Geometry 13.4
Design simulations to estimate probabilities
Summarize data from simulations — use math to create
                                              a model
probability model   proportional
simulation
random   dice, spinner, coin, random number $n \geq 30$
expected value
Law of large numbers

$0 \text{——————} 100$
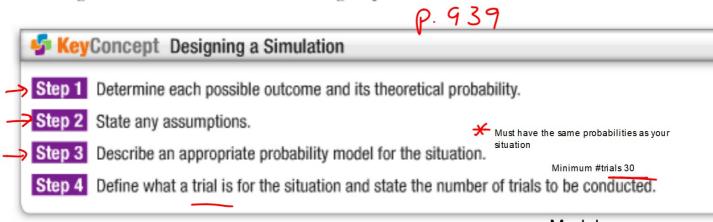$0 \text{——————} 1$

1 Design a Simulation A ==probability model== is a mathematical model used to match a random phenomenon. A ==simulation== is the use of a probability model to recreate a situation again and again so that the likelihood of various outcomes can be estimated. To design a simulation, use the following steps.

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KeyConcept Designing a Simulation

→ **Step 1** Determine each possible outcome and its theoretical probability.

→ **Step 2** State any assumptions.

⋆ Must have the same probabilities as your situation

→ **Step 3** Describe an appropriate probability model for the situation.

Minimum #trials 30

Step 4 Define what a trial is for the situation and state the number of trials to be conducted.

Model:
spinner
dice
random number
flip coin
etc.

Example 1 Design a Simulation by Using a Geometric Model

BASKETBALL Allen made 70% of his free throws last season. Design a simulation that can be used to estimate the probability that he will make his next free throw this season.

spinner

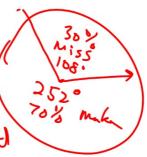make 70%

Step 1 Possible outcomes
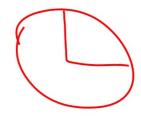miss 30%

Assumption(s) if any
Step 2 Appropriate model (prob. must match the situation

Step 3 Spinner 70% (make) 252°
30% (miss) 108°

30% Miss 108°
252°
70% make

Describe what a trial will be   One spin + record
Determine # of trials (min. 30 unless otherwise stated)

Step 4
Theor.
70%

$\frac{5 \times P.}{23}$
$\frac{23}{30} \approx 77\%$

Note: if using a spinner, always describe the percent for each section
    AND number of degrees in each section.
The drawing (sketch) of your spinner should be proportional to your description
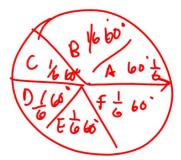
dice/spinner

1. **RESTAURANTS** A restaurant attaches game pieces to its large drink cups, awarding a prize to anyone who collects all 6 game pieces. Design a simulation using a geometric model that can be used to estimate how many large drinks a person needs to buy to collect all 6 game pieces.

A B C D E F

Step 1 Possible outcomes   1 2 3 4 5 6

roll dice

assumptions   assume = likely

Step 2 model   roll dice + record
each roll = 1 purchase   (min 30)

Step 3

trial
n = 30

1	2	3	4	5	6
II	III	II	HtI	I	II

Step 4

Example 2 Design a Simulation by Using Random Numbers

EYE COLOR A survey of East High School students found that 40% had brown eyes, 30% had hazel eyes, 20% had blue eyes, and 10% had green eyes. Design a simulation that can be used to estimate the probability that a randomly chosen East High student will have one of these eye colors.

spinner

Step 1 Outcomes   Spinner Brown 40% = 144°

hazel 30% = 108°

assumptions
no other colors   blu 20% = 72°

spinner not on line   gree 10% 36°

Step 2 model

Step 3 $n = 30$

trial

Step 4

2. SOCCER Last season, Yao made 18% of his free kicks. Design a simulation using a random number generator that can be used to estimate the probability that he will make his next free kick.
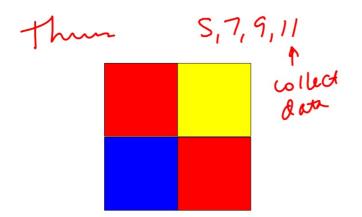
Use 100 slips of paper...

Outcome
Assumptions
Model
Trial

Example 1 Design a Simulation by Using a Geometric Model

BASKETBALL Allen made 70% of his free throws last season. Design a simulation that can be used to estimate the probability that he will make his next free throw this season.

Thurs   5, 7, 9, 11
                              ↑
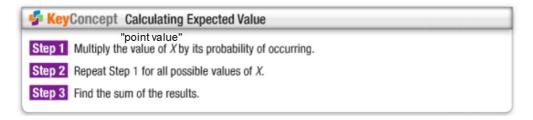   collect
                            data

Dart board:
Expected value:
Red = 1 point
Yellow = 4 points
Blue = 6 points

Overall average amount expected on a
typical turn...(if you play multiple rounds)

Expected value:
Roll number cube:
1 = 4 pts
even number = 10 pts
3 = 1 pt
5 = 2 pts

Average amount expected on a
typical turn...(overall)

Expected value, also known as mathematical expectation, is the average value of a random variable that one *expects* after repeating an experiment or simulation a theoretically infinite number of times. To find the expected value $E(X)$ of a random variable X, follow these steps.

KeyConcept Calculating Expected Value

"point value"

Step 1 Multiply the value of X by its probability of occurring.

Step 2 Repeat Step 1 for all possible values of X.

Step 3 Find the sum of the results.

overall average if you play multiple rounds...