A.F.
B.S.
S.J.
M.I.

2^n = number of combos
n = number of toppings
$\Big\}$ generalization

$1 = 2^0$
$1\ 1 = 2^1$
$1\ 2\ 1 = 2^2$
$1\ 3\ 3\ 1 = 2^3$
$1\ 4\ 6\ 4\ 1 = 2^4$
$1.\ 5\ 10\ 10\ 5\ 1 = 2^5$

✳ The "2" comes from when the numbers are brought down. The toppings can go 2 ways → they can remain unchanged from the previous row or they can add another topping.
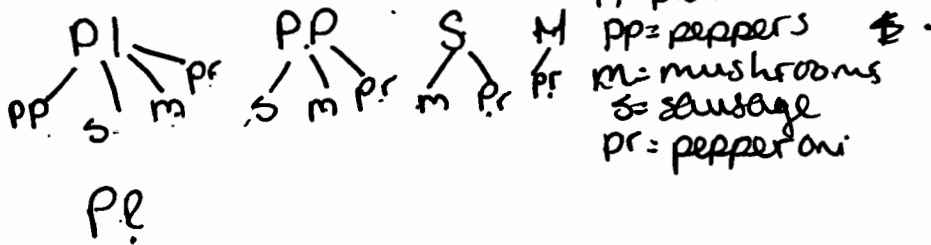
Amy-Lynn F.

A Pizza Problem

Pizza Hut has asked us to help design a form to keep track of certain pizza choices.

They offer a plain pizza, that is, "cheese with tomato sauce". A customer can then select from the following toppings: peppers, sausage, mushrooms and pepperoni.

1. How many different choices for pizza does a customer have? 16

2. List all the possible choices.

pl = plain
pp = peppers
m = mushrooms
s = sausage
pr = pepperoni

Pl   PP   S   M
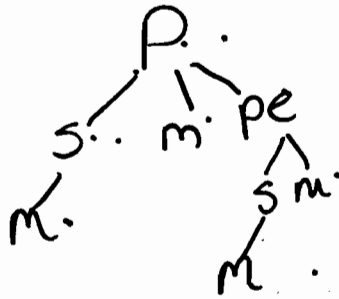PP   s   m   pr   s   m   pr   m   pr   pr

Pl

3. Find a way to convince each other that you have accounted for all possible choices.

4. Suppose a fifth topping, anchovies, were available. How many different choices for pizza does a customer now have? Why?

32

Amy-Lynn F.

Plain ~~mushrooms~~ Peppers   Sausage   Mushrooms   Pepperoni.
Peppers saus mush pepp   saus mush pepp ps   mush pepperoni   pepperoni

$$5! + 4! + 3! + 2! + 1! = 153$$

Pl   Peppers   Saus   Mush   Pepperoni:

Pl + Peppers + sausage + mushrooms + pepperoni

pepp saus m pr   saus mush pr mush p

16 (circled)

$10 + 6 = 16$ (circled)

Mushrooms

Pl   P

$1 \ 4 \ 6 \ 41 = 16$

$15 \ 10 \ 10 \ 51 = 32$

```
      1
    1  2  1.
   1  3  3  1
  1  4  6  41
 1 5 10 10 5 1
```

$$2^N = \text{\# of Combos}$$

where n=toppings

```
        P.
      /  |  \
    S.   m.  pe
   /          / \
  M.         S   m.
             |
             M.
```

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    See tree diagram.

3. Find a way to convince each other that you have accounted for all possible choices. 16

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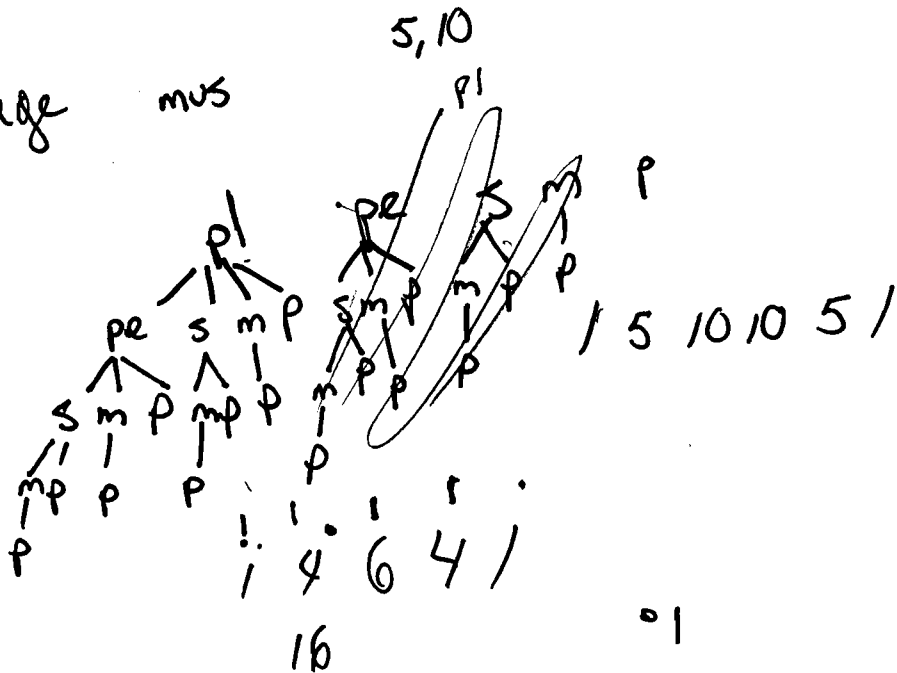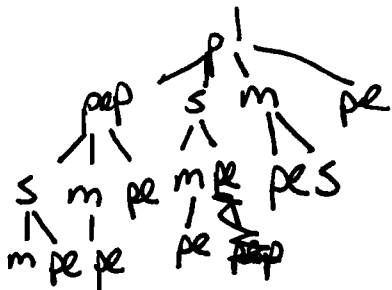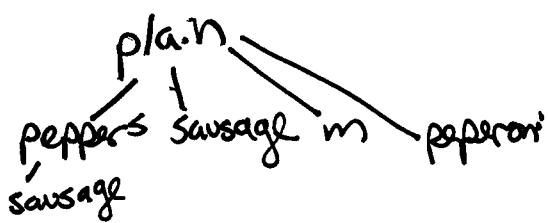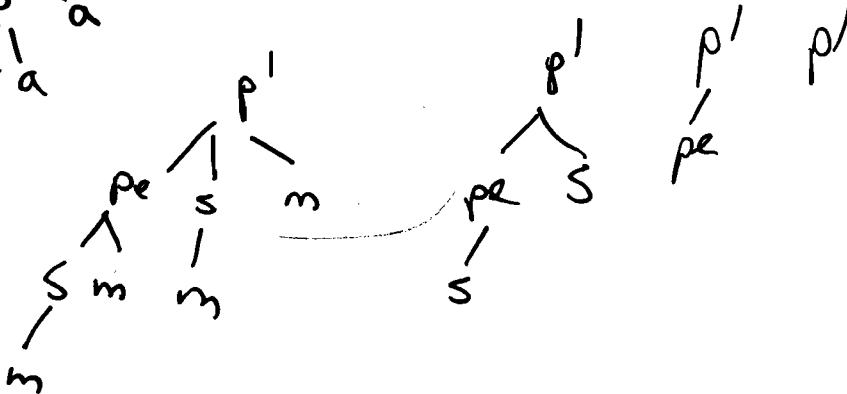
    32 - See ditto.

plain
pe
s
m
pep

$5! + 4! + 3! + 2! + 1! = 153$

5,10

plain   peppers   sausage   mus
peppers

plain

plain — peppers sausage m   peperoni

sausage

pl
pe s m p

pl
pep s m pe

s m pe m pe pes

m pe pe   pe

1 5 10 10 5 1

1 4 6 4 1

16

pl = plain
pe = peppers
s = sausage
m = mushrooms
p = peparoni
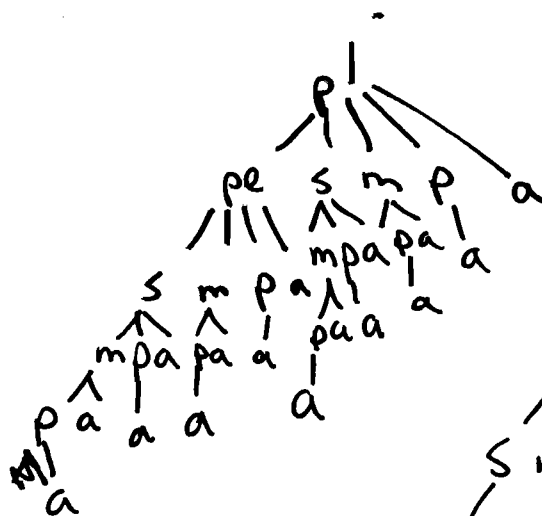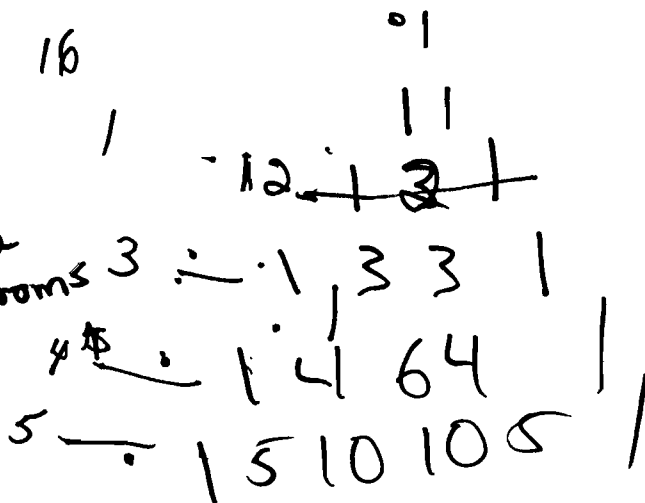
1   01
1 1
-12 + 3 +

3 :— . 1 3 3 1

4 ↓ — . 1 4 64 1

5 — . 1 5 10 10 5 1

p
pe s m p a

s m p a
mpapa a
m papa a a
p a pa a
m p a a a
m a

pl
pe s m

s m m
m

pl pl pl
pe s   pe
s

Robert S███████

A Pizza Problem

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They offer a plain pizza, that is, "cheese with tomato sauce". A customer can then select from the following toppings: peppers, sausage, mushrooms and pepperoni.

1. How many different choices for pizza does a customer have?

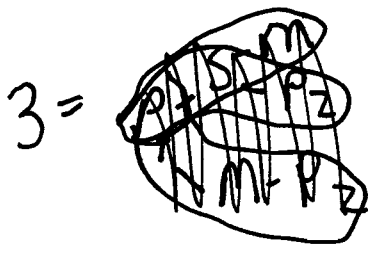 16

2. List all the possible choices.

    $\emptyset = $ plain $= 1$ $1 = p, s, m,$ pepperoni $= 4$

    $2 = $

    $p \overset{-s}{\underset{-m}{}}$ $s \overset{-m}{\underset{-p_2}{}}$ $m - p_2 = 6$ $2 \cdot 11$

    $p_1 \searrow m$

    $\searrow p_2$

    $3 = 4$

    $4 = 1$

3. Find a way to convince each other that you have accounted for all possible choices.

4. Suppose a fifth topping, anchovies, were available. How many different choices for pizza does a customer now have? Why?
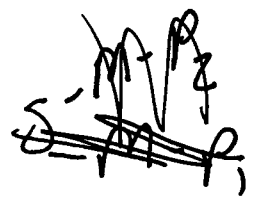
    32

    $25 = 32$

#1
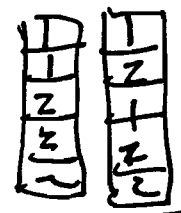
0 - plain, p, s, e = 8

0 - plain
1 - p, s, e
2, p·s, p'e, s'e
3 - p·s·e

plain, p, s
0 - plain = 4
1 - p·s
2 - p·s

1 - plain, p
0 - plain = 2
1 - p

$3 =$

$13?$

$P_1 - S - M - \cancel{M - S}$

$P_1 - S - P_2$

$P_1 - M - P_2$

$S - M - P_2$

$4 = P_1, S, M, P_2$

2 $\cancel{2}$ $\boxed{\begin{smallmatrix}1\\1\\1\end{smallmatrix}}$ ●

3 B $\boxed{\begin{smallmatrix}1\\1\\2\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\1\\2\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\2\\1\end{smallmatrix}}$

4 6 $\boxed{\begin{smallmatrix}1\\1\\2\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}1\\2\\1\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\2\\2\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\1\\2\end{smallmatrix}}$

$\boxed{\begin{smallmatrix}2\\1\\1\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\2\\1\end{smallmatrix}}$

5 10 $\boxed{\begin{smallmatrix}1\\1\\2\\2\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}1\\2\\1\\2\end{smallmatrix}}$ $1 , 1$ $= 4$

$\boxed{\begin{smallmatrix}2\\2\\1\\1\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\2\\1\end{smallmatrix}}$ $\boxed{\begin{smallmatrix}2\\1\\1\end{smallmatrix}}$ $= 3$

$= 2$

$= 1$

#2

$$1 = 2^0 = 1$$

$$H\ 1 = 2^1 = 2$$

$$1\ 2\ 1 = 2^2 = 4$$

$$1\ 3\ 3\ 1 = 2^3 = 8$$

$$1\ 4\ 6\ 4\ 1 = 2^4 = 16$$

$$1\ 5\ 10\ 10\ 5\ 1 = 2^5 = 32$$

$0 = 1$

$1 = S$

$2 = P \sim S$

$\sim M$

$\sim P_2$

a

$S \sim P_2$

$M \sim P_2$

a

a

$P_2 - a = 10$

$3 = P \sim S$

$\sim M$

$\sim P_2$

a

$m \sim P_2$

a

$P_2 - a$

$S - M - P = 7$

$4 = P \sim S$

$\sim M$

P_2

$P \sim S$

$M \sim P_2$

a

P_2

$P_2 - M$

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Plain   Peppers   Sausage   mushrooms   Pepperoni   Stephanie

Mush Pepperoni   mush Pepperoni   Pepperoni   Pepperoni

Pep. Saus   Sausage   mushroom   Sausage

Plain   Peppers   Peppers   Peppers   Peppers   Peppers   Peppers
Sausage
Pepperoni   Mushroom   Sausage   Sausage   Sausage   Pepperoni   mushrooms
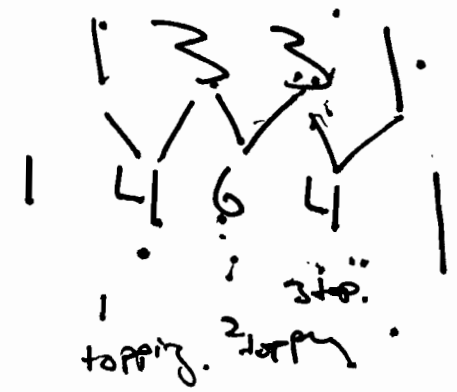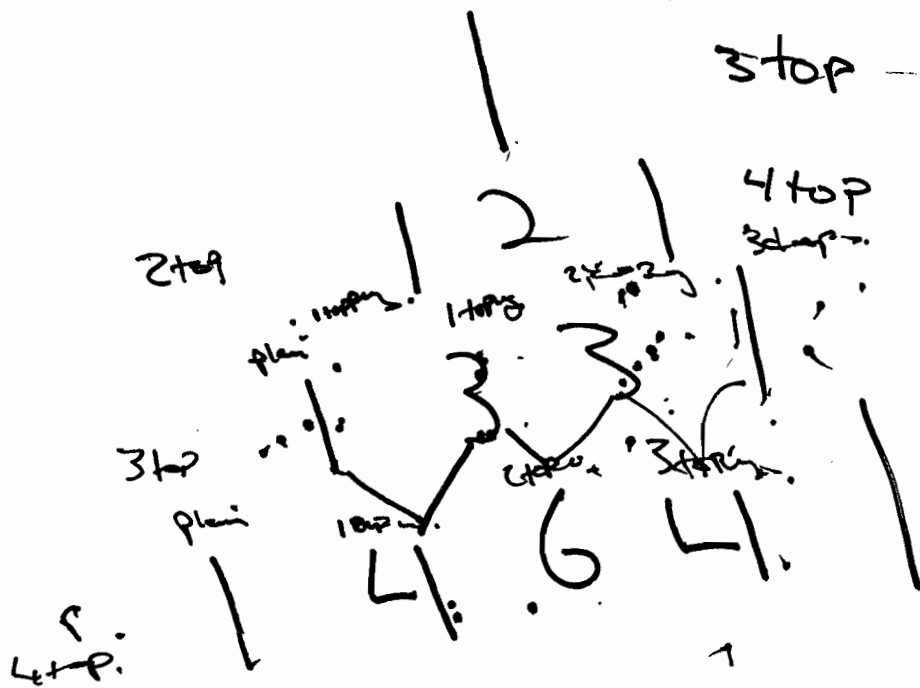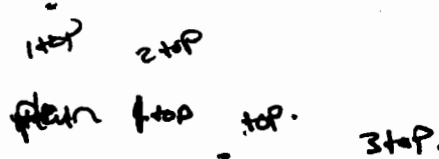Mushroom   mushrooms
Pepperoni
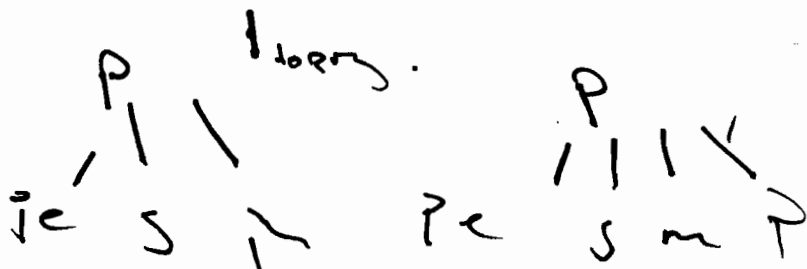
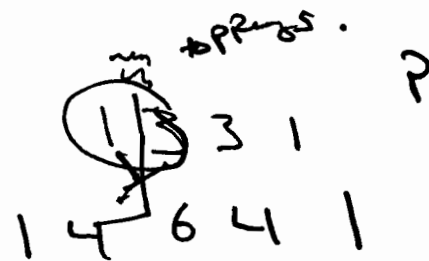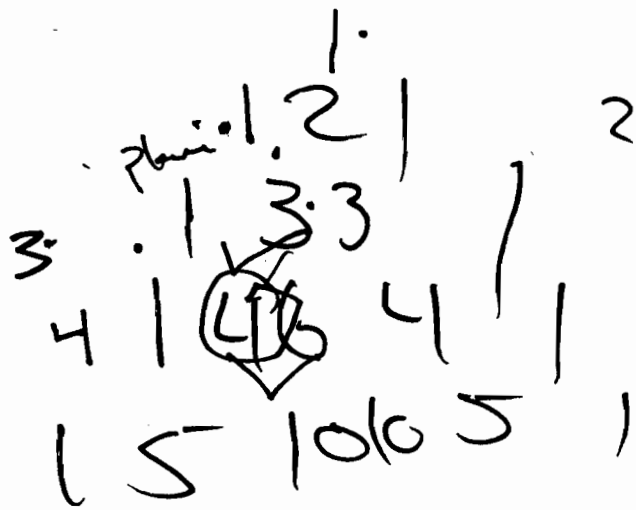Sausage   Sausage   Sausage   Sausage   Sausage   Sausage
Pepperoni   mushrooms   Peppers   Pepperoni   Peppers
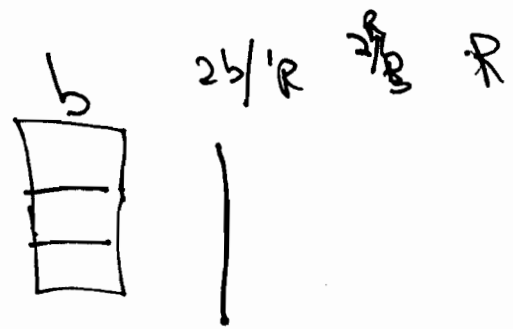   Pepperoni   mushrooms   mushrooms

Pepperoni   Pepperoni   Pepperoni
Mushrooms   mushrooms   mushrooms
          Sausage
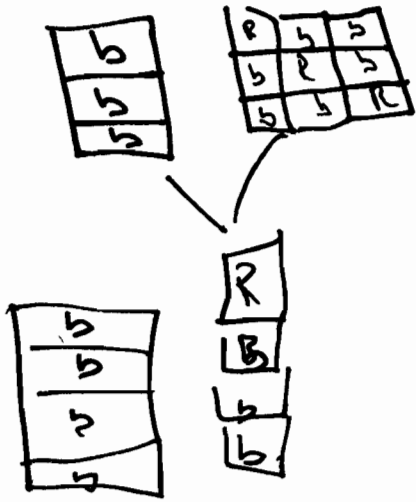
Mushrooms

anchovies
Peppers
Sausage
mushrooms
Pepperoni

Plain Stephanie

3. Plain 1. 2 | 2. Plain
3. . | 3. 3 |
4 | 4 6 4 | |
| 5 | 6 6 5 | |

toppings.
| 3 | P
1 4 6 4 |

P | | 1 toppng.   P | | V
Je S N   Pe S m P

1 top   2 top
plain 1 top   top.   3 top.
3 top — | 3 3 |.
4 top   1 4 6 4 |
3 top.
2 | | 1   3 top.
2 top   1 topng.   1 topng.   topping. 2 topng.
3 tp | 2 | |
plain |
| 4 | 6 4 |.
3 tp   1 topng.   3 topping.
plain | 4 | 6 4 |.

Peppers

P   b   2b/1R   2b/3 R
4+P.

1   3   3   1

choose
b
don't

mush

R

pepper