Sample Questions Secondary Junior

1. In one of his books, Isaac Asimov described the communication between a human and an alien. Imagine that you are in the place of this person and you know the following principles of the aliens' mathematics:

Alien Math	**Our Math**
a↝b↨c	$c \times \frac{a^3 - b}{a + b}$
a↞b↺c	$a \times b + c$

You want to explain to him explain how gravity acceleration works on your planet by describing the following formula in their Math language:

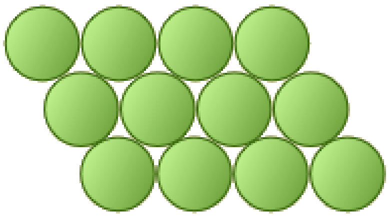
$$S = vt + 4.9t^2$$

How will this formula look in the mathematical language of the alien?

A. v↞t↺(4.9↝t↨0)
B. (v↝t↨4.9) ↞t↺v
C. 9.8↝t↨(v↞5↺v)
D. t↞v↺(9.8↝t↨2)

2. The most efficient way to pack many spheres into a given volume is to use a regular, hexagonal lattice. This fact has been 'known' to us for thousands of years, yet it was only mathematically proven in 1998 by Thomas Hales. It has many profound implications on our daily lives, from stacks of groceries and cannonballs, to the atoms in a crystal.

Let us consider the simpler 2D case. Those who play pool, will know that the most efficient way to "squeeze" circles into a given area is to use hexagonal packing, as shown below.



Packing efficiency is defined as how efficiently the space is used, i.e. the area of the circles divided by the total area used (including 'between' circles). If the 2D hexagonal packing is extended infinitely, what is the packing efficiency?

A. 80% to 85%
B. 85% to 90%
C. 90% to 93%
D. 93% to 95%

3. The Chicken McNugget Theorem was discovered when people realised certain numbers of nuggets could not be bought from a fast-food restaurant. As nuggets could only be purchased in groups of 9 and 20, certain numbers of nuggets, such as 7 and 28, cannot be purchased.

The greatest number of items that cannot be purchased is given by the formula

$$mn - m - n$$

if the items can only be purchased in groups of m and n.

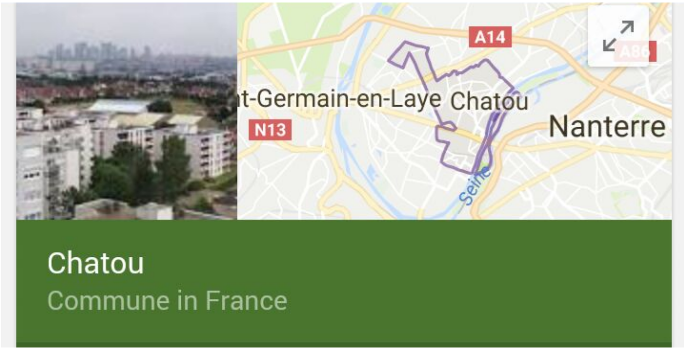
Hence, the greatest number of nuggets that cannot be purchased is:

9(20) – 9 – 20 = 151 nuggets. Any larger number of nuggets can be purchased. For example, 152 nuggets can be purchased in 4 bags of 20 and 8 bags of 9, and 153 nuggets can be purchased in 17 bags of 9.

Another restaurant sells chicken wings in boxes of 7 and 16. What is the greatest number of chicken wings that cannot be bought?

A. 23
B. 82
C. 89
D. 111

4. A tour group consisting of one family of three, two couples, and three individual travellers are visiting Chatou in France and need to stay in a hotel for the night.



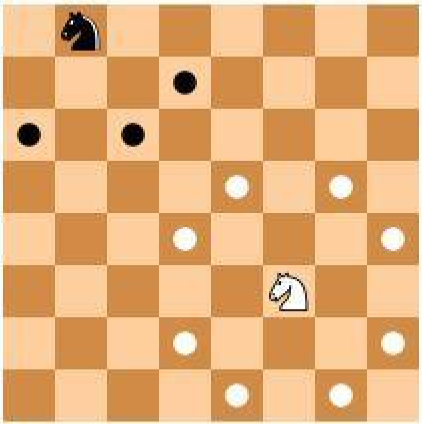
The following shows prices of the rooms in the hotel:

Single bed room	$100
Double bed room	$130
Extra bed (only one extra bed can be added per room)	$40

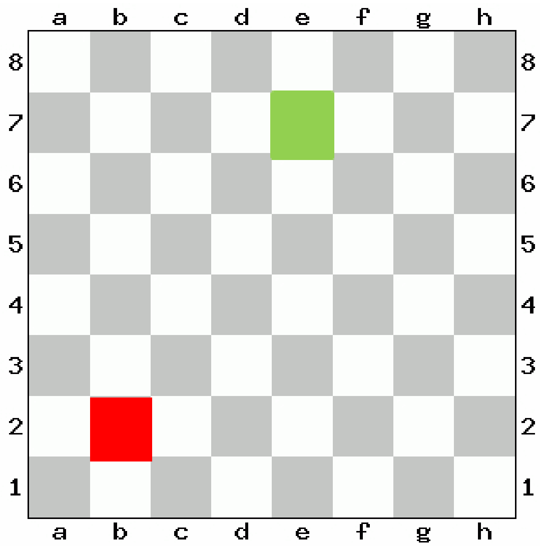
What is the minimum cost required to house the travellers, given that the family of three must stay in one room, and each couple must not be sharing their room with another person?

A. $600
B. $470
C. $730
D. $520

5. A knight in chess moves in a L-shaped pattern as shown below:



The white knight can move to any square with a white dot, and the black knight can move to any square with a black dot.



What is the minimum number of moves needed for a knight to move from the red square to the green square?

A. 3
B. 4
C. 5
D. 6

Answers

1. A
2. C
3. C
4. A
5. B