured diagrammatically:

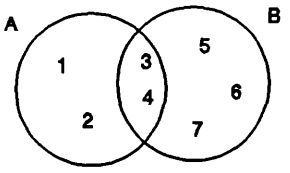


For example:

if $A = \{1, 2, 3, 4\}$ and $B = \{3, 4, 5, 6, 7\}$

then $A \cup B = \{1, 2, 3, 4, 5, 6, 7\}$.

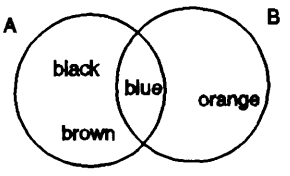
Note that the same set element is not repeated.



Another example:

if A = {black, brown, blue} and B = {orange, blue}

then $A \cup B$ = {black, brown, blue, orange}.



HINTS FOR REMEMBERING SYMBOLS

$\in$ element

e for element

$\cup$ union

u for union

$\cap$ intersection

n in intersection

$\subset$ subset

(like jaws biting a piece of a set)

Summary:

The symbol $\in$ means "is a member of" or "is an element of".

The symbol $\subset$ means "is a subset of".

The empty set is written showing empty braces { }.

The $\cap$ symbol means "in intersection with".

The $\cup$ symbol means "in union with":

EXERCISE 3

1. If A = {1, 3, 5}, B = {2, 5, 7} and C = {4, 6, 10} find:

   (a) $B \cup C$ **(b)** $A \cap B$

1(a):	1(b):

2. If A = {a, b, c}, B = {a, b} and C = {c}, write Yes if the following sentences are correct, and write No if they are not.

   (a) $c \in B$ **(b)** $a \in A$ **(c)** $b \in C$

   (d) $A \cup B = \{a, b, c\}$ **(e)** $B \cup C = \{a, c\}$ **(f)** $C \cap B = \{\ \}$

2(a):	2(b):	2(c):	2(d):	2(e):	2(f):

3. If J = {Jenny, Joanne} who like to collect jewels, and S = {Sarah, Sharon, Simone} who like to collect shells, find: **(a)** $S \cup J$ **(b)** $S \cap J$

3(a):	3(b):

NEGATION OF SYMBOLS

The symbol = is used to show "contains the elements". **The symbol ≠ means "does not contain the elements of":** If A = {1, 2} and B = {2, 3} then A ≠ B

The symbol ∈ is used to show "is a member of" or "is an element of".

The symbol ∉ means "is not a member of" or "is not an element of":

If A = {1, 2, 3}, then 4 ∉ A

The symbol ⊂ means "is a subset of". **The symbol ⊄ means "is not a subset of":**

If A = {1, 2, 3} and B = {4}, then B ⊄ A

EXERCISE 4

1. If A = {lions, tigers}, B = {tigers, cats} and C = {cats}, write Yes if the following statements are correct, and write No if they are not.

(a) lions ∉ B **(b)** lions ∉ A **(c)** lions ∉ C

(d) A ∪ B ≠ {lions, tigers} **(e)** C ∩ A ≠ {lions} **(f)** C ∩ B ≠ { }

1(a):	1(b):	1(c):	1(d):	1(e):	1(f):

2. If A = {1, 3, 5, 7, 9} and B = {7, 9, 11}, write Yes if the following statements are correct, and write No if they are not.

(a) A ∪ B = {7, 9} **(b)** A ∩ B = {7, 9}

(c) B ⊂ A **(d)** {7, 9, 11} ≠ A ∩ B

2(a):	2(b):	2(c):	2(d):

PART B - SYLLOGISMS

Syllogisms are of the type:

All tigers are animals.

Some animals are koalas.

Therefore some koalas are tigers.

The idea of syllogisms is to decide whether the conclusion, in this example "*Therefore some koalas are tigers*" is "valid" (meaning correct - from the information given in the two lines above it) or "invalid" (meaning not correct - from the information given). In the above example, the conclusion is invalid. The idea of these notes is to teach you rules that will help you find out if the conclusions to certain types of syllogisms are valid or invalid.

THE FIRST TWO LINES OF A SYLLOGISM ARE CALLED PREMISES.

THE FINAL THIRD LINE IS CALLED A CONCLUSION.

THE FIRST TWO STATEMENTS ARE PREMISES AND ARE ALWAYS ASSUMED TO BE TRUE EVEN IF THEY ARE NOT SENSIBLE. WE ONLY NEED TO DECIDE IF THE CONCLUSION IS VALID IN TERMS OF THE PREMISES GIVEN.

For example, in the syllogism:

Some drets are blue.

All quists are drets.

Therefore some quists are blue.

... we do not need to know whether the premises are true or not. These lessons will teach you how to reason and decide whether the conclusion is valid or invalid. For example, in the syllogism above we do not need to know anything about quists or drets!

When solving syllogisms, do not worry about whether the premises are true or false. Just assume that they are true. Then use the reasoning skills you will be taught in these notes to see if the conclusion is valid. ASSUME THE PREMISES ARE TRUE!

For example, in:

All dogs are fish.

All kelpies are dogs.

Therefore all kelpies are fish.

the conclusion is valid!

We know the first premise "All dogs are fish" is not really true, but we are told this and must carry on with the reasoning believing it is a true statement.

EXERCISE 5

1. Answer the questions following from the information given in this syllogism. Answer the questions Yes or No:

   Some dogs are pink.

   All pigs are pink.

   Therefore some pigs are dogs.

   (a) Do you assume all pigs are pink?

   (b) Do you assume that only some dogs are pink?

(c) Do you assume all dogs are not pink?

(d) Do you assume that only some pigs are pink?

(e) "*All pigs are pink*" is a premise.

(f) "*Some dogs are pink*" is a premise.

(g) "*Therefore some pigs are dogs*" is the conclusion.

1(a):	1(b):	1(c):	1(d):	1(e):	1(f):	1(g):

2. "We only need to decide if the conclusion of a syllogism is valid in terms of the premises given, even if the premises and conclusion are not sensible."

   If this is a correct statement write Yes, and write No if it is not.

2:

REMEMBER - CHECK YOUR ANSWERS NOW!

TERMS USED WITH SYLLOGISMS

In the syllogism:

All M are P

All S are M

Therefore all S are P

the letters M, P and S can be used to stand for anything the writer of the syllogism chooses. We will be able to work out if the syllogism is valid or invalid whatever the letters stand for!

The letters could stand for "States of Australia" or "fish" or "shapes" or "prings" or "quints"! The letters can be anything - either real things or make-up things - and the reasoning task is not changed. We can still decide if the conclusion written is "valid" (is a correct conclusion logically).

In the syllogism:

All M are P

All S are M

Therefore all S are P

"*M*" is common to the two premises but is not in the conclusion.

"*M*" is called the middle term.

Remember: THE MIDDLE TERM IS THE TERM THAT IS IN BOTH PREMISES!

"*S*" is the subject of the conclusion.

Remember: THE SUBJECT COMES FIRST IN THE CONCLUSION!

"*P*" is the predicate of the conclusion.

Remember: THE PREDICATE COMES LAST IN THE CONCLUSION!

Therefore, in:

All animals have fur.

All cats are animals.

Therefore all cats have fur.

"*animals*" is called the middle term - (IT IS THE TERM IN BOTH PREMISES)

"*cats*" is the subject of the conclusion - (IT COMES FIRST IN THE CONCLUSION)

"*fur*" is the predicate of the conclusion - (IT COMES LAST IN THE CONCLUSION)

The terms S, P and M can occupy different positions in the premises. However, the positions of S and P are fixed in the conclusion.

Examples of different positions of the S, P and M terms in the premises are:

All M are P

All S are M

Therefore all S are P

and *All P are M*

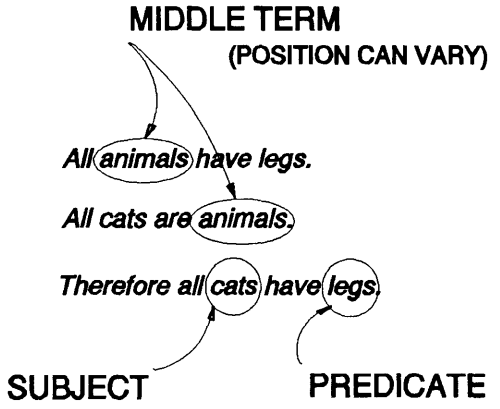
All M are S

Therefore all S are P

REMEMBER, THE MIDDLE TERM IS COMMON TO BOTH PREMISES BUT IS NOT IN THE CONCLUSION.

ALSO, TO FIND THE SUBJECT AND THE PREDICATE, JUST LOOK AT THE CONCLUSION. THE SUBJECT COMES FIRST, THE PREDICATE LAST.

SUMMARY



EXERCISE 6

1. *All boys are footballers.*

   All animals are boys.

   Therefore all animals are footballers.

   What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

2. *All dumbos are stupid.*

   Some blips are stupid.

   Therefore some blips are dumbos.

   What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

3. *All plants are flowers.*

   Some plants are trees.

   Therefore all trees are flowers.

   What is **(a)** the middle term, **(b)** the subject, **(c)** the predicate?

middle term:	subject:	predicate:

REMEMBER - CHECK YOUR ANSWERS NOW!

SENTENCE TYPES

In our study of syllogisms in these lessons, we will only be concerned with two (2) sentence types. Some examples of these two types of sentences are:

1. *All S are P*

   e.g., *All politicians are honest.*

2. *Some S are P*

   e.g., *Some politicians are honest.*

Notice either the words *all* or *some* can appear in our sentence types.

DIAGRAMMING SENTENCE TYPES

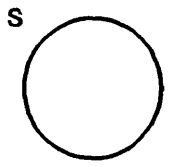
When a term in a syllogism (such as "politicians", or "girls", or letters like "S") has the word "*All*" in front of it, it means that every member is included.

All politicians are honest means that every politician is honest - every member of the set of politicians.

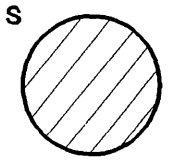
When a term in a syllogism has the word "*Some*" in front of it, it means that some of the members of the set are included but not all the members.

Some politicians are honest means that at least one member of the set of politicians is honest, but not all members.

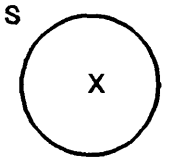
Each term in a premise can be represented by a set, and shown diagrammatically. For example, the set S can be pictured:



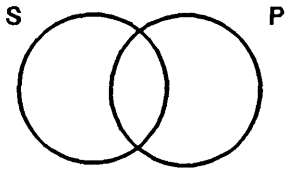
Shaded areas are used to show areas that have no members. For example, no elements or members in the set S can be shown:



A letter **X** (or other marking) is used to show areas that have at least one member:



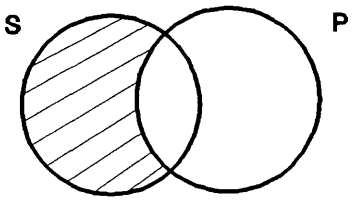
Intersecting circles are always used to represent the two terms in a premise of a syllogism. For example, we can represent a sentence involving S and P by the diagram:



These diagrams are called Venn diagrams.

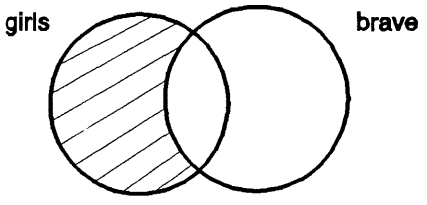
We can diagram our two sentence types as follows:

1. *All S are P*



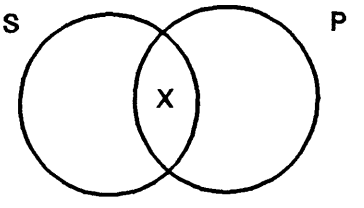
The shaded area indicates that there are no members of S that are not members of P. The "hatching" shows that no members are in this area of set S ... they are all in the region which intersects with set P.

Example: *All girls are brave*



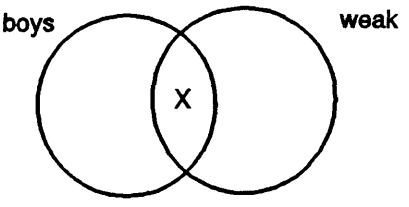
The shaded area indicates that *all girls are brave* and there are no girls that are not brave.

2. *Some S are P*



The **X** marked in the common region indicates that the region is not empty but that there is at least one member of S that is also a member of P.

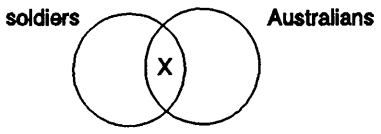
Example: *Some boys are weak*



The **X** marked in the common region indicates that at least one member of the group of boys is also a member of the weak group.

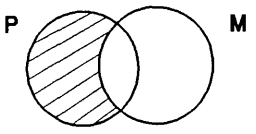
Examples of Venn Diagrams representing premises.

Example 1: *Some soldiers are Australians.*



We are only saying something about some and not all of the soldiers. Nor are we saying something about all Australians. The **X** marked in the common region indicates that the region is not empty but that there is at least one soldier who is an Australian.

Example 2: *All P are M.*

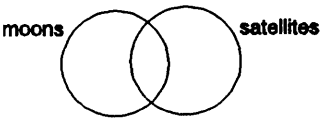


We are saying something about the set of all P but we have not said anything about the set of all M. The shaded area indicates that there are no P that are not M. The hatching shows that there are no members in this area.

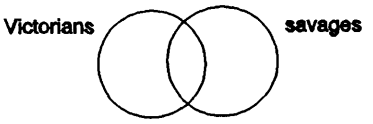
EXERCISE 7

"Shade" or "X" the diagrams below (work on the circles opposite each question) to represent these premises. If you need help, just look at the examples above!

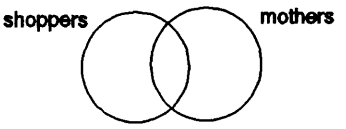
1. *All moons are satellites.*



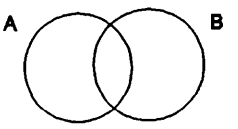
2. *Some Victorians are savages.*



3. *Some shoppers are mothers.*



4. *All A are B.*



[REMEMBER: CHECK YOUR ANSWERS!]

VALIDITY OF SYLLOGISMS

We can use Venn diagrams to determine the validity of syllogisms. We can use the diagrams to find out if the conclusion stated is valid or invalid.

Each syllogism, as you have learnt, has three terms, as in the example:

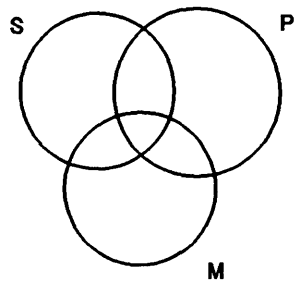
All M are P.

All S are M.

Therefore all S are P.

The three terms are S, M and P.

The three terms of any syllogism can be represented by overlapping circles.



The subject of the conclusion is always represented by the circle on the left, and the predicate of the conclusion is represented by the circle on the right. The middle term is represented by the lower circle.

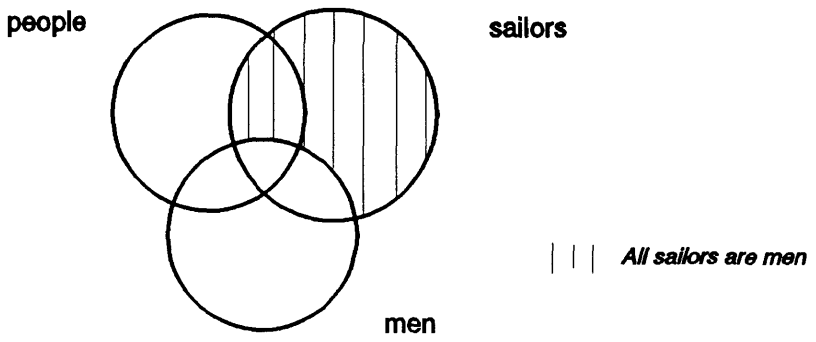
The premises of a syllogisms can be diagrammed on one set of three circles.

Example: *All sailors are men.*

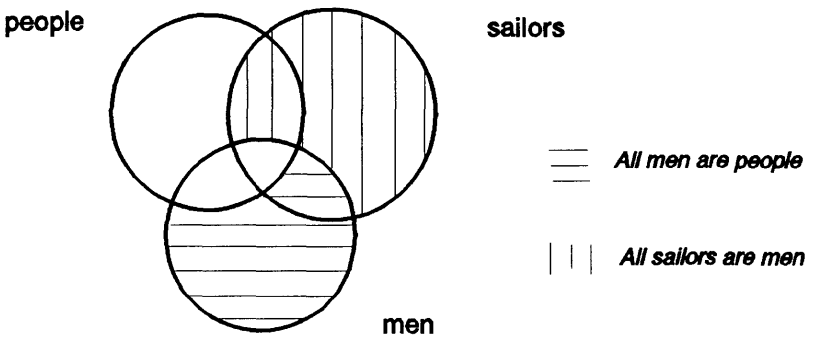
All men are people.

Therefore all people are sailors.

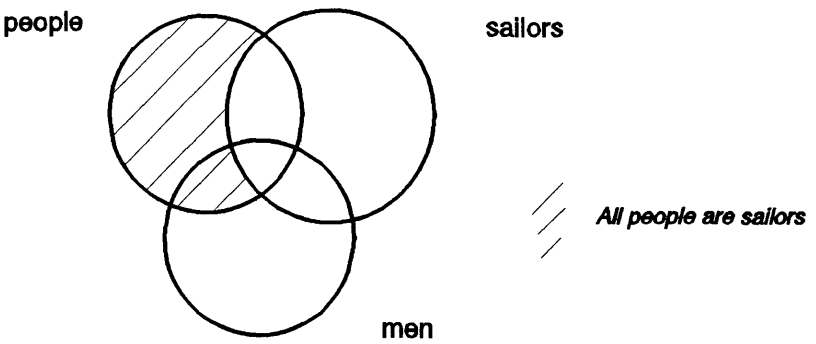
The first premise can be diagrammed by considering the "sailors" and "men" circles:



The second premise can be diagrammed by considering the "men" and "people" circles and adding the appropriate shading:



The conclusion is diagrammed on a separate set of circles:



STEPS AND RULE FOR VALIDITY OF SYLLOGISMS

STEPS

1. Use one "three circle" diagram to represent the premises, using shading to represent those regions that have no members, and a letter X to indicate a region with at least one member.
2. Use another "three circle" diagram to represent the conclusion, using shading to represent a region that has no members, or a letter X to indicate a region with at least one member.

RULE

If the shading or X in the diagram of the conclusion is also present in the corresponding regions in the diagram of the premises, the syllogism is valid. If the diagram of the conclusion contains any shading or X that is not present in the same regions in the diagram of the premises, the syllogism is invalid.

In summary, a syllogism can be checked for validity if corresponding regions in the diagram of the conclusion that are shaded out or contain a cross are similarly marked in the diagram of the premises.

This does not mean that the reverse applies. That is, there may be regions which are shaded or crossed in the diagram of the premises which are not similarly marked in the diagram of the conclusion.

THESE STEPS AND RULE WILL BE CLEAR BY CAREFULLY LOOKING AT THE EXAMPLES ON THE FOLLOWING PAGES.

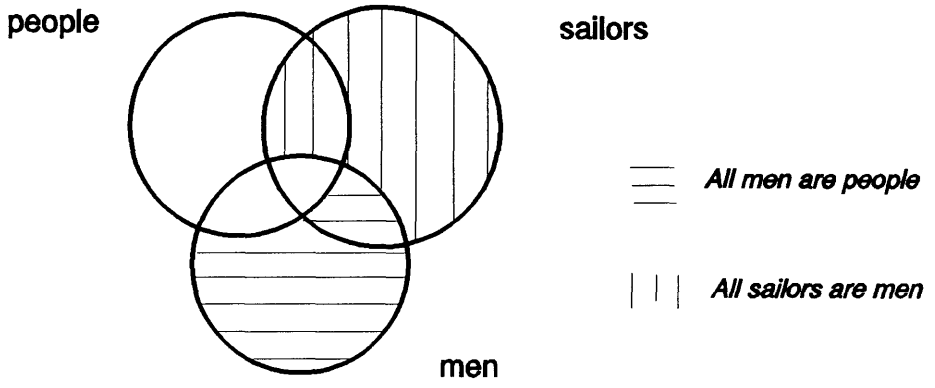
EXAMPLE 1

All sailors are men.

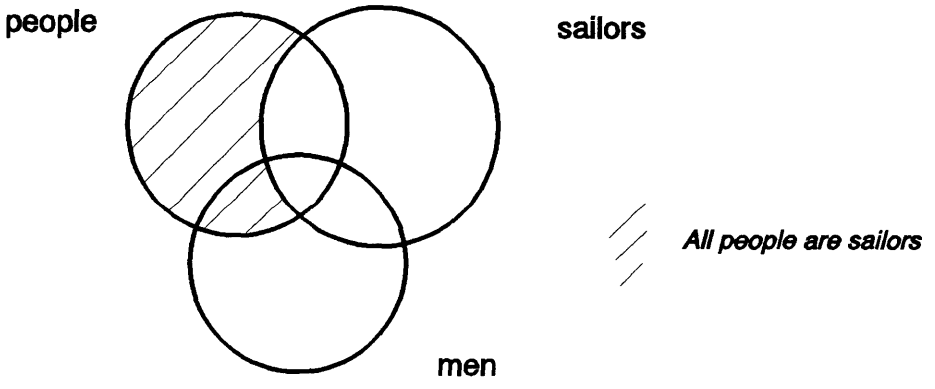
All men are people.

Therefore all people are sailors.

The diagram for the two premises is:



The diagram for the conclusion is:



The shaded region in the second diagram is not shaded in the first diagram.

Therefore the given syllogism is **invalid.**

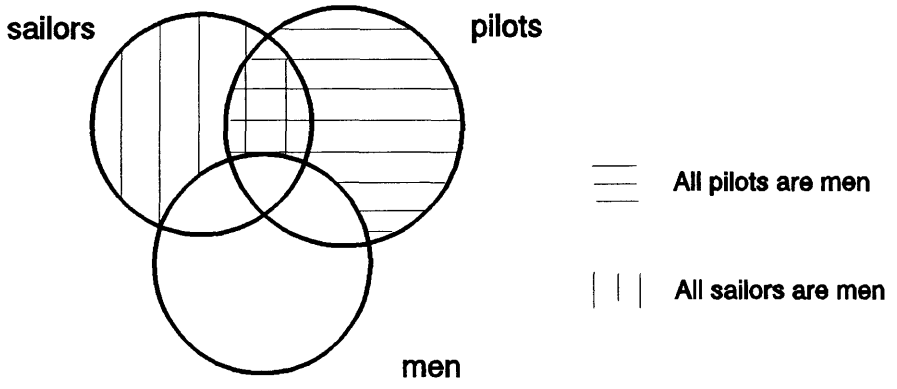
EXAMPLE 2

All pilots are men.

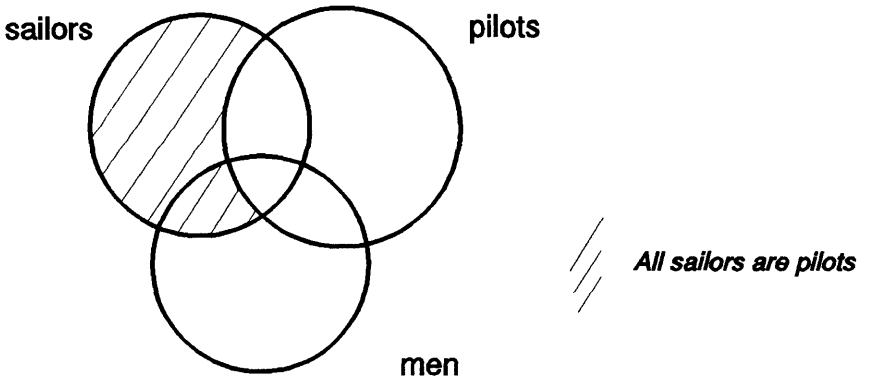
All sailors are men.

Therefore all sailors are pilots.

The diagram for the two premises is:



The diagram for the conclusion is:



The shaded region in the second diagram is not ALL shaded in the first diagram.

Therefore the given syllogism is **invalid.**

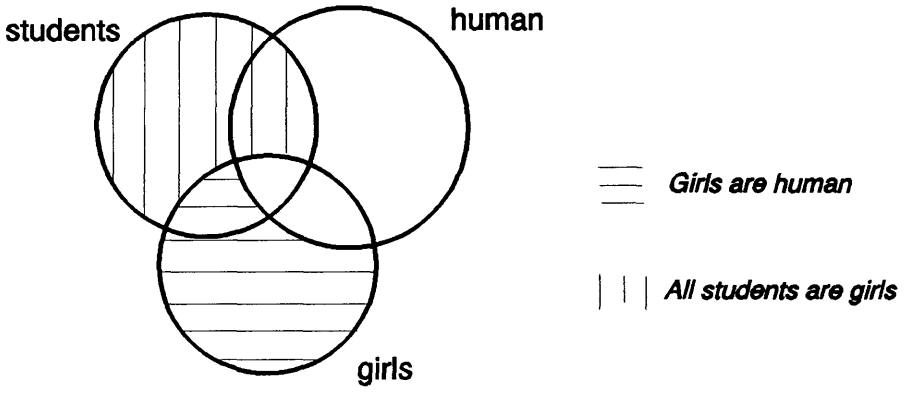
EXAMPLE 3

Girls are human. [means "All girls are human]

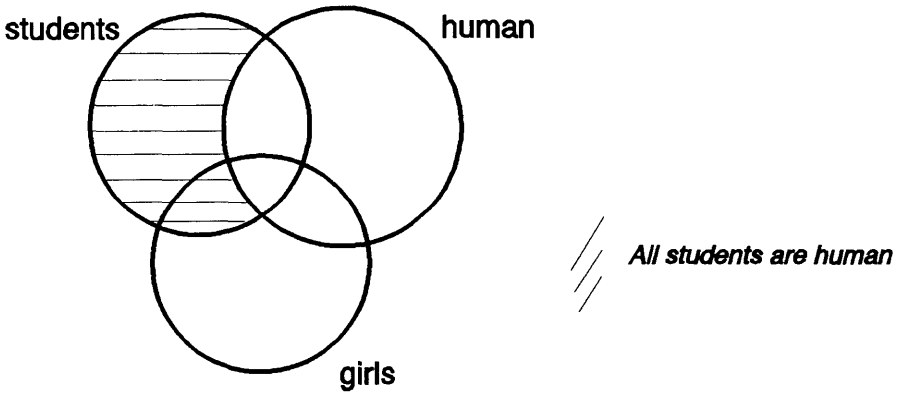
All students are girls.

Therefore all students are human.

The diagram for the two premises is:



The diagram for the conclusion is:



The shaded region in the second diagram is shaded in the first diagram.

Therefore the given syllogism is **valid.**

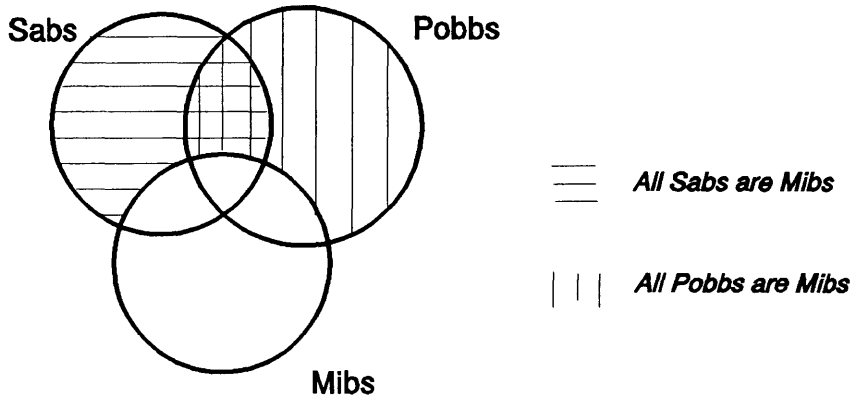
EXAMPLE 4

All Pobbs are Mibs.

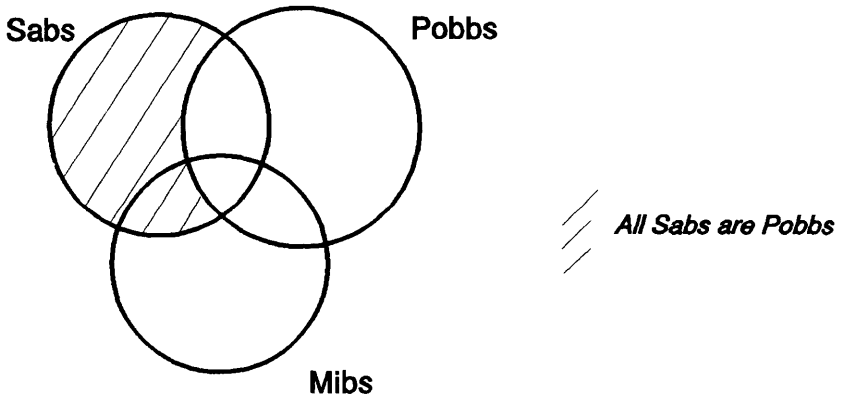
All Sabs are Mibs.

Therefore all Sabs are Pobbs.

The diagram for the two premises is:



The diagram for the conclusion is:



The shaded region in the second diagram is not ALL shaded in the first diagram.

Therefore the given syllogism is **invalid.**

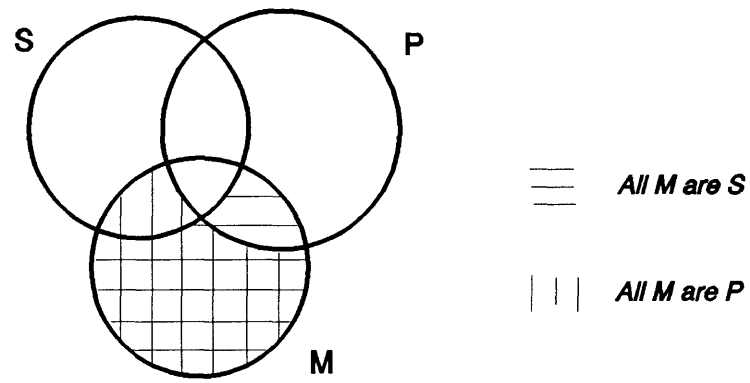
EXAMPLE 5

All M are P.

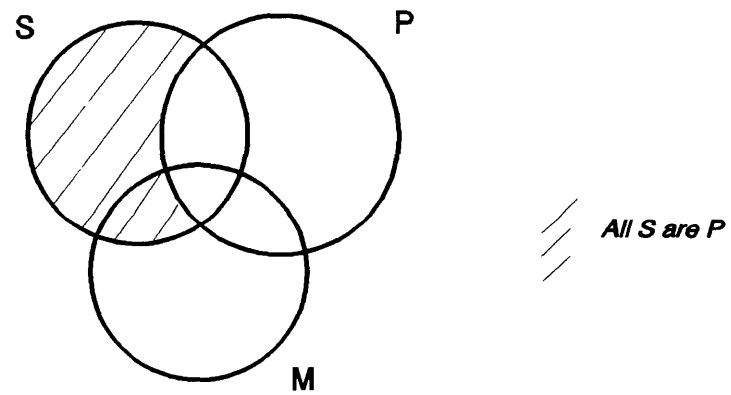
All M are S.

Therefore all S are P.

The diagram for the two premises is:



The diagram for the conclusion is:



The shaded region in the second diagram is not shaded in the first diagram.

Therefore the given syllogism is **invalid.**

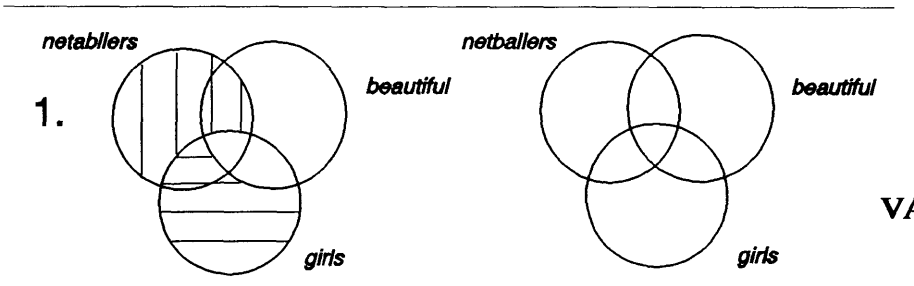
EXERCISE 8

"Shade" the Venn diagrams (on this page!), to find out if the following syllogisms are valid or invalid. (The left sets of circles have already been shaded for the premises. You should shade the right set of circles for the conclusions and then decide if each syllogism is valid or invalid.)

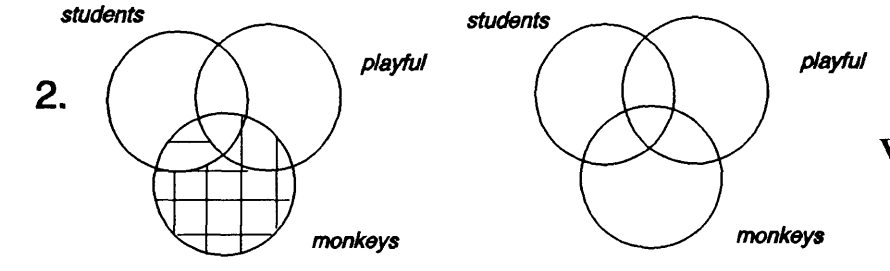
1. *All girls are beautiful.*
   All netballers are girls.
   Therefore all netballers are beautiful.

2. *All monkeys are playful.*
   All monkeys are students.
   Therefore all students are playful.

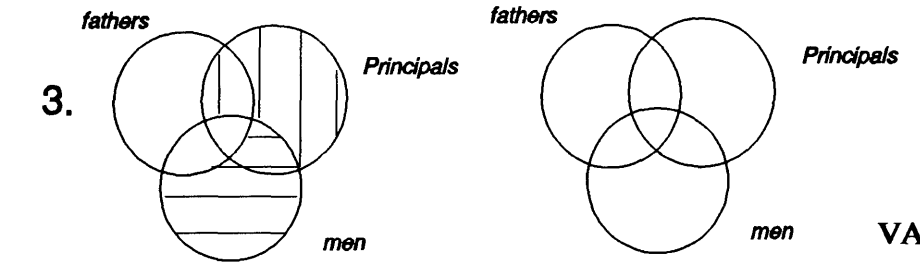
3. *All Principals are men.*
   All men are fathers.
   Therefore all fathers are Principals.



VALID or INVALID?



VALID or INVALID?



VALID or INVALID?

FURTHER EXAMPLES

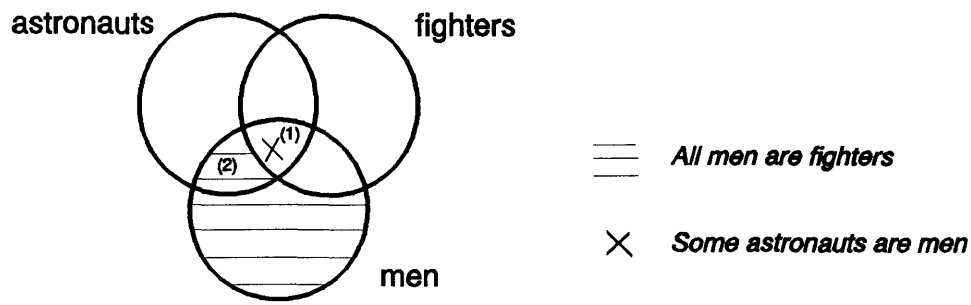
EXAMPLE 6

All men are fighters.

Some astronauts are men.

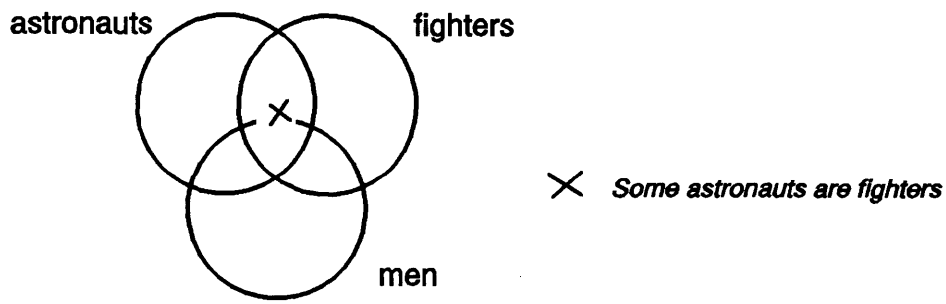
Therefore some astronauts are fighters.

Diagram of the premises:



Note that the **X** applies to the total regions (1) and (2).

Diagram of the conclusion:



The information in the diagram of the conclusion is also shown in the diagram of the premises. (There is an **X** in the intersecting region between "astronauts" and "fighters" in both diagrams.) Therefore the conclusion is **valid.**

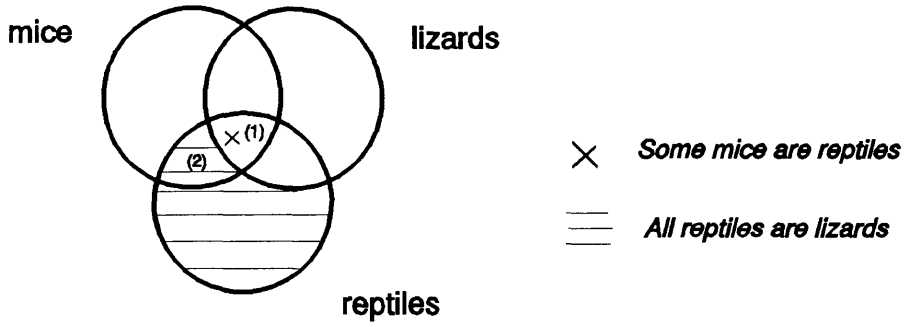
EXAMPLE 7

All reptiles are lizards.

Some mice are reptiles.

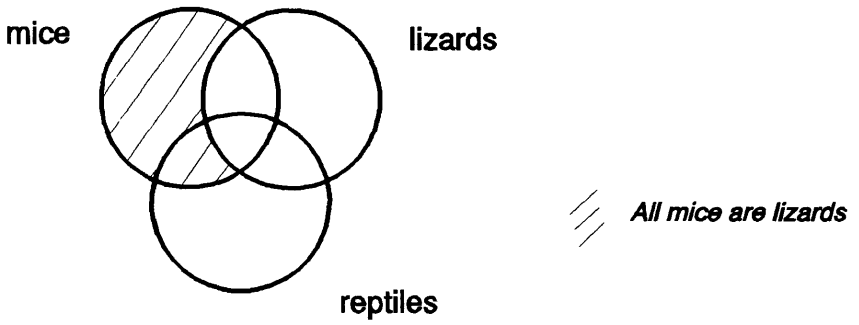
Therefore all mice are lizards.

Diagram of the premises:



Note that the **X** applies to the total regions (1) and (2). (If we had placed the **X** on the line between these regions it may have obscured some of the shading.)

Diagram of the conclusion:



The information shown in the diagram of the conclusion is not shown in the diagram of the premises. Therefore the conclusion is **invalid.**

EXAMPLE 8

Some cars are Fords.

Some Fords are vehicles.

Therefore all vehicles are cars.

Diagram of the premises:

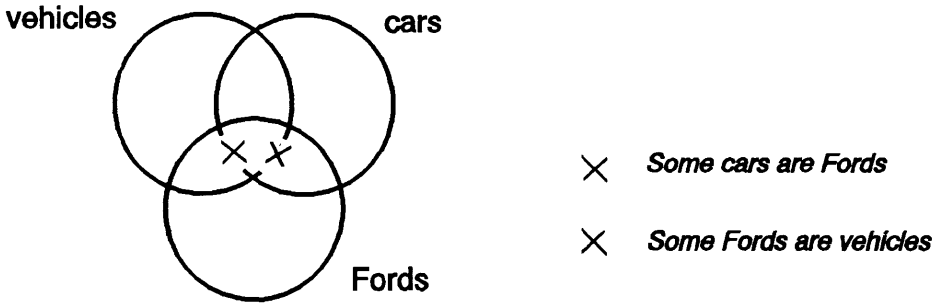
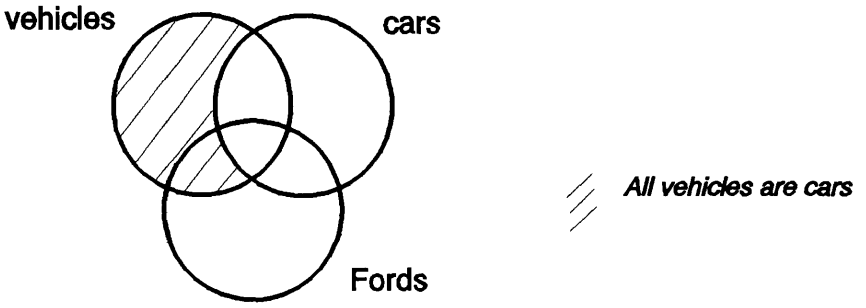


Diagram of the conclusion:



The information shown in the diagram of the conclusion is not shown in the diagram of the premises. Therefore the conclusion is **invalid.**

EXAMPLE 9

All Z are Q.

All K are Z.

Therefore all K are Q.

Diagram of the premises:

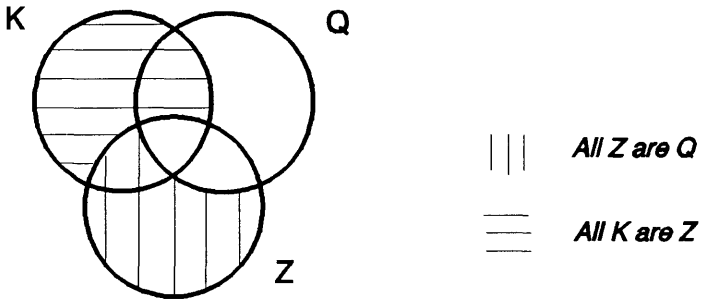
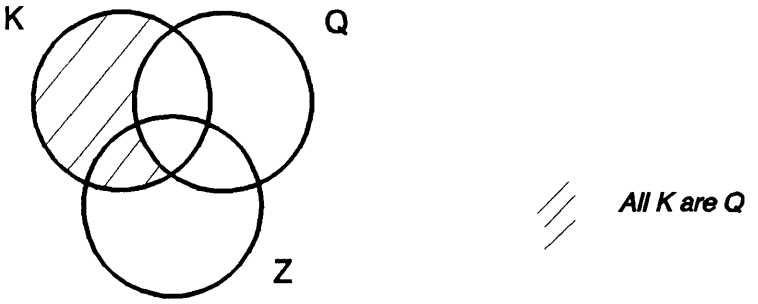


Diagram of the conclusion:



The information in the diagram of the conclusion is also shown in the diagram of the premises. Therefore the conclusion is **valid.**

EXERCISE 9

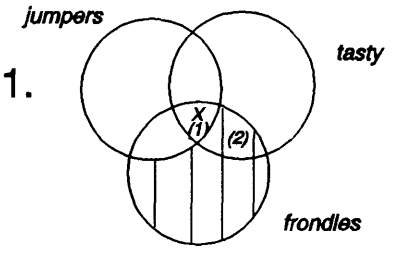
"Shade" or "X" the diagrams (on this page!), and decide if the syllogisms are valid or invalid. (The left sets of circles have been shaded or marked with an "X" for the premises. Shade or X the right set of circles for the conclusions and decide if each syllogism is valid or invalid.)

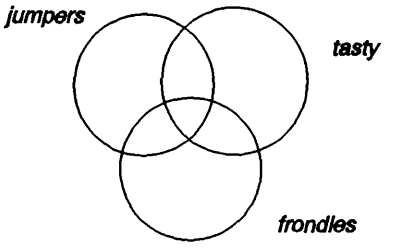
1. *Some frondles are tasty.*
   All frondles are jumpers.
   Therefore some jumpers are tasty.

2. *Some tigers are budgies.*
   All budgies are flowers.
   Therefore some flowers are tigers.

3. *All astronauts are brave.*
   Some husbands are astronauts.
   Therefore all husbands are brave.

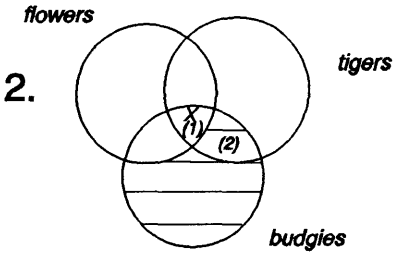
1.

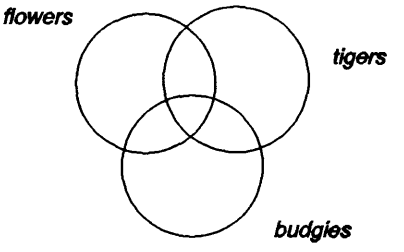




VALID or INVALID?

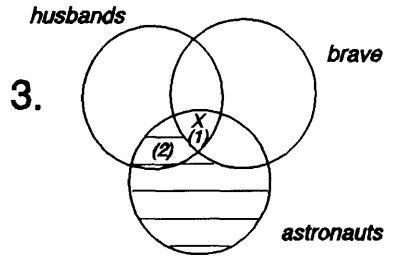
2.

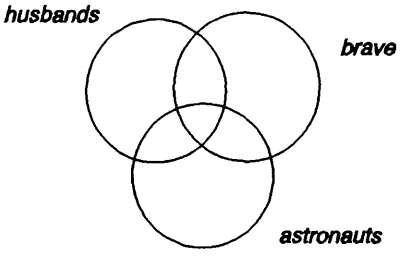




VALID or INVALID?

3.





VALID or INVALID?

ANSWERS TO EXERCISES

EXERCISE 1

1. **(a)** {F, R, O, G} **(b)** {B, A, N} **(c)** {1, 2, 3, 4, 5, 6, 7} **2.** Yes **3.** Yes
4. **(a)** 5 **(b)** Yes **5. (a)** 7 **(b)** No

EXERCISE 2

1. P ⊂ Q **2.(a)** Yes **(b)** No **3. (a)** No **(b)** Yes **(c)** No **(d)** No **4. (a)** B = {1, 2, 5} **(b)** Yes

EXERCISE 3

1. **(a)** {2, 4, 5, 6, 7, 10} **(b)** {5} **2. (a)** No **(b)** Yes **(c)** No **(d)** Yes **(e)** No **(f)** Yes
3. **(a)** {Jenny, Joanne, Sarah, Sharon, Simone} **(b)** { }

EXERCISE 4

1. **(a)** Yes **(b)** No **(c)** Yes **(d)** Yes **(e)** Yes **(f)** Yes **2. (a)** No **(b)** Yes **(c)** No **(d)** Yes

EXERCISE 5

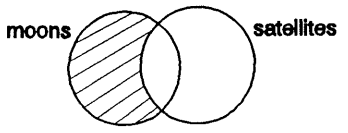
1. **(a)** Yes **(b)** Yes **(c)** No **(d)** No **(e)** Yes **(f)** Yes **(g)** Yes **2.** Yes

EXERCISE 6

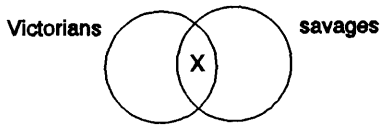
1.	Middle term: "boys"	Subject: "animals"	Predicate: "footballers"
2.	Middle term: "stupid"	Subject: "blips"	Predicate: "dumbos"
3.	Middle term: "plants"	Subject: "trees"	Predicate: "flowers"

EXERCISE 7

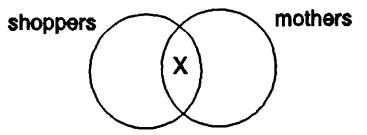
1.



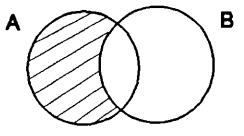
2.



3.

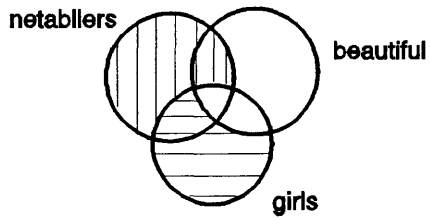


4.



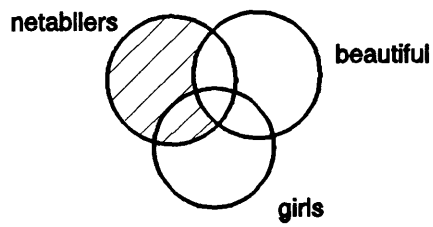
ANSWERS TO EXERCISE 8

1.



All girls are beautiful

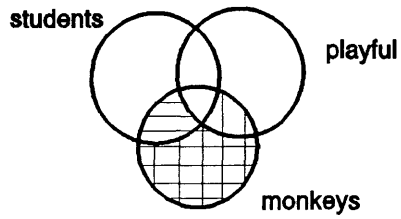
All netballers are girls



All netballers are beautiful

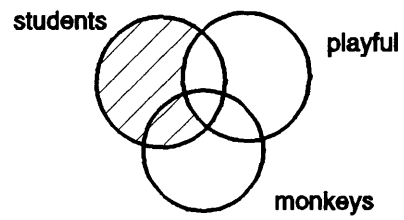
CONCLUSION VALID

2.



All monkeys are playful

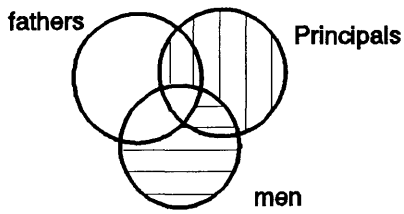
All monkeys are students



All students are playful

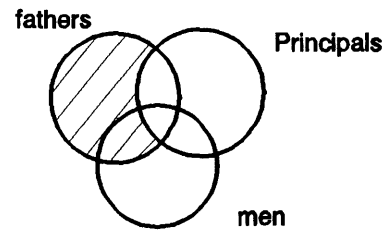
CONCLUSION INVALID

3.



All men are fathers

All Principals are men

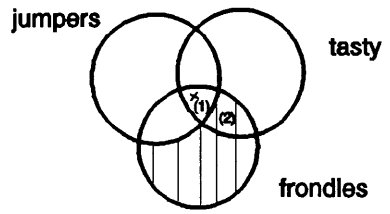


All fathers are Principals

CONCLUSION INVALID

ANSWERS TO EXERCISE 9

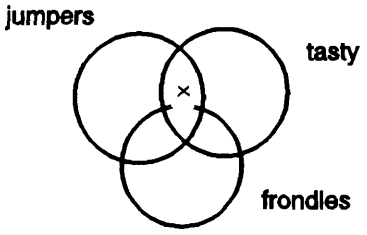
1.



× *Some frondles are tasty*

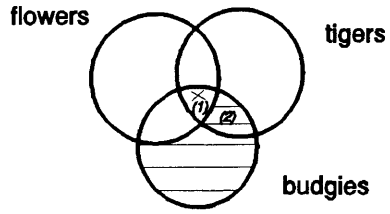
||| *All frondles are jumpers*

CONCLUSION VALID



× *Some jumpers are tasty*

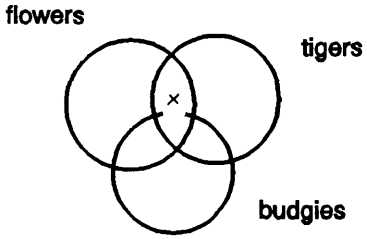
2.



× *Some tigers are budgies*

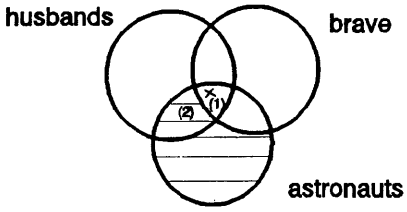
≡ *All budgies are flowers*

CONCLUSION VALID



× *Some flowers are tigers*

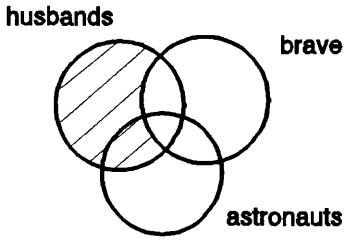
3.



= *All astronauts are brave*

× *Some husbands are astronauts*

CONCLUSION INVALID



// *All husbands are brave*

APPENDIX F

TRIAL ACHIEVEMENT TEST AND RESULTS (Study 2)

TRIAL ACHIEVEMENT TEST

Please attempt all questions.

You can do rough working on the spare paper provided.

Circle the letter of your answer. If you change your mind, cross out the circle you no longer want. Then circle your new answer.

****

Now let us try some examples:

1. Which of the following statements is **not** correct?:

   A: A set can have any number of members.

   B: A set can be empty.

   C: A set can have letters and numbers as members.

   D: All sets have exactly one member.

Your answer: **A B C D**

Some questions ask if a conclusion is **V**alid or **I**nvalid.

2. *All birds can fly.*

   All swans are birds.

   Therefore all swans can fly.

Is the conclusion **V**alid or **I**nvalid? Your answer: **V I**

1. Which one of the following statements is **not** correct?:

   A: A set is a collection of elements.

   B: An element can belong to more than one set.

   C: A set must have at least one element.

   D: A set may have its elements listed in any order.

   Your answer: **A B C D**

2. Which one of the following is a correct statement?:

   A: A set may have no elements.

   B: The empty set must have one letter as an element.

   C: Two sets are equal if they have an equal numbers of elements.

   D: Elements can be letters or numbers, but not words.

   Your answer: **A B C D**

3. Which one of the following statements is **not** correct?:

   A: A set is represented by a capital letter.

   B: The symbol $\subset$ is used for the words "is a subset of".

   C: The symbol $\cap$ is used for the words "is a subset of".

   D: The symbol $\in$ is used for the words "is an element of".

   Your answer: **A B C D**

4. Which one of the following is a correct statement?:

   A: All sets labelled A in every textbook have the same number of elements.

   B: The symbol $\not\subset$ is used for the words "is not a subset of".

   C: Set A $\neq$ Set B means the two sets must have an unequal numbers of elements.

   D: The symbol $\in$ is used for the words "is not an element of".

   Your answer: **A B C D**

5. Which one of the following statements is correct?

   A: $P \subset Q$ means that the elements in set Q are a subset of the elements in set P

   B: $\{\} \subset P$ means that set P is a subset of the empty set

   C: $P \subset Q$ means that P is a subset of set Q

   D: $P = \{Q, R, S\}$ means that P has 4 elements.

   Your answer: **A B C D**

6. If $A = \{dog, cat, cow\}$ and $B = \{cat, horse\}$, what are the elements of $A \cap B$?

   A: {dog, cat, cow, horse}

   B: {dog, cat, cow, cat, horse}

   C: {dog, cat}

   D: {cat}

   Your answer: **A B C D**

7. If $A = \{dog, cat, cow\}$ and $B = \{cow, horse\}$, what are the elements of $A \cup B$?

   A: {dog, cat, cow, horse}

   B: {horse}

   C: {dog, cat}

   D: {cat}

   Your answer: **A B C D**

8. If $B = \{1, 2, 3, 4, 5\}$ and $C = \{1, 3, 5\}$, which sentence is a correct statement?

   A: Set C = {all numbers less than 20}

   B: $C \subset B$

   C: $B \subset C$

   D: $B = C$

   Your answer: **A B C D**

9. Which set shows the elements in the word ASSESS ?

A: {A, 4 Ss, E}

B: {A, S, E}

C: {A, S, S, E, S, S}

D: {A, four Ss, E}

Your answer: **A B C D**

10. If P = {5, 10, 15, 20} and Q = {5, 20} which of the following statements is correct?

A: $\{15\} \subset Q$

B: $\{15\} \subset P$

C: $\{5, 15\} \subset Q$

D: $\{5, 10\} \not\subset P$

Your answer: **A B C D**

11. Given the sets S = {a, b, c, d, e} and A = {a, c, e}, which one of the following statements is correct?

A: The set A is a subset of set S.

B: The set B = {f} is a subset of the empty set.

C: The set C = {d} is a subset of set A.

D: The set D = {e, d, c, b, a} is not equal to the set S.

Your answer: **A B C D**

12. S is the set of all workers at a Pizza Hut, and M is the set of all male workers. The names of the male workers are Adams, Brown, Cook and Dale. The names of the female employees are Evans and Ford. Which one of the following statements is correct?

A: M = S

B: M = {Adams, Cook}

C: $M \neq S$

D: $M \cap S = \{\ \}$

Your answer: **A B C D**

13. If P = {1, 2, 5} and Q = {2, 5, 1} which of the following statements is correct?

A: $P = Q$

B: $P \neq Q$

C: $P \not\subset Q$

D: $P \cap Q = \{\ \}$

Your answer: **A B C D**

14. If A = {1, 2, apple} and B = {3, apple}, which of the following statements is correct?

A: $A \cap B = \{1, 2, 3\}$

B: $A \cap B = \{3\}$

C: $A \cap B = \{\text{apple}\}$

D: $A \cap B = \{1, 2\}$

Your answer: **A B C D**

15. If A = {4, 5, 6,}, B = {5, 6, 7} and C = {6, 7, 8}, which of the following statements is correct?

A: $A \cap B = \{5, 6, 7\}$

B: $A \cup B = \{5, 6, 7\}$

C: $B \cap C = \{6, 7\}$

D: $B \cup C = \{5, 6, 7\}$

Your answer: **A B C D**

END OF PART A

PART B

16. Which is a correct understanding of "*All dogs are animals*"?

A: all dogs and animals are the same group

B: all dogs and animals are separate groups

C: animals are part of the group of all dogs

D: all dogs are part of the group of animals

Your answer: **A B C D**

17. Which one of the following statements is **not** correct?:

A: To solve a syllogism, you need to know the meaning of each term.

B: The subject and predicate of a syllogism is found in the conclusion.

C: A syllogism can be valid, but it also can be untrue.

D: A syllogism contains two premises.

Your answer: **A B C D**

18. Which one of the following statements is correct?:

A: The middle term of a syllogism only occurs in the first premise.

B: In the premise "*All dogs are animals*", the middle term must be "dogs".

C: In the premise "*All dogs are animals*", the middle term must be "animals".

D: The middle term of a syllogism occurs in both premises.

Your answer: **A B C D**

19. Which one of the following statements is correct?:

A: The middle term's position in the premises cannot vary.

B: The subject of the conclusion is in neither premise.

C: The middle term of a syllogism may be preceded by "*all*".

D: The middle term of a syllogism must be in the conclusion.

Your answer: **A B C D**

20. For a syllogism to be valid:

A: The conclusion must include all three terms.

B: The conclusion must be "common sense".

C: The subject of the conclusion must be a real animal or a real object.

D: The conclusion must follow logically from the premises.

Your answer: **A B C D**

[If your lesson set used diagrams, there are two pages at the end of this test to use as worksheets to save you drawing the circles for the last 10 questions that follow. If your lesson set did not use Venn diagram circles, ignore these worksheets as you do these questions.]

21. *All frisky animals are puppies.*
All puppies are cute animals.
Therefore some cute animals are frisky animals.

Is the conclusion Valid or Invalid?

Your answer: **V I**

22. *All M are P.*
Some S are M.
Therefore all S are P.

Is the conclusion Valid or Invalid?

Your answer: **V I**

23. *Some dogs are mammals.*
All mammals are cats.
Therefore some cats are dogs.

Is the conclusion Valid or Invalid?

Your answer: **V I**

24. *All M are P.*
All S are M.
Therefore all S are P.

Is the conclusion Valid or Invalid?

Your answer: **V I**

25. *All elephants are grey.*
This animal is grey.
Therefore this animal is an elephant.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

26. *Some seals bark.*
Some dogs are seals.
Therefore all dogs bark.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

27. *Some dogs like to sing.*
All dogs are snowdrops.
Therefore some snowdrops like to sing.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

28. *Some quiples can talk.*
All grobs are quiples.
Therefore all grobs can talk.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

29. *All B are C.*
Some A are B.
Therefore every A is C.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

30. *All artists are happy people.*
Some artists are rich people.
Therefore some rich people are happy people.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

END OF PART B

PART C

31. Which one of the following statements is correct?:

A: A set S cannot be defined as a set of shapes.

B: A set can have any number of members.

C: A set must have at least one member.

D: A set cannot be empty.

Your answer: **A B C D**

32. Which one of the following is a correct statement?:

A: Set A = {p, i} is the set of elements in the word "pip".

B: All sets labelled S in every textbook are equal.

C: Set A = Set B means the two sets must have equal numbers of elements.

D: The symbol ∩ is used for the words "is not in intersection with".

Your answer: **A B C D**

33. In the syllogism:

Some M are P.
All S are M.
Therefore all S are P.

which statement is correct?:

A: M is the subject of the conclusion.

B: M is the middle term.

C: M is the predicate of the conclusion.

D: S is the middle term.

Your answer: **A B C D**

34. In the syllogism: *Some men are strong.*
All boxers are men.
Therefore all boxers are strong.

which statement is correct, based upon its premises?:

A: All boxers are not men.

B: All men are strong.

C: No boxers are men.

D: Only some men are strong.

Your answer: **A B C D**

35. Which set shows the elements in the union of the set of letters in the word ASSESS and the set of letters in the word SEAS ?

A: {2 As, 6 Ss, 2 Es}

B: {A, S, E}

C: {A, S, S, E, S, S, S, E, A, S}

D: {two As, six Ss, two Es}

Your answer: **A B C D**

36. If R = {a, b, 15, 20} and S = {a, 20} which of the following statements is correct?

A: $\{15\} \subset R$

B: $\{15\} \subset S$

C: $\{a, 15\} \subset S$

D: $\{a, b\} \not\subset R$

Your answer: **A B C D**

37. Given the sets A = {straw, box, hen, egg} and B = {hen}, which one of the following statements is correct?

A: The set D = {hen, box} is equal to the set A.

B: The set C = {h} is a subset both sets A and B.

C: The set C = {straw} is a subset of set B.

D: The set B is a subset of set A.

Your answer: **A B C D**

38. *All Ms are Ps.*
Some Ss are Ms.
Therefore all Ss are Ps.

Is the conclusion Valid or Invalid?

Your answer: **V I**

39. *All R are Q.*
All T are R.
Therefore all T are Q.

Is the conclusion Valid or Invalid?

Your answer: **V I**

40. *All marsupials are cuddly.*
Some marsupials are koalas.
Therefore some koalas are cuddly.

Is the conclusion Valid or Invalid?

Your answer: **V I**

END OF TEST

ITEM ANALYSES OF TRIAL ACHIEVEMENT TEST -
UNDERSTANDING AND KNOWLEDGE OF SETS AND SYLLOGISMS (UK)

TYPE	QUESTION	DIFFICULTY PARAMETER	ITEM - TOTAL CORRELATION [$r_{i(t-1)}$]	ALPHA RELIABILITY COEFFICIENT
UK	1	.85	.65	.81
	2	.78	.64	
	3	.74	.34	
	4	.81	.60	
	5	.76	.47	
	16	.78	.06	
	17	.67	.36	
	18	.81	.61	
	19	.43	.19	
	20	.63	.46	
	31	.81	.57	
	32	.74	.41	
	33	.72	.46	
	34	.81	.33	

Using the multiple criteria of difficulty, reliability and redundancy, the above group of 14 questions were reduced to 9 questions:

Questions 1, 2, 4, 5, 31 on understanding and knowledge of Set Theory, and

Questions 17, 18, 20, 33 on understanding and knowledge of syllogisms.

ITEM ANALYSES OF TRIAL ACHIEVEMENT TEST - SET MANIPULATION TASKS (SM)

TYPE	QUESTION	DIFFICULTY PARAMETER	ITEM - TOTAL CORRELATION [$r_{i(t-1)}$]	ALPHA RELIABILITY COEFFICIENT
SM	6	.59	.66	.87
	7	.61	.71	
	8	.67	.55	
	9	.80	.60	
	10	.72	.45	
	11	.85	.50	
	12	.56	.43	
	13	.87	.39	
	14	.56	.62	
	15	.59	.54	
	35	.72	.69	
	36	.72	.43	
	37	.74	.36	

Using the multiple criteria of difficulty, reliability and redundancy, the above group of 14 questions were reduced to 9 questions:

Questions 6, 7, 8, 9, 10, 11, 14, 15, 35 on performance on manipulatory tasks related to sets.

ITEM ANALYSES OF TRIAL ACHIEVEMENT TEST - SYLLOGISTIC REASONING TASKS (SR)

TYPE	QUESTION	DIFFICULTY PARAMETER	ITEM - TOTAL CORRELATION [$r_{i(t-1)}$]	ALPHA RELIABILITY COEFFICIENT
SR	21	.46	.02	.60
	22	.80	.06	
	23	.44	.25	
	24	.83	.34	
	25	.54	.42	
	26	.69	.53	
	27	.48	.42	
	28	.70	.26	
	29	.74	.35	
	30	.65	.09	
	38	.74	.26	
	39	.78	.30	
	40	.70	.05	

Using the multiple criteria of difficulty, reliability and redundancy, the above group of 14 questions were reduced to 8 questions:

Questions 24, 25, 26, 27, 28, 29, 38, 39 on performance on deductive reasoning tasks related to syllogisms. Two questions were added similar to questions 27 and 28 to balance the types of syllogistic reasoning questions to be 3 nonsense, 3 ordinary and 4 abstract. See Appendix A.24 for analysis of questions used in the main study.

DIFFICULTY PARAMETERS -

TRIAL ACHIEVEMENT TEST USED AS A PRE-TEST

Q1	.30	Q11	.36	Q21	.36	Q31	.21
Q2	.31	Q12	.25	Q22	.39	Q32	.18
Q3	.27	Q13	.19	Q23	.31	Q33	.19
Q4	.27	Q14	.27	Q24	.37	Q34	.31
Q5	.24	Q15	.28	Q25	.42	Q35	.25
Q6	.21	Q16	.28	Q26	.33	Q36	.20
Q7	.27	Q17	.24	Q27	.34	Q37	.47
Q8	.25	Q18	.18	Q28	.42	Q38	.38
Q9	.24	Q19	.21	Q29	.39	Q39	.55
Q10	.30	Q20	.19	Q30	.46	Q40	.59

APPENDIX G

POST AND DELAYED TESTS (Study 2)

POST TEST (ACHIEVEMENT TEST)

Please attempt all questions.

You can do rough working on the back of each page.

Circle the letter of your answer. If you change your mind, cross out the circle you no longer want. Then circle your new answer.

****

Now let us try some examples:

1. Which of the following statements is **not** correct?

   A: All sets have exactly one member.

   B: A set can be empty.

   C: A set can have letters and numbers as members.

   D: A set can have any number of members.

Your answer: **A B C D**

Some questions ask if a conclusion is **V**alid or **I**nvalid.

2. *All birds can fly.*

   All swans are birds.

   Therefore all swans can fly.

   Is the conclusion **V**alid or **I**nvalid? Your answer: **V I**

[Answers: 1 - **A**, 2 - **V**]

1. Which one of the following statements is **not** correct?

   A: A set is a collection of elements.

   B: An element can belong to more than one set.

   C: A set must have at least one element.

   D: A set may have its elements listed in any order.

   Your answer: **A B C D**

2. Which one of the following is a correct statement?

   A: A set may have no elements.

   B: The empty set must have one letter as an element.

   C: Two sets are equal if they have an equal numbers of elements.

   D: Elements can be letters or numbers, but not words.

   Your answer: **A B C D**

3. Which one of the following is a correct statement?

   A: All sets labelled A in every textbook have the same number of elements.

   B: The symbol $\not\subset$ is used for the words "is not a subset of".

   C: Set A $\neq$ Set B means the two sets must have an unequal numbers of elements.

   D: The symbol $\in$ is used for the words "is not an element of".

   Your answer: **A B C D**

4. Which one of the following statements is correct?

   A: $P \subset Q$ means that the elements in set Q are a subset of the elements in set P.

   B: $\{\} \subset P$ means that set P is a subset of the empty set.

   C: $P \subset Q$ means that P is a subset of set Q.

   D: $P = \{Q, R, S\}$ means that P has 4 elements.

   Your answer: **A B C D**

5. Which one of the following statements is correct?

   A: A set S cannot be defined as a set of shapes.

   B: A set can have any number of members.

   C: A set must have at least one member.

   D: A set cannot be empty.

Your answer: **A B C D**

6. If A = {dog, cat, cow} and B = {cat, horse}, what are the elements of $A \cap B$?

   A: {dog, cat, cow, horse}

   B: {dog, cat, cow, cat, horse}

   C: {dog, cat}

   D: {cat}

Your answer: **A B C D**

7. If A = {dog, cat, cow} and B = {cow, horse}, what are the elements of $A \cup B$?

   A: {dog, cat, cow, horse}

   B: {horse}

   C: {dog, cat}

   D: {cat}

Your answer: **A B C D**

8. If B = {1, 2, 3, 4, 5} and C = {1, 3, 5}, which sentence is a correct statement?

   A: Set C = {all numbers less than 20}

   B: $C \subset B$

   C: $B \subset C$

   D: B = C

Your answer: **A B C D**

9. Which set shows the elements in the word ASSESS ?

A: {A, 4 Ss, E}

B: {A, four Ss, E}

C: {A, S, S, E, S, S}

D: {A, S, E}

Your answer: **A B C D**

10. If P = {5, 10, 15, 20} and Q = {5, 20} which of the following statements is correct?

A: $\{15\} \subset Q$

B: $\{15\} \subset P$

C: $\{5, 15\} \subset Q$

D: $\{5, 10\} \not\subset P$

Your answer: **A B C D**

11. Given the sets S = {a, b, c, d, e} and A = {a, c, e}, which one of the following statements is correct?

A: The set A is a subset of set S.

B: The set B = {f} is a subset of the empty set.

C: The set C = {d} is a subset of set A.

D: The set D = {e, d, c, b, a} is not equal to the set S.

Your answer: **A B C D**

12. If A = {1, 2, apple} and B = {3, apple}, which of the following statements is correct?

A: $A \cap B = \{1, 2, 3\}$

B: $A \cap B = \{3\}$

C: $A \cap B = \{\text{apple}\}$

D: $A \cap B = \{1, 2\}$

Your answer: **A B C D**

13. If A = {4, 5, 6,}, B = {5, 6, 7} and C = {6, 7, 8}, which of the following statements is correct?

A: $A \cap B = \{5, 6, 7\}$

B: $A \cup B = \{5, 6, 7\}$

C: $B \cap C = \{6, 7\}$

D: $B \cup C = \{5, 6, 7\}$

Your answer: **A B C D**

14. Which set shows the elements in the union of the set of letters in the word ASSESS and the set of letters in the word SEAS ?

A: {2 As, 6 Ss, 2 Es}

B: {A, S, E}

C: {A, S, S, E, S, S, S, E, A, S}

D: {two As, six Ss, two Es}

Your answer: **A B C D**

END OF PART A

STOP HERE

PART B

15. Which one of the following statements is **not** correct?

A: To solve a syllogism, you need to know the meaning of each term.

B: The subject and predicate of a syllogism is found in the conclusion.

C: A syllogism can be valid, but it also can be untrue.

D: A syllogism contains two premises.

Your answer: **A B C D**

16. Which one of the following statements is correct?

A: The middle term of a syllogism only occurs in the first premise.

B: In the premise "*All dogs are animals*", the middle term must be "dogs".

C: In the premise "*All dogs are animals*", the middle term must be "animals".

D: The middle term of a syllogism occurs in both premises.

Your answer: **A B C D**

17. For a syllogism to be valid:

A: The conclusion must include all three terms.

B: The conclusion must be "common sense".

C: The subject of the conclusion must be a real animal or a real object.

D: The conclusion must follow logically from the premises.

Your answer: **A B C D**

18. In the syllogism: *Some M are P.*
All S are M.
Therefore all S are P.

which statement is correct?

A: M is the middle term.

B: M is the subject of the conclusion.

C: M is the predicate of the conclusion.

D: S is the middle term.

Your answer: **A B C D**

19. *All M are P.*
All S are M.
Therefore all S are P.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V I**

20. *All elephants are grey.*
This animal is grey.
Therefore this animal is an elephant.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V I**

21. *Some seals bark.*
Some dogs are seals.
Therefore all dogs bark.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V I**

22. *Some dogs like to sing.*
All dogs are snowdrops.
Therefore some snowdrops like to sing.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V I**

23. *Some quiples can talk.*
All grobs are quiples.
Therefore all grobs can talk.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

24. *All B are C.*
Some A are B.
Therefore every A is C.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

25. *All Ms are Ps.*
Some Ss are Ms.
Therefore all Ss are Ps.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

26. *All R are Q.*
All T are R.
Therefore all T are Q.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

27. *Some trees are evergreens.*
All evergreens are gums.
Therefore all gums are trees.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

28. *Some Tasmanians are athletic.*
All Tasmanians are dancers.
Therefore some dancers are athletic.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

END OF TEST

DELAYED TEST (FOLLOW-UP TEST)

Please attempt all questions.

You can do rough working on the back of each page.

Circle the letter of your answer. If you change your mind, cross out the circle you no longer want. Then circle your new answer.

****

Now let us try some examples:

1. Which of the following statements is **not** correct?

   A: An empty set has only one element.

   B: A set can have words as elements.

   C: A set can have letters as elements.

   D: A set can have any number of elements.

Your answer: **A B C D**

Some questions ask if a conclusion is **V**alid or **I**nvalid.

2. *All girls can sing.*

   All students are girls.

   Therefore all students can sing.

   Is the conclusion **V**alid or **I**nvalid? Your answer: **V I**

[Answers: 1 - **A**, 2 - **V**]

1. Which one of the following statements is **not** correct?

   A: A set is a collection of elements.

   B: An element can belong to more than one set.

   C: A set must have at least one element.

   D: A set may have its elements listed in any order.

   Your answer: **A B C D**

2. Which one of the following is a correct statement?

   A: A set may have no elements.

   B: The empty set must have one letter as an element.

   C: Two sets are equal if they have an equal numbers of elements.

   D: Elements can be letters or numbers, but not words.

   Your answer: **A B C D**

3. Which one of the following is a correct statement?

   A: All sets labelled A in every textbook have the same number of elements.

   B: The symbol $\not\subset$ is used for the words "is not a subset of".

   C: Set A $\neq$ Set B means the two sets must have an unequal numbers of elements.

   D: The symbol $\in$ is used for the words "is not an element of".

   Your answer: **A B C D**

4. Which one of the following statements is correct?

   A: P $\subset$ Q means that the elements in set Q are a subset of the elements in set P.

   B: $\{\} \subset$ P means that set P is a subset of the empty set.

   C: P $\subset$ Q means that P is a subset of set Q.

   D: P = {Q, R, S} means that P has 4 elements.

   Your answer: **A B C D**

5. Which one of the following statements is correct?

   A: A set S cannot be defined as a set of shapes.

   B: A set can have any number of members.

   C: A set must have at least one member.

   D: A set cannot be empty.

Your answer: **A B C D**

6. If A = {emu, pig, bull} and B = {pig, donkey}, what are the elements of $A \cap B$?

   A: {emu, pig, bull, donkey}

   B: {emu, pig, bull, pig, donkey}

   C: {emu, pig}

   D: {pig}

Your answer: **A B C D**

7. If A = {emu, pig, bull} and B = {bull, donkey}, what are the elements of $A \cup B$?

   A: {emu, pig, bull, donkey}

   B: {donkey}

   C: {emu, pig}

   D: {pig}

Your answer: **A B C D**

8. If B = {1, 2, 3, 4, 5} and C = {1, 3, 5}, which sentence is a correct statement?

   A: Set C = {all numbers less than 20}

   B: $C \subset B$

   C: $B \subset C$

   D: B = C

Your answer: **A B C D**

9. Which set shows the elements in the word POPPY ?

A: {3 Ps, O, Y}

B: {three Ps, O, Y}

C: {P, O, P, P, Y}

D: {P, O, Y}

Your answer: **A B C D**

10. If P = {5, 10, 15, 20} and Q = {5, 20} which of the following statements is correct?

A: $\{15\} \subset Q$

B: $\{15\} \subset P$

C: $\{5, 15\} \subset Q$

D: $\{5, 10\} \not\subset P$

Your answer: **A B C D**

11. Given the sets S = {a, b, c, d, e} and A = {a, c, e}, which one of the following statements is correct?

A: The set A is a subset of set S.

B: The set B = {f} is a subset of the empty set.

C: The set C = {d} is a subset of set A.

D: The set D = {e, d, c, b, a} is not equal to the set S.

Your answer: **A B C D**

12. If A = {1, 2, turtle} and B = {3, turtle}, which of the following statements is correct?

A: $A \cap B = \{1, 2, 3\}$

B: $A \cap B = \{3\}$

C: $A \cap B = \{\text{turtle}\}$

D: $A \cap B = \{1, 2\}$

Your answer: **A B C D**

13. If A = {4, 5, 6,}, B = {5, 6, 7} and C = {6, 7, 8}, which of the following statements is correct?

A: $A \cap B = \{5, 6, 7\}$

B: $A \cup B = \{5, 6, 7\}$

C: $B \cap C = \{6, 7\}$

D: $B \cup C = \{5, 6, 7\}$

Your answer: **A B C D**

14. Which set shows the elements in the union of the set of letters in the word POPPY and the set of letters in the word POP ?

A: {5 Ps, 2 Os, Y}

B: {P, O, Y}

C: {P, O, P, P, Y, P, O, P}

D: {five Ps, two Os, one Y}

Your answer: **A B C D**

END OF PART A

CONTINUE WITH PART B

PART B

15. Which one of the following statements is **not** correct?

A: To solve a syllogism, you need to know the meaning of each term.

B: The subject and predicate of a syllogism is found in the conclusion.

C: A syllogism can be valid, but it also can be untrue.

D: A syllogism contains two premises.

Your answer: **A B C D**

16. Which one of the following statements is correct?

A: The middle term of a syllogism only occurs in the first premise.

B: In the premise "*All pins are sharp*", the middle term must be "pins".

C: In the premise "*All pins are sharp*", the middle term must be "sharp".

D: The middle term of a syllogism occurs in both premises.

Your answer: **A B C D**

17. For a syllogism to be valid:

A: The conclusion must include all three terms.

B: The conclusion must be "common sense".

C: The subject of the conclusion must be a real animal or a real object.

D: The conclusion must follow logically from the premises.

Your answer: **A B C D**

18. In the syllogism:

Some M are P.
All S are M.
Therefore all S are P.

which statement is correct?

A: M is the middle term.

B: M is the subject of the conclusion.

C: M is the predicate of the conclusion.

D: S is the middle term.

Your answer: **A B C D**

19. *All M are P.*
All S are M.
Therefore all S are P.

Is the conclusion Valid or Invalid?

Your answer: **V I**

20. *All possums are grey.*
This animal is grey.
Therefore this animal is a possum.

Is the conclusion Valid or Invalid?

Your answer: **V I**

21. *Some lions roar.*
Some big cats are lions.
Therefore all big cats roar.

Is the conclusion Valid or Invalid?

Your answer: **V I**

22. *Some kangaroos like to hop.*
All kangaroos are macropods.
Therefore some macropods like to hop.

Is the conclusion Valid or Invalid?

Your answer: **V I**

23. *Some quiples can chatter.*
All grobs are quiples.
Therefore all grobs can chatter.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

24. *All B are C.*
Some A are B.
Therefore every A is C.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

25. *All Ms are Ps.*
Some Ss are Ms.
Therefore all Ss are Ps.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

26. *All R are Q.*
All T are R.
Therefore all T are Q.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

27. *Some artists are happy people.*
All happy people are Australians.
Therefore all Australians are artists.

Is the conclusion **V**alid or **I**nvalid?

Your answer: **V** **I**

28. *Some birds are talkers.*
All birds are feathered animals.
Therefore some feathered animals are talkers.

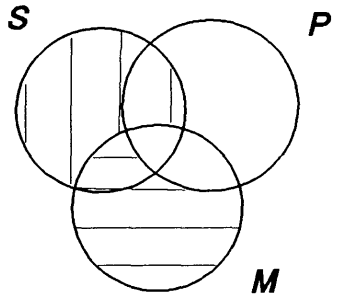
Is the conclusion **V**alid or **I**nvalid?

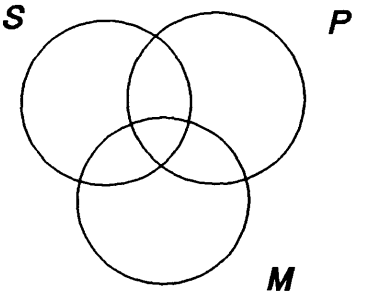
Your answer: **V** **I**

END OF TEST

WORKSHEETS FOR POST TEST AND DELAYED TEST (SPATIAL TREATMENT SUBJECTS)

19





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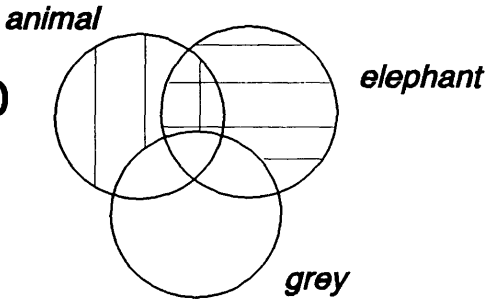

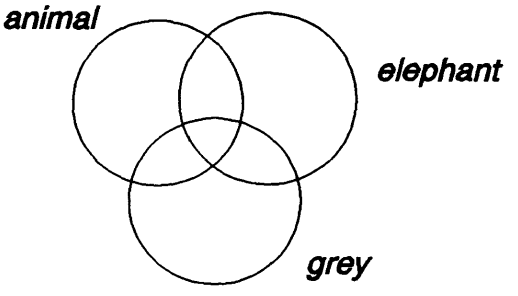

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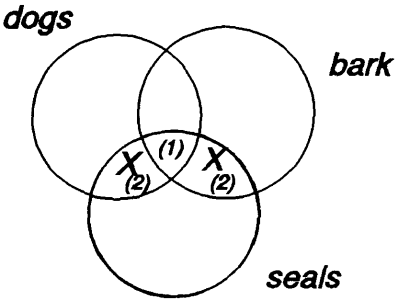

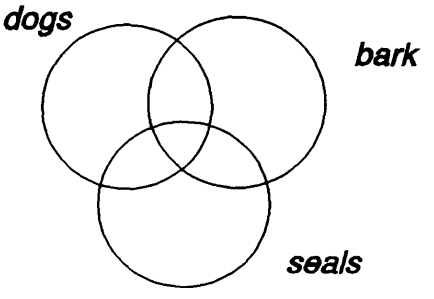

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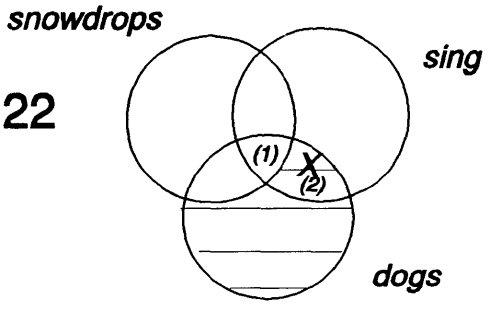

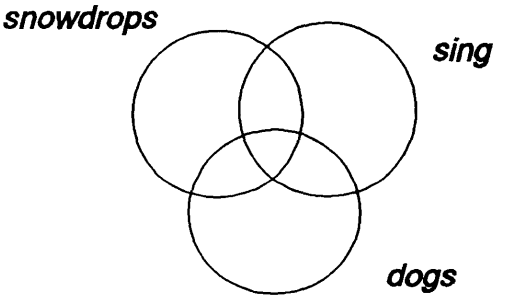

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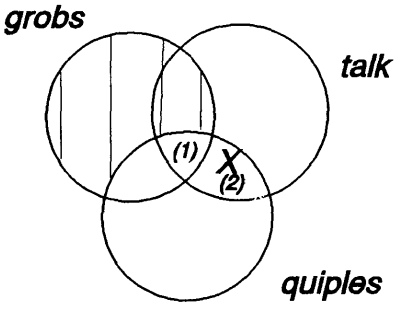

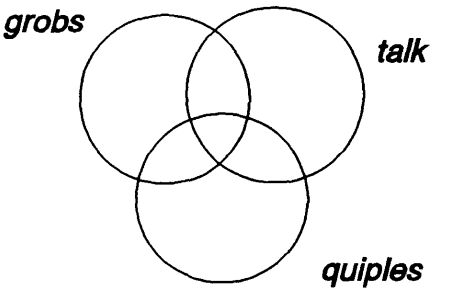

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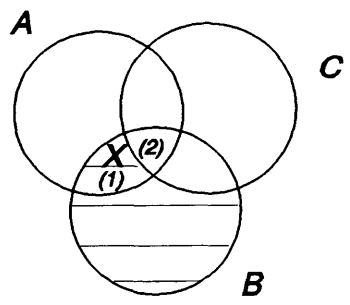
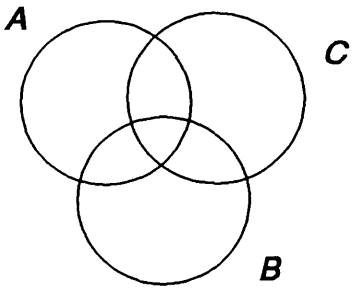
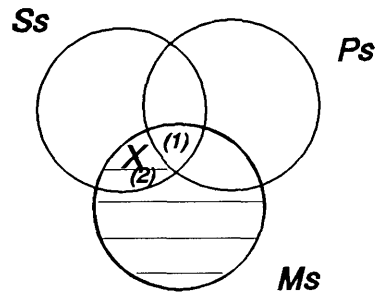
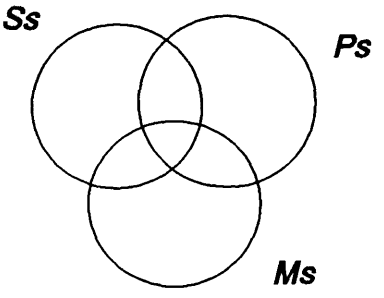

A
C
X
(2)
(1)
B

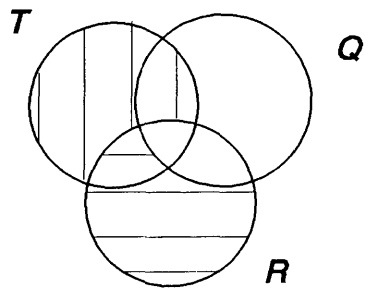

A
C
B

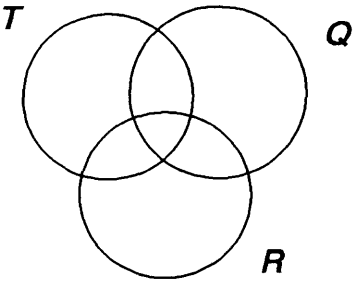
25


Ss
Ps
(1)
X
(2)
Ms

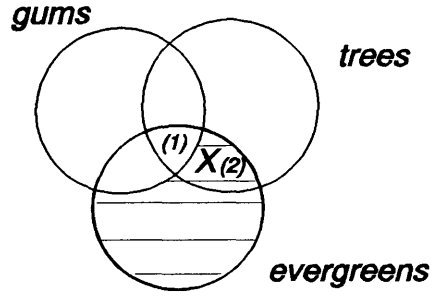

Ss
Ps
Ms

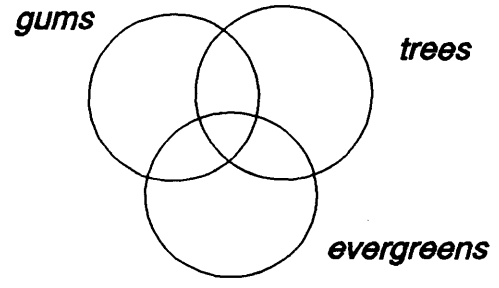
26


T
Q
R

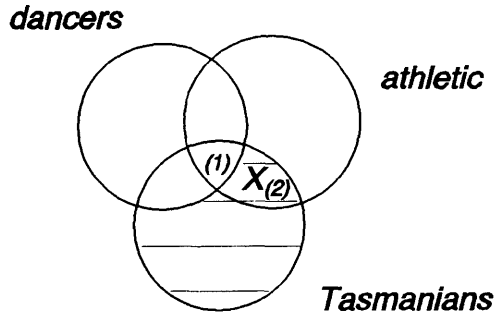

T
Q
R

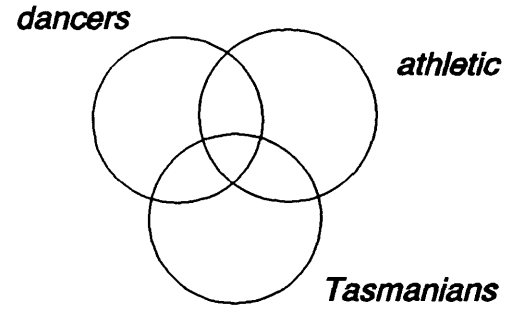
27


gums
trees
(1)
X
(2)
evergreens


gums
trees
evergreens

28


dancers
athletic
(1)
X
(2)
Tasmanians


dancers
athletic
Tasmanians

CORRECT ANSWERS (POST TEST AND DELAYED TEST)

1	C	15	A
2	A	16	D
3	B	17	D
4	C	18	A
5	B	19	V
6	D	20	I
7	A	21	I
8	B	22	V
9	D	23	I
10	B	24	I
11	A	25	I
12	C	26	V
13	C	27	I
14	B	28	V

IDENTIFICATION OF QUESTIONS TYPES (POST TEST AND DELAYED TEST)

1	UK	15	UK
2	UK	16	UK
3	UK	17	UK
4	UK	18	UK
5	UK	19	SR
6	SM	20	SR
7	SM	21	SR
8	SM	22	SR
9	SM	23	SR
10	SM	24	SR
11	SM	25	SR
12	SM	26	SR
13	SM	27	SR
14	SM	28	SR

LEGEND: UK: Understanding and knowledge of sets and syllogisms
SM: Manipulatory tasks related to sets
SR: Deductive reasoning tasks related to syllogistic reasoning tasks

TOTALS: Type UK: 9 questions
Type SM: 9 questions
Type SR: 10 questions

BREAKDOWN OF SYLLOGISTIC REASONING QUESTIONS (POST TEST AND DELAYED TEST)

Q.	V	I	O	N	A	T1	T2	T3	T4	T5
19	X				X	X				
20		X	X			X				
21		X		X			X			
22	X			X					X	
23		X		X						X
24		X			X			X		
25		X			X			X		
26	X				X	X				
27		X	X							X
28	X		X						X	
Totals	4	6	3	3	4	3	1	2	2	2

LEGEND:

V: Valid **I**: Invalid **O**: Ordinary **N**: Nonsense **A**:Abstract

Sentence type qualifiers (major premise, minor premise, conclusion):

T1: all,all,all **T2**: some,some,all **T3**: all,some,all
T4: some,all,some **T5**: some,all,all

APPENDIX H

STUDY 2 RESULTS

CONTRAST MATRIX USED IN MANOVA OF STUDY 2 DATA

GROUP->	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
VECTOR	1	1	1	1	1	1	1	1	1
V1	**0**	**0**	**-1**	**0**	**0**	**0**	**1**	**0**	**0**
V2	**0**	**0**	**0**	**0**	**0**	**-1**	**0**	**1**	**0**
V3	**0**	**-1**	**0**	**1**	**0**	**0**	**0**	**0**	**0**
V4	-1	0	0	0	0	0	0	0	1
V5	-3	0	2	0	2	0	2	0	-3
V6	0	0	-1	0	2	0	-1	0	0
V7	0	-1	0	-1	0	1	0	1	0
V8	4	-5	4	-5	4	-5	4	-5	4

POST TEST and DELAYED TEST OBSERVED MEANS AND STANDARD DEVIATIONS BY APTITUDE GROUPS AND TREATMENT

Subjects using SPATIAL TREATMENT

		APTITUDE GROUPS								
		1 HH	2 HM	3 HL	4 MH	5 MM	6 ML	7 LH	8 LM	9 LL
TEST TOTALS										
Post Test	$\bar{x}$	22.71	20.73	18.73	18.80	17.16	16.73	16.25	14.79	12.56
	s	4.21	4.43	5.75	5.71	5.94	4.13	5.18	3.91	3.60
Delayed Test	$\bar{x}$	24.07	20.55	18.27	19.13	18.94	17.36	15.69	16.07	14.31
	s	3.58	4.52	5.75	4.94	5.02	5.61	4.38	3.71	3.42
UNDERSTANDING & KNOWLEDGE										
Post Test	$\bar{x}$	7.21	6.46	5.80	6.67	5.16	5.60	5.19	4.50	3.75
	s	1.93	2.16	2.34	1.88	2.65	2.23	2.61	1.87	1.73
Delayed Test	$\bar{x}$	7.64	6.91	5.47	6.67	5.44	5.00	5.31	5.50	3.81
	s	1.60	2.34	2.00	1.80	2.45	2.48	2.12	1.34	2.20
SET MANIPULATION										
Post Test	$\bar{x}$	7.50	7.18	6.07	5.80	6.00	5.67	4.83	5.14	3.81
	s	1.70	1.66	2.28	2.51	2.33	2.89	2.87	1.75	1.94
Delayed Test	$\bar{x}$	8.00	6.00	5.47	5.47	6.17	5.43	4.50	4.86	4.18
	s	1.11	2.41	2.42	2.64	1.82	2.17	1.79	2.03	2.40
SYLLOGISTIC REASONING										
Post Test	$\bar{x}$	8.00	7.09	6.87	6.33	6.00	5.47	6.06	5.14	5.00
	s	2.15	1.92	2.10	2.23	2.33	2.00	1.61	1.41	1.67
Delayed Test	$\bar{x}$	8.43	7.64	7.33	7.00	7.33	6.93	5.69	5.71	6.31
	s	1.99	1.75	2.29	2.14	1.94	2.34	2.15	1.44	1.96

POST TEST and DELAYED TEST OBSERVED MEANS AND STANDARD DEVIATIONS BY APTITUDE GROUPS AND TREATMENT

Subjects using VERBAL TREATMENT

		APTITUDE GROUPS								
		1 HH	2 HM	3 HL	4 MH	5 MM	6 ML	7 LH	8 LM	9 LL
TEST TOTALS										
Post Test	$\bar{x}$	20.13	18.36	16.93	20.25	16.44	14.86	16.67	15.86	12.90
	s	4.76	4.68	5.06	4.65	7.60	3.84	4.88	4.55	3.10
Delayed Test	$\bar{x}$	20.75	21.09	17.93	20.43	16.63	16.19	16.40	16.75	14.00
	s	4.28	4.21	3.79	4.45	6.46	3.47	5.47	4.29	4.29
UNDERSTANDING & KNOWLEDGE										
Post Test	$\bar{x}$	6.50	5.64	6.20	6.44	4.44	4.62	4.73	5.67	4.70
	s	2.13	2.30	2.54	2.00	3.43	2.20	2.02	1.77	2.26
Delayed Test	$\bar{x}$	6.31	7.14	6.00	6.71	4.38	5.05	4.60	5.35	4.40
	s	1.78	2.10	2.04	1.33	2.97	1.91	2.23	1.78	2.50
SET MANIPULATION										
Post Test	$\bar{x}$	5.69	7.14	6.00	6.38	6.00	5.38	4.93	4.43	3.60
	s	2.77	2.05	2.33	1.93	2.40	1.63	2.40	1.78	1.58
Delayed Test	$\bar{x}$	6.44	7.32	6.13	5.36	5.78	5.52	4.33	5.00	4.70
	s	1.90	2.15	2.42	2.59	2.77	1.63	2.64	1.95	1.77
SYLLOGISTIC REASONING										
Post Test	$\bar{x}$	7.94	5.59	4.73	7.44	6.00	4.86	7.00	5.76	4.60
	s	1.34	2.02	1.39	1.75	2.50	1.42	1.93	2.07	1.17
Delayed Test	$\bar{x}$	8.00	6.64	5.80	8.36	6.88	5.62	7.67	6.40	4.90
	s	1.86	1.81	1.15	1.60	1.89	1.47	1.50	1.73	1.60

OBSERVED MEANS AND STANDARD DEVIATIONS FOR POST TEST AND DELAYED TEST BY SCHOOL.

	COMBINED	SCHOOL 1	SCHOOL 2	SCHOOL 3
TEST TOTALS				
Post Test				
$\bar{x}$	17.25	17.89	17.32	16.13
s	5.29	5.17	5.60	4.56
Delayed Test				
$\bar{x}$	18.10	18.68	17.93	17.64
s	5.04	4.84	5.20	4.93
UNDERSTANDING AND KNOWLEDGE				
Post Test				
$\bar{x}$	5.52	5.63	5.70	4.89
s	2.33	2.15	2.43	2.26
Delayed Test				
$\bar{x}$	5.69	5.84	5.72	5.41
s	2.23	2.00	2.32	2.32
SET MANIPULATION				
Post Test				
$\bar{x}$	5.64	5.87	5.52	5.61
s	2.33	2.20	2.45	2.25
Delayed Test				
$\bar{x}$	5.60	5.63	5.45	5.93
s	2.32	2.27	2.41	2.15
SYLLOGISTIC REASONING				
Post Test				
$\bar{x}$	6.08	6.39	6.07	5.63
s	2.08	2.13	1.96	2.24
Delayed Test				
$\bar{x}$	6.79	7.22	6.75	6.27
s	2.01	2.13	1.88	2.05

OBSERVED MEANS AND STANDARD DEVIATIONS FOR POST TEST AND DELAYED TEST BY SCHOOL CLASS

	CLASS									
	1.D	1.H	1.L	2.B	2.C	2.H	2.L	2.P	3.B	3.G
TEST TOTALS										
Post test										
$\bar{x}$	19.45	15.44	18.67	15.75	15.07	13.63	24.41	17.59	17.39	15.03
s	4.94	5.39	4.41	4.59	5.10	4.06	2.73	3.84	4.81	4.11
Delayed test										
$\bar{x}$	19.85	16.93	19.37	16.04	15.31	15.27	24.15	19.17	18.31	17.07
s	4.86	4.97	4.31	4.96	4.86	3.26	3.03	3.66	5.38	4.52
UNDERSTANDING AND KNOWLEDGE										
Post test										
$\bar{x}$	6.21	4.44	6.19	5.42	4.52	4.23	8.39	5.97	5.19	4.63
s	2.29	2.14	1.49	2.24	2.18	2.06	.78	2.08	2.55	1.99
Delayed test										
$\bar{x}$	6.23	4.93	6.41	5.30	4.72	4.33	8.04	6.32	5.96	4.93
s	1.88	2.09	1.74	2.74	2.17	1.77	1.13	1.59	2.32	2.24
SET MANIPULATION										
Post test										
$\bar{x}$	6.53	5.22	5.79	4.76	4.93	4.10	8.31	5.45	5.73	5.50
s	2.26	2.23	1.97	2.26	2.34	2.01	.89	2.05	2.36	2.18
Delayed test										
$\bar{x}$	6.48	4.89	5.54	4.33	4.35	4.73	8.19	5.68	5.67	6.17
s	2.31	2.36	1.91	2.22	2.39	1.91	1.21	1.84	2.39	1.93
SYLLOGISTIC REASONING										
Post test										
$\bar{x}$	6.69	5.78	6.67	5.46	5.62	5.30	7.72	6.17	6.46	4.90
s	1.95	2.22	2.18	1.64	1.99	1.51	1.94	1.71	2.12	2.12
Delayed test										
$\bar{x}$	7.23	7.11	7.33	6.35	6.24	6.20	7.93	7.07	6.62	5.97
s	2.12	1.81	2.50	1.61	1.92	1.65	1.92	1.78	2.26	1.83

OBSERVED MEANS AND STANDARD DEVIATIONS OF SYLLOGISM TYPES FOR POST TEST and DELAYED TEST BY SCHOOL.

	COMBINED	SCHOOL 1	SCHOOL 2	SCHOOL 3
ORDINARY SYLLOGISMS				
Post Test				
$\bar{x}$	1.65	1.70	1.65	1.55
s	.85	.85	.85	.85
Delayed Test				
$\bar{x}$	1.92	2.10	1.87	1.79
s	.86	.86	.86	.83
ABSTRACT SYLLOGISMS				
Post Test				
$\bar{x}$	2.73	2.98	2.68	2.46
s	1.10	1.08	1.06	1.16
Delayed Test				
$\bar{x}$	2.85	3.05	2.88	2.50
s	1.08	1.07	1.09	1.01
NONSENSE SYLLOGISMS				
Post Test				
$\bar{x}$	1.70	1.71	1.74	1.61
s	.96	1.03	.91	1.00
Delayed Test				
$\bar{x}$	2.02	2.07	2.01	1.98
s	.93	.99	.90	.94

OBSERVED MEANS AND STANDARD DEVIATIONS OF SYLLOGISM TYPES FOR POST TEST AND DELAYED TEST BY SCHOOL CLASS

	CLASS									
	1.D	1.H	1.L	2.B	2.C	2.H	2.L	2.P	3.B	3.G
ORDINARY SYLLOGISMS										
Post Test										
$\bar{x}$	1.76	1.74	1.59	1.46	1.59	1.37	1.97	1.86	1.77	1.37
s	.91	.86	.80	.88	.78	.67	.94	.83	.71	.93
Delayed Test										
$\bar{x}$	1.96	2.36	1.96	1.97	1.72	1.73	2.19	1.79	1.89	1.70
s	.92	.62	.98	.88	.88	.82	.74	.92	.82	.84
ABSTRACT SYLLOGISMS										
Post Test										
$\bar{x}$	3.28	2.41	3.22	2.33	2.55	2.47	3.28	2.72	2.96	2.03
s	.92	1.08	1.05	.87	1.06	1.01	1.19	.92	1.08	1.07
Delayed Test										
$\bar{x}$	2.92	2.89	3.33	2.78	2.62	2.50	3.33	3.18	2.65	2.37
s	1.13	1.17	.88	1.04	1.12	1.07	1.11	.95	1.13	.89
NONSENSE SYLLOGISMS										
Post Test										
$\bar{x}$	1.66	1.63	1.85	1.67	1.48	1.47	2.48	1.59	1.73	1.50
s	1.01	1.08	1.03	.70	1.02	.86	.69	.83	1.96	1.04
Delayed Test										
$\bar{x}$	2.35	1.86	2.04	1.61	1.90	1.97	2.41	2.11	2.08	1.90
s	.89	.93	1.09	.78	1.01	.77	.84	.92	.98	.92

OBSERVED MEANS AND STANDARD DEVIATIONS
FOR POST TEST AND DELAYED TEST BY INSTRUCTIONAL TREATMENT

	SPATIAL "S" TREATMENT	VERBAL "V" TREATMENT	% "S" MEANS BETTER THAN "V"
TEST TOTALS			
Post Test			
$\bar{x}$	17.44	17.08	1.2
s	5.52	5.09	
Delayed Test			
$\bar{x}$	18.14	18.05	0.3
s	5.25	4.85	
UNDERSTANDING AND KNOWLEDGE			
Post Test			
$\bar{x}$	5.53	5.50	0.3
s	2.37	2.31	
Delayed Test			
$\bar{x}$	5.68	5.70	0.0
s	2.28	2.19	
SET MANIPULATION			
Post Test			
$\bar{x}$	5.70	5.59	1.2
s	2.40	2.27	
Delayed Test			
$\bar{x}$	5.51	5.69	2.0
s	2.32	2.32	
SYLLOGISTIC REASONING			
Post Test			
$\bar{x}$	6.17	5.99	1.8
s	2.11	2.06	
Delayed Test			
$\bar{x}$	6.90	6.69	2.1
s	2.14	1.89	

PERCENTAGE OF CORRECT RESPONSES TO INDIVIDUAL QUESTIONS FOR POST TEST AND DELAYED TEST

NO.	PERCENT CORRECT -P0ST TEST	PERCENT CORRECT -DELAYED TEST	NO.	PERCENT CORRECT -P0ST TEST	PERCENT CORRECT -DELAYED TEST
1	65	71	**15**	47	54
2	64	72	**16**	53	49
3	68	71	**17**	55	62
4	51	47	**18**	72	65
5	76	77	**19**	72	79
6	65	59	**20**	50	52
7	81	72	**21**	60	70
8	61	53	**22**	54	68
9	59	62	**23**	56	65
10	43	55	**24**	64	65
11	81	81	**25**	62	63
12	57	62	**26**	75	78
13	58	58	**27**	50	73
14	60	59	**28**	65	67