Base 2 Number Prediction Cards

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Base 2: Predict a Number from 1 to 15

1	3	5	7
9	11	13	15

2	3	6	7
10	11	14	15

4	5	6	7	
12	13	14	15	

8	9 10		11	
12	13	14	15	

Base 2: Predict a Number from 1 to 15

Procedure:

Cut out the four cards.

A student is asked to think of a number from 1 to 15 inclusive. You then hand the student all 4 cards. You ask the student to look at all the cards and hand you all the cards that have their number on it. Tell them that their number may not be on all the cards. Be sure to ask them to look closely at the cards so they do not miss a number on one of the cards. After the cards with their number on them have been given back you announce their exact number!

How it's done:

Find the **smallest number** on each of the cards given to you. For these cards the smallest number is in the top left square. Add up those numbers. The total will be the number that they thought of.

8	9	10	11	4	5	6	7	2	3	6	7]	1	3	5	7
12	13	14	15	12	13	14	15	10	11	14	15		9	11	13	15

Example 1:

The student picks 13 They hand you 3 cards.

The smallest number on one of the cards is 1 The smallest number on a second card is 4 The smallest number on a third card is 8.

Their number is 8 + 4 + 1 = 13

Example 2:

The student picks 9 They hand you 2 cards.

The smallest number on one of the cards is 1 The smallest number on a second card is 8

Their number is 8 + 1 = 9

How it works

In base 10 the first place value represents the 1's place, the second place value represents the 10's place and the third place value represents the 100's place. Any single digit from 0 to 9 can be placed in each place value

Consider the base 10 three digit number 234

2 3 4 100's 10's 1's place place place

The 4 in the 1's place means we have 4 ones 4(1) = 4The 3 in the 10's place means we have 3 tens 3(10) = 30The 2 in the 100's place means we have 2 hundreds 2(100) = 200

2(100) + 3(10) + 4(1) = 234 base 10

In base 2 the first place value represents the 1's place, the second place value represents the 2's place and the third place value represents 4s place. In base 2 we can only use a digit that is 0 or 1 for each place value-

Consider the three digit number in base 2 101

1 0 1 4s 2's 1's place place place

In base 10 this means The 1 in the 1's place means we have 1 ones 1(1) = 1The 0 in the 2's place means we have 0 twos 0(2) = 0The 1 in the 4s place means we have 1 fours 1(4) = 4

1(4) + 0(2) + 1(1) = 5 base 10

In base 10 any single digit from 0 to 9 can be placed in each place value

In base 10, if I say there is a zero in the ones place I know the ones place contains 0. If I say there is a nonzero digit in the ones place the number there could be any nonzero digit 1 to 9. Just knowing there is a nonzero digit in the ones place does not tell us anything about the number. The same thing is true of all the other number places.

Lets say I am thinking of a three digit number in base 10. I state that there is a nonzero digit in the 100's place and the 1's place and a zero in the 10's place. You cannot determine what the number is. You know there is a zero in the 10;s place as there is only one number that represents 0. But there are 9 nonzero numbers that could go into the 100 's place and the 1's place.

	There a	There are many numbers that meet that requirement: 907, 205, 604 and many others						
100's 10's 1's 100's 10's 1's 100's 10's 1	_9_) _7	<u>2 0</u>	_5_	_6_	_0_	_4	
place place place place place place place place place	100's place	's 1's 10 ace place pla	0's 10's ce place	1's place	100's place	10's place	1's place	

In base 2 we can only use a digit that is 0 or 1 for each place value-

In binary form just knowing if a zero or a nonzero number is in each place vale determines a unique number in base 2 and the number converts to a unique in base 10.

In base 2 every place value has only a one or a zero allowed in that place value. if I say there is a zero in the ones place I know the ones place contains 0. If I say there is a nonzero digit in the ones place the number there can only be a 1 in that place. The same thing is true of all the other number places.

Is there a nonzero number in any of the 3 place values?									
<u>yes yes yes</u>	<u>no yes yes</u>	<u>yes yes no</u>							
	coverts to this base 2 number								
<u>1</u> <u>1</u> <u>1</u>	<u>0 1 1</u>	<u>1 1 0</u>							
4's 2's 1's place place place	4's 2's 1's place place place	4's 2's 1's place place place							
each of these base 2 numbers covert to a unique base 10 number									
<u> 1 1 1 </u>	<u>0 1 1</u>	<u>1 1 0</u>							
4's 2's 1's	4's 2's 1's	4's 2's 1's							
4 + 2 + 1 = 7 base 10 0 + 2 + 1 = 3 base 10 4 + 2 + 0 = 6 base 10									
. Is there a nonzero number in any of the 4 places values?									
<u>yes yes yes yes</u>	<u>yes no yes no</u>	<u>no yes yes no</u>							
	coverts to this base 2 number	er							
$\begin{array}{c c} \underline{1} & \underline{1} & \underline{1} & \underline{1} & \underline{1} \\ 8's & 4's & 2's & 1's \\ place place place place place \end{array}$	$ \frac{1}{8's} \frac{0}{4's} \frac{1}{2's} \frac{0}{1's} $ place place place place	$\begin{array}{c ccc} \underline{0} & \underline{1} & \underline{1} & \underline{0} \\ \hline 8's & 4's & 2's & 1's \\ place place place place place \\ \end{array}$							
each of these base 2 numbers covert to a unique base 10 number									
$\frac{1}{8's}$ $\frac{1}{4's}$ $\frac{1}{2's}$ $\frac{1}{1's}$	$\frac{1}{8's}$ $\frac{0}{4's}$ $\frac{1}{2's}$ $\frac{0}{1's}$	$\frac{0}{8's}$ $\frac{1}{4's}$ $\frac{1}{2's}$ $\frac{0}{1's}$							
8 + 4 + 2 + 1 = 15 base 10	8 + 0 + 2 + 0 = 10 base 10	0 + 4 + 2 + 0 = 6 base 10							

The cards allow us to ask "Is there a nonzero number in each decimal place"?

Card 1						
1	3	5	7			
9	11	13	15			

Card 1 acts as a YES or NO for the question "Is there a nonzero number in the 1's place"?

You ask is your number on this card

If you say yes the place a 1 in the 1's place. If you say no place a 0 in the 1's place



Card 2 acts as a YES or NO for the question "Is there a nonzero number in the 2's place"?

You ask is your number on this card

If you say yes the place a 1 in the 2's place. If you say no place a 0 in the 2's place



Card 3						
4	5	6	7			
12	13	14	15			

Card 3 acts as a YES or NO for the question "Is there a nonzero number in the 4's place"?



If you say yes the place a 1 in the 8's place. If you say no place a 0 in the 8's place

<u>0</u> ____ ___

The answers to the question about the 4 cards allows us to create a 4 digit base 2 number and then convert it into the base 10 number that was chosen.

Pick a number. Lets say they pick 14.

Use all 4 cards. Ask what cards are your number is on.

Card 4						
8	9	10	11			
12	13	14	15			

Card 3						
4	5	6	7			
12	13	14	15			

 Card 2

 2
 3
 6

 10
 11
 14

Card 1						
1	3	5	7			
9	11	13	15			

Card 4 is yes put a 1 in the 8's place

Car	d 3	is y	/es	
put a	1 in	the	4's	place

Card 2 is yes put a 1 in the 2's place

7

15

Card 1 is no put a 0 in the 1's place

1	_1		_0
yes	yes	yes	no



place place place place

this base 2 number coverts to a base 10 number

8 + 4 + 2 + 0 = **14** base 10

14 is the card they selected

Pick a number. Lets say they pick 9.

Card 4					
8	9	10	11		
12	13	14	15		

Use all 4 cards. Ask what cards are your number is on.

Card 4 is yesCaput a 1 in the 8's placeput a

Card 3				
4	5	6	7	
12	13	14	15	

2 3 6 7 10 11 14 15

Card 2

Card 1					
1	3	5	7		
9	11	13	15		

Card 3 is no put a 0 in the 4's place **Card 2 is no** put a 0 in the 2's place

Card 1 is yes put a 1 in the 1's place

1	_0	0	1
yes	no	no	yes

$$\frac{1}{8's} \quad \frac{0}{4's} \quad \frac{0}{2's} \quad \frac{1}{1's}$$

place place place place

this base 2 number coverts to a base 10 number

8 + 0 + 0 + 1 = **9** base 10

9 is the card they selected

How to make a set of cards for the numbers 1 to 15

Write each number from 1 to 15 in base 2. Each of the base 10 numbers will be a 4 digit number with a 0 or 1 for each digit in base 2.

Base 2 <u>1 or 0 1 or 0 1 or 0 1 or 0</u>

All the numbers on card 1 have a 1 in the ones place. All the numbers on card 2 have a 1 in the twos place. All the numbers on card 3 have a 1 in the fours place. All the numbers on card 4 have a 1 in the eight's place.

Base 10		card 4 $2^3 = 8$	card 3 $2^2 = 4$	card 2 $2^1 = 2$	card 1 $2^0 = 1$	the number is on
1	0 + 0 + 0 + 1	0	0	0	1	Card 1
2	0 + 0 + 2 + 0	0	0	1	0	Card 2
3	0 + 0 + 2 + 1	0	0	1	1	Card 2 , 1
4	0 + 4 + 0 + 0	0	1	0	0	Card 3
5	0 + 4 + 0 + 1	0	1	0	1	Card 3 , 1
6	0 + 4 + 2 + 0	0	1	1	0	Card 3 , 2
7	0 + 4 + 2 + 1	0	1	1	1	Card 3 , 2 , 1
8	8 + 0 + 0 + 0	1	0	0	0	Card 4
9	8 + 0 + 0 + 1	1	0	0	1	Card 4 , 1
10	8 + 0 + 2 + 0	1	0	1	0	Card 4 , 2
11	8 + 0 + 2 + 1	1	0	1	1	Card 4 , 2 , 1
12	8 + 4 + 0 + 0	1	1	0	0	Card 4 , 3
13	8 + 4 + 0 + 1	1	1	0	1	Card 4, 3 ,1
14	8 + 4 + 2 + 0	1	1	1	0	Card 4 , 3 , 2
15	8 + 4 + 2 + 1	1	1	1	1	Card 4 , 3 , 2 ,1

If your number is NOT on that card there is a zero in that place

List each number from 1 to 15 on the cards that are shown for that number. 15 is on cards 1, 2, 3 and 4. Put a 15 on all those cards. 10 is on cards 2 and 4. Put a 4 on those cards. List the numbers on the cards from lowest to highest starting in the upper left corner of the card. Some numbers will be on only one card and other numbers will be on multiple cards.

The completed cards

Card 4				
8	9	10	11	
12	13	14	15	

Card 3				
4	5	6	7	
12	13	14	15	

Card 2				
2	3	6	7	
10	11	14	15	

Card 1				
1	3	5	7	
9	11	13	15	

Card 4				
8	9	10	11	
12	13	14	15	

Card 3							
4	5	6	7				
12	13	14	15				

Card 2								
2	3	6	7					
10	11	14	15					

Card 1								
1	3	5	7					
9	11	13	15					

The upper left corner tells you if you have a ones digit in the 1's place, the 2's place the 4's place or the 8's place depending on the card.

All the All th All th All the If your nu	e numbers on e numbers or e numbers or numbers on mber is NOT	a card 1 have a n card 2 have a n card 3 have a card 4 have a on that card th	a 1 in the one a 1 in the two a 1 in the four 1 in the eight ere is a zero i	s place. s place. s place. t's place. in that place.
Base 2				
Base 10	8's place	4's place	2's place	1's place

Example 1

If your number is on cards 1, 2 and 3 and not on card 4 then your number is 0111 base 2. Using the base 10 values in the upper left corner of each card your number is

base 2 <u>0 1 1 1</u> base 10 0 + 4 + 2 + 1 = 7 base 10

Example 2

If your number is on cards 2, 3 and 4 and not on card 1 then your number is 1110 base 2. Using the base 10 values in the upper left corner of each card your number is

base 2 <u>1 1 1</u> <u>0</u>

base 10 8 + 4 + 2 + 0 = 14 base 10

Example 3

If your number is on cards 2 and 4 and not on cards 1 and 3 then your number is 1010 base 2. Using the base 10 values in the upper left corner of each card your number is

base 2 <u>1 0 1 0</u>

base 10 8 + 0 + 2 + 0 = 10 base 10

	Ca	ʻd 4		Card 3			Card 2					Ca	rd 1		
8	9	10	11	4	5	6	7	2	3	6	7	1	3	5	7
12	13	14	15	12	13	14	15	10	11	14	15	9	11	13	15

Use all 4 cards. Ask what cards are your number is on.

The first trick involved using 4 cards. 4 cards were used because the numbers 1 to 15 in base 10 convert to 4 digit numbers in base 2. Each card represent 1 place value of the 4 digits. Card 1 tells us the place value of the ones digit to be 1 or 0. Card 2 tells us the place value of the twos digit to be 2 or 0. Card 3 tells us the place value of the fours digit to be 4 or 0. Card 4 tells us the place value of the eight's digit to be 8 or 0. For easy reference we put the place value in the upper left corner of each card.

It is possible to condense the information on each of the 4 cards onto one card. The card below takes each of the 4 cards and puts that information on separate roes of the same card. The left most number is the place values for that row,

Row 1	1	3	5	7	9	11	13	15
Row 2	2	3	6	7	10	11	14	15
Row 3	4	5	6	7	12	13	14	15
Row 4	8	9	10	11	12	13	14	15

Use only 1 card. Ask what rows the number is on.

Example

The student picks 13

They say the number is in row 1 3 and 4.

The place value for row 1 is 1 The place value for row 3 is 4 The place value for row 4 is 8.

Their number is 8 + 4 + 1 = 13

Note: By having all the information on one card patterns may be seen that were not apparent on the 4 separate cards. A drawback of this may be that the way the trick works may be easier to see.

	Ca	rd 4		Card 3			Card 2			Card 1					
8	9	10	11	4	5	6	7	2	3	6	7	1	3	5	7
12	13	14	15	12	13	14	15	10	11	14	15	9	11	13	15

Use all 4 cards. Ask what cards are your number is on.

It is possible to condense the information on each of the 4 cards onto one card. The card below takes all 4 cards and puts their information on separate rows of the same card. Each row is given a different color. The left most number in each row is the place values for that row,

Note: The addition of a color for each row allows us to condense the 4 card onto one card. The key numbers used for the place value are still on the left of each row and in order.

By having all the information on one card students may be able to see patterns that were not apparent on the 4 separate cards. A drawback of this may be that it can make it easier to see how the trick works.

Base 2: Predict a Number from 1 to 15

1	3	5	7	9	11	13	15
2	3	6	7	10	11	14	15
4	5	6	7	12	13	14	15
8	9	10	11	12	13	14	15

Procedure:

Cut out the card.

A student is asked to think of a number from 1 to 15 inclusive. Hand the student the card. You ask the student to look a the card and tell you **ALL** the colors their number is printed in. After the colors have been stated you announce their exact number!

How it's done:

When the student names the colors of their number. Find the **smallest number** on each of the rows of for a mentioned color. For these row the smallest number is in the left square for that row. Add up those numbers. The total will be the number that they thought of.

The use of colors instead of numbered rows allows us to extend the trick further. We can use one card but make it a bit more deceptive by mixing up the numbers so the colors are not all on the same row. **The key numbers for the place values of each color are in the center**. I used a 6 by 6 square for the card. There are only 32 data bits so we have 4 unused squares. I left the 4 corners open.

8	9	10	11
12	13	14	15

Card 3							
4	5	6	7				
12	13	14	15				

	2	3	6	7
5	10	11	14	15

Card 1									
1	3	5	7						
9	11	13	15						

	3	11	14	9	
13	13	15	12	3	6
7	5	1	2	10	13
14	15	4	8	11	7
11	7	14	15	6	5
	9	12	10	15	

Predict a Number from 1 to 15

	3	11	14	9	
13	13	15	12	3	6
7	5	1	2	10	13
14	15	4	8	11	7
11	7	14	15	6	5
	9	12	10	15	

Base 2 Predict a Number from 1 to 15

Procedure:

Hand the student the card. Ask the student to select a number from 1 to 15 inclusive. Ask the student to look a the card and tell you **ALL** the colors their number is printed in. After the colors have been stated you announce their exact number!

How it's done:

Find the **smallest number on the card for each of the colors the students states the number is.** For this card smallest numbers for each of the colors is the the center 4 squares of the card. Add up numbers of the mentioned numbers. The total will be the number that they thought of.

Example

The student picks 13. They say their number is black, blue and green

Looking at the 4 center squares we see that

The place value for black is 1 The place value for blue is 4 The place value for green is 8.

Their number is 8 + 4 + 1 = 13

Card 4						
8	9 10 11					
12	13	14	15			

Card 3							
4	5	6	7				
12	13	14	15				

Card 2						
2	3	6	7			
10	11	14	15			

Card 1							
1	3	5	7				
9	11	13	15				

The final version puts the place value numbers in the 4 corners and leaves the 4 square sin the middle open. This square was made into one large square and the instructions for the trick are in this area.

1	3	11 14		9	2
13	13	15 12		3	6
7	5	Pick a from 1	number to 15.	10	13
14	15	Name colors numb	e all the s your per is	11	7
11	7	14	14 15		5
8	9	12 10		15	4

Predict a Number from 1 to 15

1	3	11	14	9	2
13	13	15	15 12		6
7	5	Pick a from 1	number to 15.	10	13
14	15	Name colors numb	e all the s your per is	11	7
11	7	14	15	6	5
8	9	12	10	15	4

Procedure:

Hand the student the card. Ask the student to select a number from 1 to 15 inclusive. Ask the student to look a the card and tell you **ALL** the colors their number is printed in. After the colors have been stated you announce their exact number!

How it's done:

Find the smallest number on the card for each of the colors the students states the number is. For this card smallest numbers for each of the colors is the the center 4 squares. Add up numbers for those colored squares. The total will be the number that they thought of.

Example

The student picks 13. They say the number is black, blue and green The place value for black is 1 The place value for blue is 4 The place value for green is 8. Their number is 8 + 4 + 1 = 13

Predict a Number from 1 to 31

1	3	5	7	2	3	6	7
9	11	13	15	9	11	14	15
17	19	21	23	17	19	22	23
25	27	29	31	25	27	30	31

4	5	6	7	8	9	10
12	13	14	15	12	13	14
20	21	22	23	24	25	26
28	29	30	31	28	29	30

16	17	18	19
20	21	22	23
24	25	26	27
28	29	30	31

11

15

27

31

Procedure:

Cut out the four cards.

Ask a student to think of a number from 1 to 31 inclusive. You then hand the student all 5 cards . You ask the student to look at all the cards and hand you all the cards that have their number on it. Tell them that their number may not be on all the cards. Be sure to ask them to look closely at the cards so they do not miss a number on one of the cards. After the cards with their number on them have been given back you announce their exact number!

How it's done:

Find the **smallest number** on each of the cards given to you. For these cards the smallest number is in the top left square. Add up those numbers. The total will be the number that they thought of.

Example 1:

The student picks 30 They hand you 4 cards.

The smallest number on one of the cards is 2 The smallest number on a second card is 4 The smallest number on a third card is 8. The smallest number on a fourth card is 16.

Their number is 16 + 8 + 4 + 2 = 30

Example 2:

The student picks 17. They hand you 2 cards.

The smallest number on one of the cards is 1 The smallest number on a second card is 16

Their number is 16 + 1 = 17

A presentation that makes it more personal.

Ask a student to think of the **day** of the month they were born. it will be a number form 1 to 31. Do the trick to find the day they were born. Do not revel it yet.

Ask a student to think of the number for the **month** they were born. Have then start with January as 1 and count with their fingers until they get the number of their month.

January = 1February= 2March = 3April = 4May = 5June = 6July = 7August = 8September = 9October = 10November = 11December = 12

Do the trick again to find the month they were born. You can now tell them the day and month they were born.

Predict a Number from 1 to 63

Card 1									
1	3	5	7	9	11	13	15		
17	19	21	23	25	27	29	31		
33	35	37	39	41	43	45	47		
49	51	53	55	57	59	61	63		

	Card 2										
2	3	6	7	10	11	14	15				
18	19	22	23	26	27	30	31				
34	35	38	39	42	43	46	47				
50	51	54	55	58	59	62	63				

Card 3										
4	5	6	7	12	13	14	15			
20	21	22	23	28	29	30	31			
36	37	38	39	44	45	46	47			
52	53	54	55	60	61	62	63			

Card 4										
8	9	10	11	12	13	14	15			
24	25	26	27	28	29	30	31			
40	41	42	43	44	45	46	47			
56	57	58	59	60	61	62	63			

Card 5									Ca	rd 6					
16	17	18	19	20	21	22	23	32	33	34	35	36	37	38	39
24	25	26	27	28	29	30	31	40	41	42	43	44	45	46	47
48	49	50	51	52	53	54	55	48	49	50	51	52	53	54	55
56	57	58	59	60	61	62	63	56	57	58	59	60	61	62	63

Procedure:

Cut out the four cards.

Ask a student to think of a number from 1 to 63 inclusive. You then hand the student all 6 cards. Ask the student to look at all of the cards and hand you all the cards that have their number on it. Tell them that their number may not be on all the cards. Be sure to ask them to look closely at the cards so they do not miss a number on one of the cards. After the cards with their number on them have been given back you announce their exact number!

How it's done:

Find the **smallest number** on each of the cards given to you. For these cards the smallest number is in the top left square. Add up those numbers. The

Example 1:

The student picks 37

They hand you Card 1.	The smallest number on card 1 is 1
They hand you Card 3.	The smallest number on card 3 is 4
They hand you Card 6.	The smallest number on card 6 is 32

Their number is 32 + 4 + 1 = 37

Example 2:

The student picks 60

They hand you Card 3.	The smallest number on card 3 is 4
They hand you Card 4.	The smallest number on card 4 is 8
They hand you Card 5.	The smallest number on card 5 is 16
They hand you Card 6.	The smallest number on card 6 is 32

Their number is 32 +16 + 8 + 4 = 60

		card 5	card 4	card 3	card 2	card 1	the number is on
Base 10		2 ⁴ = 16	2 ³ = 8	2 ² = 4	2 ¹ = 2	2 ⁰ = 1	Cards
1	0 + 0 + 0 + 0 + 1	0	0	0	0	1	Card 1
2	0 + 0 + 0 + 2 + 0	0	0	0	1	0	Card 2
3	0 + 0 + 0 + 2 + 1	0	0	0	1	1	Card 2 , 1
4	0 + 0 + 4 + 0+ 0	0	0	1	0	0	Card 3
5	0 + 0 + 4 + 0 + 1	0	0	1	0	1	Card 3 , 1
6	0 + 0 +4 + 2 + 0	0	0	1	1	0	Card 3 , 2
7	0 + 0 + 4+ 2 + 1	0	0	1	1	1	Card 3 , 2 , 1
8	0 + 8 + 0 + 0 + 0	0	1	0	0	0	Card 4
9	0 + 8 + 0 + 0 + 1	0	1	0	0	1	Card 4 , 1
10	0 + 8 + 0 + 2 + 0	0	1	0	1	0	Card 4 , 2
11	0 + 8 + 0 + 2 + 1	0	1	0	1	1	Card 4 , 2 , 1
12	0 + 8 + 4 + 0 + 0	0	1	1	0	0	Card 4 , 3
13	0 + 8 + 4 + 0 + 1	0	1	1	0	1	Card 4, 3 ,1
14	0 + 8 + 4 + 2 + 0	0	1	1	1	0	Card 4 , 3 , 2
15	0 + 8 + 4 + 2 + 1	0	1	1	1	1	Card 4 , 3 , 2 ,1
16	16 + 0 + 0 + 0 + 0	1	0	0	0	0	Card 5
17	16 + 0 + 0 + 0 + 1	1	0	0	0	1	Card 5 ,1
18	16 + 0 + 0 + 2 + 0	1	0	0	1	0	Card 5 , 2
19	16 + 0 + 0 + 2 + 1	1	0	0	1	1	Card 5 , 2 ,1
20	16 + 0 + 4 + 0 + 0	1	0	1	0	0	Card 5 , 3
21	16 + 0 + 4 + 0 + 1	1	0	1	0	1	Card 5 , 3 ,1
22	16 + 0 + 4 + 2 + 0	1	0	1	1	0	Card 5 , 3 , 2
23	16 + 0 + 4 + 2 + 1	1	0	1	1	1	Card 5 , 3 , 2 ,1
24	16 + 8 + 0 + 0 + 0	1	1	0	0	0	Card 5 , 4
25	16 + 8 + 0 + 0 + 1	1	1	0	0	1	Card 5 , 4 , 1
26	16 + 8 + 0 + 2 + 0	1	1	0	1	0	Card 5 , 4 , 2
27	16 + 8 + 0 + 2 + 1	1	1	0	1	1	Card 5 , 4 , 2 ,1
28	16 + 8 + 4 + 0 + 0	1	1	1	0	0	Card 5 , 4 , 3
29	16 + 8 + 4 + 0 + 1	1	1	1	0	1	Card 5, 4, 3, 1
30	16 + 8 + 4 + 2 + 0	1	1	1	1	0	Card 5, 4, 3, 2
31	16 + 8 + 4 + 2 + 1	1	1	1	1	1	Card 5, 4, 3, 2, 1

Base 2 digits for the numbers 1 to 31 base 10

Base		card 6	card 5	card 4	card 3	card 2	card 1	the number is on
10		2 ⁵ = 32	2 ⁴ =16	2 ³ = 8	$2^2 = 4$	2 ¹ = 2	2 ⁰ = 1	cards
32	32 + 0 + 0 + 0 + 0 + 0	1	0	0	0	0	0	6
33	$32 \pm 0 \pm 0 \pm 0 \pm 0 \pm 1$	1	0	0	0	0	1	6 1
34	$32 \pm 0 \pm 0 \pm 0 \pm 0 \pm 2 \pm 0$	1	0	0	0	1	0	6.2
35	32 + 0 + 0 + 0 + 2 + 0	1	0	0	0	- 1		6.2.1
36	$32 \pm 0 \pm 0 \pm 0 \pm 4 \pm 0 \pm 0$	1	0	0	1	1	0	63
37	32 + 0 + 0 + 4 + 0 + 1	1	0	0		0	1	631
20	32 + 0 + 0 + 4 + 0 + 1	1	0	0				630
30	32 + 0 + 0 + 4 + 2 + 0	1	0	0	- 1	- 1	0	0,3,2
39	32+0+0+4+2+1		0	0	1	1	1	6,3,2,1
40	32+0+8+0+0+0	1	0	1	0	0	0	6,4
41	32 + 0 + 8 + 0 + 0 + 1	1	0	1	0	0	1	6,4,1
42	32 + 0 + 8 + 0 + 2 + 0	1	0	1	0	1	0	6,4,2
43	32 + 0 + 8 + 0 + 2 + 1	1	0	1	0	1	1	6,4,2,1
44	32 + 0 + 8 + 4 + 0 + 0	1	0	1	1	0	0	6,4,3
45	32 + 0 + 8 + 4 + 0 + 1	1	0	1	1	0	1	6,4,3,1
46	32 + 0 + 8 + 4 + 2 + 0	1	0	1	1	1	0	6,4,3,2
47	32 + 0 + 8 + 4 + 2 + 1	1	0	1	1	1	1	6,4,3,2,1
48	32 +16 + 0 + 0 + 0 + 0	1	1	0	0	0	0	6,5
49	32 +16 + 0 + 0 + 0 + 1	1	1	0	0	0	1	6,5,1
50	32 +16 + 0 + 0 + 2 + 0	1	1	0	0	1	0	6,5,2
51	32 +16 + 0 + 0 + 2 + 1	1	1	0	0	1	1	6,5,2,1
52	32 +16 + 0 + 4 + 0 +0	1	1	0	1	0	0	6,5,3
53	32 +16 + 0 + 4 + 0 +1	1	1	0	1	0	1	6,5,3,1
54	32 +16 + 0 + 4 + 2 +0	1	1	0	1	1	0	6,5,3,2
55	32 +16 + 0 + 4 + 2 +1	1	1	0	1	1	1	6,5,3,2,1
56	32 +16 + 8 + 0 + 0 +0	1	1	1	0	0	0	6,5,4
57	32 +16 + 8 + 0 + 0 +1	1	1	1	0	0	1	6,5,4,1
58	32 +16 + 8 + 0 + 2 +0	1	1	1	0	1	0	6,5,4,2
59	32 +16 + 8 + 0 + 2 +1	1	1	1	0	1	1	6,5,4,2,1
60	32 +16 + 8 + 4 + 0 +0	1	1	1	1	0	0	6,5,4,3
61	32 +16 + 8 + 4 + 0 +1	1	1	1	1	0	1	6,5,4,3,1
62	32 +16 + 8 + 4 + 2 +0	1	1	1	1	1	0	6,5,4,3,2
63	32 +16 + 8 + 4 + 2 +1	1	1	1	1	1	1	6 , 5 , 4 , 3 , 2 ,1

Base 2 digits for the numbers 32 to 63 base 10

Predict a Number from 1 to 7

Cai	rd 3	Car	rd 2	Cai	rd 1
4	5	2	3	1	3
6	7	6	7	5	7

Note. There cards could be used for the numbers 1 to 7. It may be a good place to start with some students. They only use the place vales of 4, 2 and 1 so they are limited to 1 to 7 base 10.

How to make a set of cards for the numbers 1 to 15

Write each number from 1 to 7 in base 2. Each of the base 10 numbers will be a 2 digit number with a 0 or 1 for each digit in base 2.

Base 2 <u>1 or 0</u> <u>1 or 0</u> <u>1 or 0</u>

All the numbers on card 1 have a 1 in the ones place.

All the numbers on card 2 have a 1 in the twos place.

All the numbers on card 3 have a 1 in the fours place.

If your number is NOT on that card there is a zero in that place

Base 10		card 3 $2^2 = 4$	card 2 $2^1 = 2$	card 1 2 ⁰ = 1	the number is on
1	0 + 0 + 1	0	0	1	Card 1
2	0 + 2 + 0	0	1	0	Card 2
3	0 + 2 + 1	0	1	1	Card 2 , 1
4	4 + 0 + 0	1	0	0	Card 3
5	4 + 0 + 1	1	0	1	Card 3 , 1
6	4 + 2 + 0	1	1	0	Card 3 , 2
7	4 + 2 + 1	1	1	1	Card 3 , 2 , 1

List each number from 1 to 7 on the cards that are shown for that number. 7 is on cards 1, 2 and 3. Put a 7 on all those cards. 6 is on cards 3 and 2. Put a 6 on those cards. List the numbers on the cards from lowest to highest starting in the upper left corner of the card. Some numbers will be on only one card and other numbers will be on multiple cards.

The completed cards are shown at the top of the page