Brain Teasers Logic (mathematics) Aptitude Cryptography Challenges Problem Solving

How do I solve cryptarithmetic problems like BASE+BALL=GAMES?

7 Answers

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Answered Aug 24, 2015

Answer is:
A=4,
B=7,
S=8,
E=3,
L=5,
G=1,and
M=9
Explanation:
Here we are provided with the following information

```
  BASE
 +BALL
------------
 GAMES
```

There are seven distinct digits from 10 preliminary digits that are from [0-9]:A,B,S,E,LG,M

As we are just adding 2 numbers so possible carry overs are either 1 or 0
But, when we are adding B+B it gives us some carry that is greater than zero as both 4 digit numbers add up to form a five digit number
Hence, G can't be zero
So, G=1
Now our question will look somewhat like this:

```
  BASE
 +BALL
------------
 1 AMES
```

Then,
if 2 B's are added and they are giving us value greater than equal to 10
Then,B must be greater than equal to 5
Consider B=9 first
if B=9 then A=8 which is not possible as then B+B+1 is not equal to A
if B=8 then A=6 which is not possible for same reason
Take B=7 then A=4 which is possible as it is not leaving any carry over.
So,
M=A+A+x where x is carry over from S+L+y where y is carry over from E+L
knowing the fact that x and y can take maximum value of 1 and minimum value of 0
We can say
M should be either 8 or 9
8 when x=0
9 when x=1
Assuming M=8
that is x=0
S+L+y=E
E+L= 10*y+S

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where y can take either 0 or 1
if y=0 then L=0 then S and E are not distint which is not possible according to question.
if y=1
then L=4.5 which is again not possible as L must be a single digit among 0 to 9
So, M=8 is not possible
So,our question further reduces to

```
   1
  74SE
 +74LL
------
 149ES
```

Now,
S+L=10*1+E=10+E,and
E+L=10*y+S
So,
here y can take maximum and minimum values of 1 and 0 respectively.
So,
if y=0
Then,
E+L=S,or S-L=E,and
S+L=10+E
Adding both we get,
2*S=2*E+10
or
S=E+5
Subtracting 1st equation from 2nd we get
2*L=10
or L=5

So,our question further reduces to

```
  10
  74SE
 +7455
------
 149ES
```

So,
E+5=S,and
S+5+0=E+10*1
S+5=E+10
S=E+5
Now we have to choose digits from 0,1,2,3,4,5,6,7,8,and 9 other than 1,4,7,9,and 5.
So,we can take values of E and S from 0,2,3,6,8 such that S=E+5
0 is there 5 can't be chosen
2 is there 7 can't be chosen
6 is there 11 can't be chosen
8 is there 13 can't be chosen
So, only possible pair left is 3 and 8 which satisfy our constraints.
Hence,
S=8 and E=3

```
  10
  7483
 +7455
------
 14938
```

So,
A=4,
B=7,
S=8,

G=1,and
M=9

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Solving problems like these involves understanding some basic principles and rules of addition and a lot of trial and error.

Take our example,

```
  BASE
 +BALL
------------
GAMES
------------
```

Since the result is one digit more than the numbers, it is quite obvious that there is a carry over and therefore G must be equal to 1. Now consider the part,

```
 SE
+LL
-------
 ES
-------
```

This suggests that S+L=E or 10+E (with 1 as a carry) and E+L=S or 10+S. Now this happens only when L=5 and S~E (difference b/w S and E) = 5

This gives us paired values of (0,5), (1,6), (2,7), (3,8) and (4,9) as possible values for (E,S) or (S,E). But out of these (0,5) and (1,6) cannot be accepted as G=1 and L=5.

The first rule of cryptic equations like this is that different letters cannot have the same numerical value. So we are left with the possibilities of (2,7) , (3,8) and (4,9). We can also infer that of S and E , E is the smaller value and S is the larger, because if E were larger , we would have a carry and then S+L=E would not be valid. This means that S+L=E has a carry over of 1.

Let these values remain for now, we shall come back to them later.

Now coming to the part

```
 BA
+BA
--------
GAM
--------
```

Since there is a carry obtained here, we can infer that B must be greater than or equal to 5. But L=5, therefore B>5. Now we have two cases - If the sum A+A produces a carry, then A is odd, else A is even. Since there is a carry over from S+L=E, M has to be an odd number.

Now we have gathered all the information we can and there is nothing else to do.
To proceed we shall have to use the trial and error method substituting values for the letters keeping all the above points in mind.

Let us assume E=2 and S=7 and B=6. So we have,

```
  1
 6A72
+6A55
-----------
1AM27
------------
```

Now A can be either 2 or 3 depending on whether we have a carry from A+A or not. But since E=2, that means A must be 3 and therefore there is a carry. But replacing the other A's in the equation with 2's gives us two contradictions. Firstly M shall become equal to 7 (S is already equal to 7) and A+A does not produce a carry. Therefore our assumptions were wrong and we will have to try again for a different values.

(I shall skip to the combination which yields the solution, but you shall have to try for all possible values in between)

Now let us try for E=3 and S=8 and B=7. We have,

```
  1
 7A83
+7A55
----------
1AM38
-----------
```

This gives us A=4 or 5 based on whether there is a carry or not, but since already L=5, A must be equal to 4, therefore M=9. We have obtained values for all unknowns without any contradictions and hence this is the solution)

So finally we have

```
  1
 7483
+7455
---------
14938
---------
```

Therefore,
G=1

L=5
B=7
S=8
M=9

Some other useful observations would be.

If,

```
 AB
+CD
-------
 AE
--------
```

We can conclude that C=0

and if

```
 AB
+CD
-------
EAF
-------
```

Then E =1 and C=9

Observing other patterns like these will help you solve the problem easily.

Sudha Sengar, Problem solver
Answered Mar 10, 2017 · Author has **266** answers and **340.2k** answer views

Each letter is one digit integer 0,1,2 to 9 each having a different value.We put the letters as equality constraints.

Expression 1=1000B+100A+10S+E

Expression 2=1000B+100A+10L+L

.....

Expression 3=10000G+1000A+100M+10E+S

.....

If(Expression 3=Expression 1+Expression 2)then report the values of{B,A,S,E,L,G,M}

The equation can be solved by substituting
B = 7
A = 8
S = 8
E = 3
L = 5

7483
+7455

14938

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