Necessary and sufficient conditions
• The concepts of necessary and sufficient conditions help us understand and explain the different kinds of connections between concepts, and how different states of affairs are related to each other.
Necessary conditions

• To say that $X$ is a necessary condition for $Y$ is to say that it is impossible to have $Y$ without $X$. In other words, the absence of $X$ guarantees the absence of $Y$. A necessary condition is sometimes also called "an essential condition".

• Some examples:
  – Oxygen is necessary for life.
  – Having four sides is necessary for being a square.
  – Having mammary glands is necessary for being a mammal.
  – Having political rights is necessary for a democracy.
• A certain state of affairs might have more than one necessary condition.
  – For example, to be a good concert pianist, having good finger techniques is a necessary condition. But this is not enough. Another necessary condition is being good at interpreting piano pieces.
To show that X is not a necessary condition for Y, we simply find a situation where Y is present but X is not.

- Being rich is not necessary for being happy, since a poor person can be happy too.
- Having a very high IQ is not necessary for being very successful since George Bush was very successful.
Sufficient Conditions

• To say that X is a *sufficient condition* for Y is to say that *the presence of X guarantees the presence of Y*. In other words, it is impossible to have X without Y. If X is present, then Y must also be present.
  – Being a square is sufficient for having four sides.
  – Being divisible by 4 is sufficient for being an even number.
• The conditional "If X then Y" can also be understood as saying that X is a sufficient condition for Y.

• Some state of affairs can have more than one sufficient condition.
  – Being blue is sufficient for being colored, but of course being green, being red are also sufficient for being coloured.
• To show that X is not sufficient for Y, we come up with cases where X is present but Y is not.
  – Loving someone is not sufficient for being loved. A person who loves someone might not be loved by anyone.
  – Loyalty is not sufficient for honesty because one might have to lie in order to protect the person one is loyal to.
Relationship to possible/impossible

• The concepts of necessary and sufficient conditions relate to the concept of possibility.
• To say that X is necessary for Y is to say that it is not possible for Y to occur without X.
• To say that X is sufficient for Y is to say that it is not possible for X to occur without Y.
4 combinations

• Given two conditions X and Y, there are four ways in which they might be related to each other:
  – 1. X is necessary but not sufficient for Y.
  – 2. X is sufficient but not necessary for Y.
  – 3. X is both necessary and sufficient for Y. (or "jointly necessary and sufficient")
  – 4. X is neither necessary nor sufficient for Y.

• This classification can be very useful in determining how concepts are related to each other.
• Having four sides is necessary but not sufficient for being a square (since a rectangle has four sides but it is not a square).

• Having a son is sufficient but not necessary for being a parent (a parent could have only a daughter).

• Being an unmarried man is both necessary and sufficient for being a bachelor.

• Being a tall person is neither necessary nor sufficient for being a successful person.
Exercises

- (a) You must pay if you want to enter
- (b) A cloud chamber is needed to observe subatomic particles.
- (c) If something is an electron it is a charged particle
- (d) I will pay for lunch if and only if you pay for dinner.
• Suppose Tom is a tall but unsuccessful person. Does it show that (a) being tall is not sufficient for being successful, or (b) being tall is not necessary for being successful?
Relationship to possible/impossible

• The concepts of necessary and sufficient conditions relate to the concept of possibility.
• To say that X is necessary for Y is to say that it is not possible for Y to occur without X.
• To say that X is sufficient for Y is to say that it is not possible for X to occur without Y.
Different meanings of possibility

• It is impossible to be a tall man without being tall.
• It is impossible to dissolve gold in pure water.
• It is impossible to travel from Hong Kong to New York in less than ten minutes.
• It is impossible to visit the army barracks without a permit.
Homework

• Switches example:  
  http://philosophy.hku.hk/think/meaning/nsc.php

• Relevant questions on worksheet.