$n(A \cup B) = 12$
$C = \{1, 2, 3, 4, 5, 6\}$
$A \cap C = = \{1, 2, 3, 4, 5, 6\}$
$n(A \cap C) = 6$
c) $A \cap B = \{1, 2, 3, 4, 5, 6, 7, 8\}$
$A \cap B \setminus C = \{7, 8\}$
d) $A \cup B \cup C = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$
$(A \cup B \cup C)'$ is all the elements not in $A \cup B \cup C$.
$(A \cup B \cup C)' = \{13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 23, 24\}$

3. Let U represent the universal set. Let W represent the students who drink bottled water. Let L represent the students who follow a low fat diet. Let F represent the students who eat fruit.
We know 15% of students do all three, so that number is the three-way intersection.
We know 22% drink bottled water and follow a low-fat diet, so $n(L \cup W / F) = 22 - 15 = 7$.
Similarly, $n(W \cup F / L) = 27 - 15 = 12$ and $n(L \cup F / W) = 23 - 15 = 8$.

From here, I know 50% of the students drink bottled water, 56% eat fruit, and 43% follow a low-fat diet.
$W / L \cup F = 50 - 15 - 7 - 12 = 16$
$F / W \cup L = 56 - 15 - 12 - 8 = 21$
$L / W \cup F = 43 - 15 - 7 - 8 = 13$

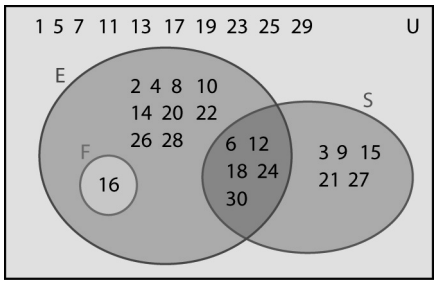
To determine the percent of students who do not drink bottled water, eat fruit or follow a low-fat diet we need $(W \cup F \cup L)'$.
$(W \cup F \cup L) = 16 + 13 + 21 + 12 + 7 + 8 + 15 = 92$
$(W \cup F \cup L)' = 100 - 92 = 8$
Therefore, 8% of students do not drink bottled water, eat fruit or follow a low-fat diet.

4. a) Conditional statement: If you want to win an election, then you must get the most votes.
Inverse: If you do not want to win an election, then you must not get the most votes.
The statement is not biconditional; e.g., in some electoral systems, you need a majority to win.
b) Conditional statement: If the planet is Earth, then it is the third planet from the Sun.
Inverse: If the planet is not Earth, then it is not the third planet from the Sun.
The statement and inverse are true so this is a biconditional statement.
The planet is Earth if and only if it is the third planet from the Sun.
c) Conditional statement: If a number is between 1 and 2, then it is not a whole number.
Inverse: If a number is not between 1 and 2, then it is a whole number.
The statement is true but the inverse is false.
Counterexample: 0.75 is not a whole number but it is less than one. The statement is not biconditional.

5. a) i) Conditional statement: If you are over 18, then you are an adult. This statement if false. e.g., The age of majority in British Columbia is 19.
ii) Converse: If you are an adult, then you are over 18. This statement is true.
iii) Inverse: If you are not over 18, then you are not an adult. This statement is true.
iv) Contrapositive: If you are not an adult, then you are not over 18. This statement is false, e.g., since the age of majority in British Columbia is 19 the statement would not hold true for an 18-year-old.
b) i) Conditional statement: If you are 16, then you can drive. This statement is false, e.g., a 44-year-old may know how to drive.
ii) Converse: If you can drive, then you are 16. This is false.
iii) Inverse: If you are not 16, then you cannot drive. This statement is also false.
iv) Contrapositive: If you cannot drive, then you are not 16. This statement is false, e.g., a 16-year-old may know how to drive.

Chapter Review, page 220

1. a)

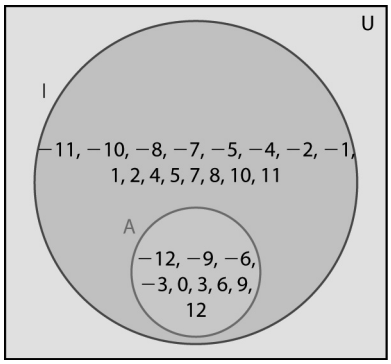


b) Sets F and S are disjoints sets.
c) Yes, set F is a subset of set E.
d) $S = \{3, 6, 9, 12, 15, 18, 21, 24, 27, 30\}$
$S' = \{1, 2, 4, 5, 7, 8, 10, 11, 13, 14, 16, 17, 19, 20, 22, 23, 25, 26, 28, 29\}$ = {natural numbers from 1 to 30 not divisible by 3}
Set S′ is different from set E' because it includes numbers that are not divisible by two and set E' only includes numbers not divisible by two.
e) e.g., H = {multiples of 50}

2. a) black hair or blue eyes: 28 – 9 = 19
Since 19 students have black hair, all students with blue eyes have black hair.
8 students have black hair and blue eyes.
b) only black hair: 19 – 8 = 11
11 students have black hair
c) only blue eyes: 8 – 8 = 0
No students have blue eyes but not black hair.

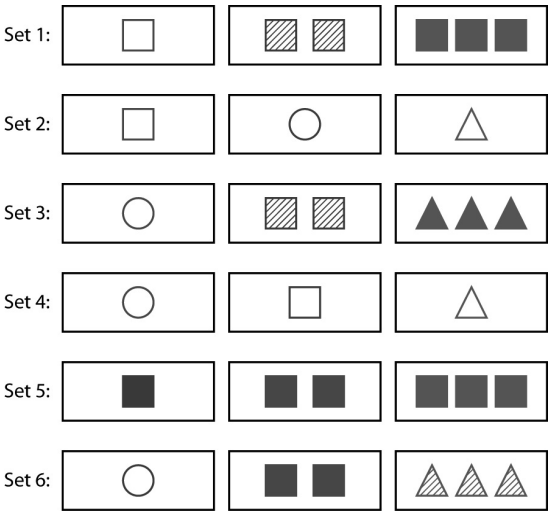
3. a) $A = \{-12, -9, -6, -3, 0, 3, 6, 9, 12\}$
$B = \{x \mid -12 \le x \le 12, x \in \mathrm{I}\}$
$A \cup B = \{x \mid -12 \le x \le 12, x \in \mathrm{I}\}$
$= \{-12, -11, -10, -9, -8, -7, -6, -5, -4, -3, -2, -1, 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12\}$
$n(A \cup B) = 25$
$A \cap B = \{-12, -9, -6, -3, 0, 3, 6, 9, 12\}$
$n(A \cap B) = 9$

b) Draw a Venn diagram of these two sets.



4. Number of people asked: 40
Number who like romance novels; 10
Number who like horror novels: 13
Number who do not like either: 18
Romance or horror or both: 40 – 18 = 22
Both romance and horror: 10 + 13 – 22 = 1
One person likes both romance and horror novels.

5. Set 1: Different numbers, same shape, different colours.
Set 2: Same number, different shape, different colour.
Set 3: Different numbers, different shape, different colour.
Set 4: Same number, different shape, different colour.
Set 5: Different number, same shape, different colour.
Set 6: Different number, different shape, different colour.



6. a) Conditional statement; If x is positive, then $10x > x$.
This statement is true. A positive number multiplied by ten will always be greater than the original number.
Converse: If $10x > x$, then x is positive.
The converse is true. Ten times a number will be greater than the original number if the number is positive.
Since both the statement and converse are true, the statement is biconditional.
Biconditional statement: x is positive if and only if $10x > x$.

b) Statement: If you live in Victoria, then you live on Vancouver Island.
This statement is true. Victoria is located on Vancouver Island.
Converse: If you live on Vancouver Island, you live in Victoria.
The converse is false. Counterexample: There are other parts of Vancouver Island you could live in, for example, Port Hardy.
Since the converse is false, the statement is not biconditional.
c) Statement: If xy is an odd number, then both x and y are odd numbers.
This statement is true. If an odd number has two factors, both factors are also odd.
Converse: If both x and y are odd numbers, then xy is an odd number.
The converse is true. The product of two odd numbers is odd.
Since both the statement and converse are true, the statement is biconditional.
Biconditional statement: xy is an odd number if and only if x and y are odd numbers.
d) Conditional statement: If two numbers are even, then their sum is even. This statement is true.
Converse: If the sum of two numbers is even, then the two numbers are even. The converse is false.
Counterexample: 5 + 7 = 12.
Since the converse is false, the statement is not biconditional.

7. a) Use the finance application on a calculator.
The number of payments is 60.
The interest rate is 2.9%.
The present value is $24 729.56.
The payment amount is unknown.
The future value is $0.
The compounding frequency is 12.
The monthly payment is 443.259…
Serge's monthly payment will be $443.26.
b) Use the finance application on a calculator.
The number of payments is unknown.
The interest rate is 2.9%.
The present value is $24 729.56.
The payment amount is
443.259… + 100 = 543.259…
The future value is $0.
The compounding frequency is 12. Serge will pay off the car in 48.28 months, or nearly 1 year sooner.

8. a) This statement is true.
Converse: If a number is not negative, then it is positive.
The statement is false. The number could be 0. Zero is neither negative nor positive.
Inverse: Contrapositive: If a number is not positive, then it is negative.
This statement is false, because the number could be 0, which is neither negative nor positive.
Contrapositive: If a number is negative, then it is not positive.

This statement is true.
b) This statement is true. Converse: If it is a long weekend, then Monday is a holiday.
This statement is false, because it could be a long weekend, but Friday is a holiday.
Inverse: If Monday is not a holiday, then it is not a long weekend. This is false, because Friday could be a holiday while Monday is a workday. This would still create a long weekend.
Contrapositive: If it is not a long weekend, then Monday is not a holiday. This statement is true.

Chapter Task, page 221

A. I would organize most of the animals according to geographic region. I would use three sets: America (**A**), Africa (**F**), and Asia/Australia (**K**). I would need to consider both indoor and outdoor animals, as well as animals that need room to roam or graze. I could put birds, insects, and reptiles as subsets of each geographic region, or I could have a separate building for them and categorize them inside this building. If I have fish, it would make sense to put them all in an aquarium building, rather than have several buildings. I would also need water for birds who swim. I would need to have enclosures for small animals and for animals that require controlled climate conditions. I could put predators and prey in the same areas, but not in the same compounds.
B. and C. Set America (**A**) will have three subsets: North America (**N**), South America (**S**), and Central America (**C**). Central America will intersect sets North America and South America. Set Africa (**F**) will have two subsets: Savanna (**V**) and Rainforest (**R**). Some of the animals from sets Africa and America will need roaming and grazing room, so set Graze (**G**) will intersect both Africa and America. The bears, lions, and wolves will need large areas to roam and should be kept apart from the other animals, so they will have a separate area (**L**). I am also going to separate the Australia/Asia (**K**) set of animals as a special attraction area. This will have two subsets: indoor (**D**) and outdoor (**T**).

I decided to put the reptiles and insects with the indoor animals from Australia (**H**), since I thought they would thrive best there. I decided to put the birds in a separate area. I could not show the intersection of the sets on my diagram, but I listed the birds. Also, I could not show the intersection of the jaguar from South America with the area for the bears, lions, and wolves, but I put it in the top area. My sets will contain the following animals:
America:
N = { moose, cougar, lynx, grizzly bear, polar bear, bison, elk, raccoon, lynx, Arctic fox, Arctic wolf, snowy owl, beaver, ferret, prairie dog, flamingo, swan}
S = { tarantula, black widow spider, blue poison dart frog, boa constrictor, two-toed sloth, tamarin, marmoset, jaguar, spider monkey, macaw, llama}
C = {boa constrictor, poison dart frog, ocelot, jaguar, spider monkey}
I = { ferret, black widow spider, prairie dog, burrowing owl, beaver, boa constrictor, blue poison dart frog, marmoset, tamarin, tarantula, two-toed sloth, macaw}
O = { moose, cougar, lynx, grizzly bear, polar bear, bison, elk, raccoon, lynx, Arctic fox, Arctic wolf, snowy owl, jaguar, spider monkey, llama}

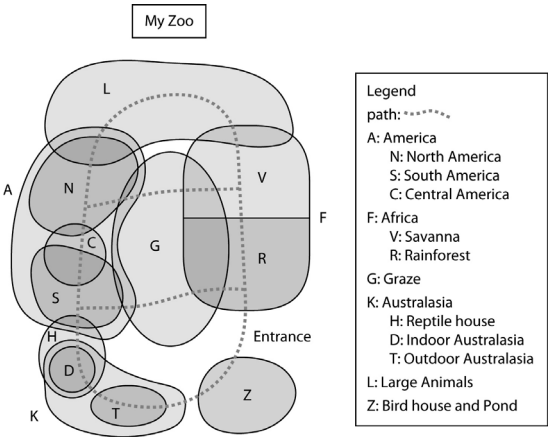
Africa:
R = { tortoise, mandrill, pygmy hippopotamus, fruit bat, gorilla}
V = { meerkat, elephant, zebra, lion, cheetah, crane, stork, baboon, hippopotamus, ostrich, hyena}
G = { moose, bison, elk, llama, elephant, zebra, ostrich}

Australia:
D = { tree boa, frilled lizard, komodo dragon, bearded dragon, tree python, kookaburra, tree kangaroo, sugar glider}
T = {kangaroo, wombat}

Reptile House
H = { tarantula, blue poison dart frog, boa constrictor, black widow spider, tree boa, frilled lizard, komodo dragon, bearded dragon, tree python, tree kangaroo, wombat, sugar glider}

D is now a subset of **H**.

Birds
Z = {snowy owl, flamingo, macaw, crane, stork, ostrich, swan}
D.



E Yes, my zoo is easy to navigate. There is a wide-open space at the entrance, with the feature birds and pond as you go in. The animals are categorized, so you can just walk around to see the different continents.
The more dangerous animals are located together, and there is a common area for the roaming and grazing animals. I think visitors will find my zoo