Complete the questions found in the probability examples lecture; complete all four questions.

1. Set operations.

```
time <- 1:24
winter2011 <- c(1,2)
winter2012 <- c(11, 12, 13, 14)
setdiff(time, union(winter2011, winter2012))

##  [1]  3  4  5  6  7  8  9 10 15 16 17 18 19 20 21 22 23 24
```

2. Conditional probability

```
P1y <- 10/25 # since 10 yellow balloons of 25 total
P2y <- 9/24 # after hitting first yellow, 9 yellow left out of 24 total
P1y*P2y # = P(1y && 2y)

## [1] 0.15
```

3. Mutual Independence

   Because $P(E_1) * P(E_2) \neq P(E_1 \cap E_2)$, we say that the events E_1 and E_2 are dependent.

```
E1 <- 2
E2 <- 1
E1_2 <- 1

E1*E2/36 == E1_2/6

## [1] FALSE
```

   For new events, E_1 and E_2, we see that $P(E_1) * P(E_2) = P(E_1 \cap E_2)$. So E_1 and E_2 are independent.

```
E1 <- 2
E2 <- 3
E1_2 <- 1

E1*E2/36 == E1_2/6

## [1] TRUE
```

4. System Reliability

   $P(system functions) = 1 - P(system fails)$.

```
Pd_fails <- 1-.9 # by set operations
Pe_fails <- 1-.85
Pf_fails <- 1-.8

P_fails <- Pd_fails * Pe_fails * Pf_fails # by independence

(P_functions <- 1 - P_fails)

## [1] 0.997
```

5. Association Rules

```
groceries <- read.csv("https://roualdes.us/data/groceries.csv")

# {yogurt, cereals} => {whole milk}
with(groceries,
     c(
         support=mean(yogurt & cereals & whole.milk),
         confidence=mean(yogurt & cereals & whole.milk)/
             mean(yogurt & cereals),
         lift=mean(yogurt & cereals & whole.milk)/
             (mean(yogurt & cereals)*mean(whole.milk))))

##     support  confidence        lift
## 0.001728521 0.809523810 3.168192068

# {butter, jam} => {whole milk}
with(groceries,
     c(
         support=mean(butter & jam & whole.milk),
         confidence=mean(butter & jam & whole.milk)/
             mean(butter & jam),
         lift=mean(butter & jam & whole.milk)/
             (mean(butter & jam)*mean(whole.milk))))

##     support  confidence        lift
## 0.001016777 0.833333333 3.261374188
```