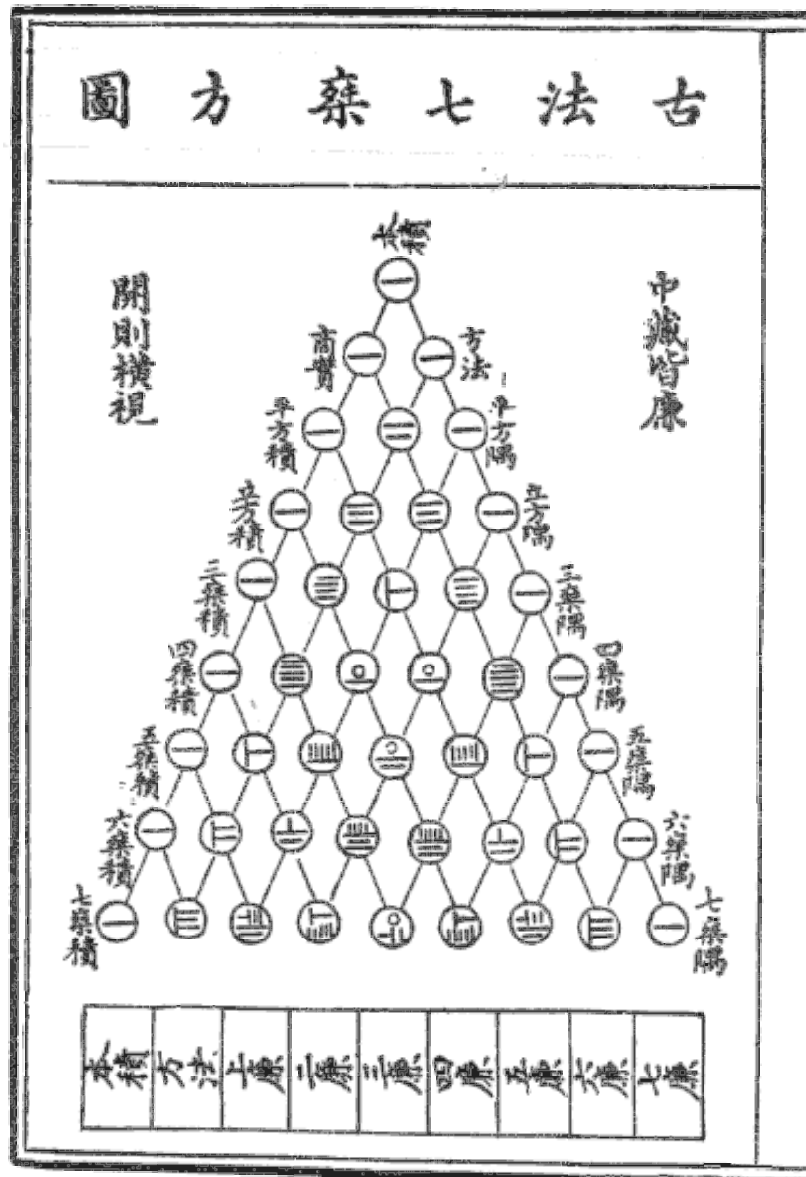


BINOMIAL EXPANSION

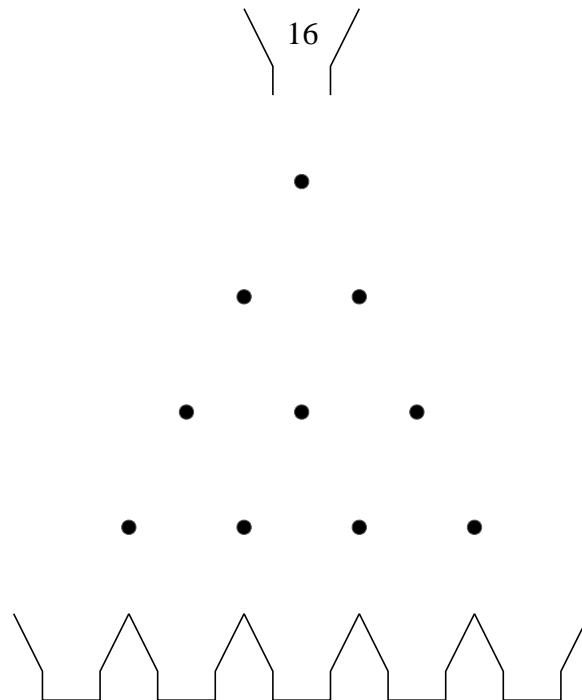


Lesson 1

Additional Mathematics A-Level Pure Mathematics : Year 1 Binomial Expansion

1.1 Pinball

Sixteen steel ball bearings are released into a mathematical pinball machine. The balls roll down the inclined surface, ending up in baskets at the bottom. At each pin it is equally probable that a ball will pass to the left or to the right. Work out how many ball bearings end up in each of the bottom baskets.



Teaching Video <http://www.NumberWonder.co.uk/v9062/1.mp4>



[6 marks]

1.2 Distribution On Average

Mathematicians would call the result “the distribution of the balls in the baskets”.

It's an “on average” result.

To achieve it in reality, the 16 steel ball bearings would be run through the machine many, many, times and the results averaged.

1.3 Exercise

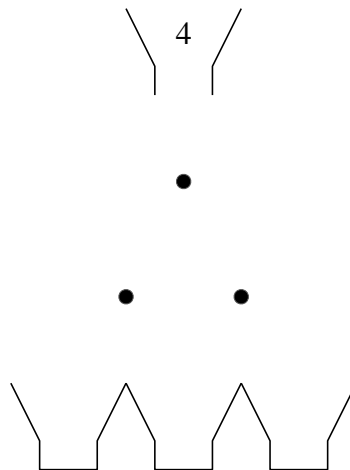
Marks Available : 30

Question 1

Four steel ball bearings are released into a pinball machine.

At each pin it is equally probable that a ball will pass to the left or to the right.

- (i) Above each pin write the total number of balls arriving at that pin
- (ii) Work out how many ball bearings end up in each of the bottom baskets.



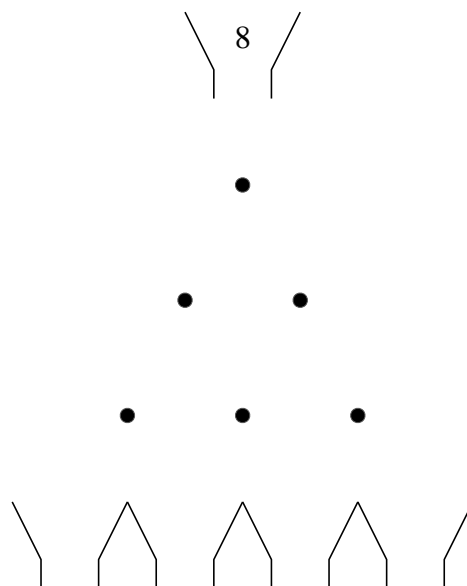
[2 marks]

Question 2

Eight steel ball bearings are released into a pinball machine.

At each pin it is equally probable that a ball will pass to the left or to the right.

- (i) Above each pin write the total number of balls arriving at that pin
- (ii) Work out how many ball bearings end up in each of the bottom baskets.



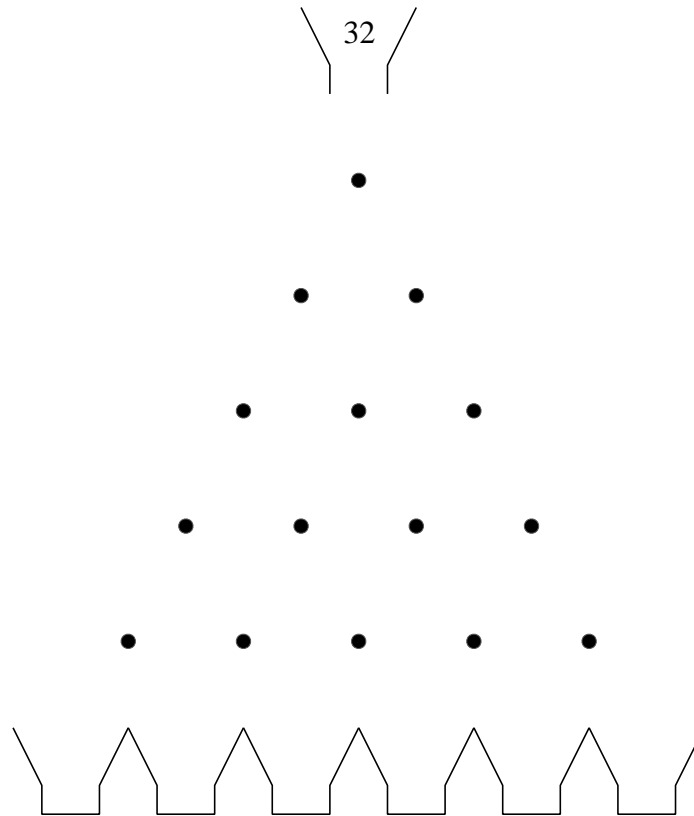
[4 marks]

Question 3

Thirty-two steel ball bearings are released into a pinball machine.

At each pin it is equally probable that a ball will pass to the left or to the right.

- (i) Above each pin write the total number of balls arriving at that pin
- (ii) Work out how many ball bearings end up in each of the bottom baskets.



[8 marks]

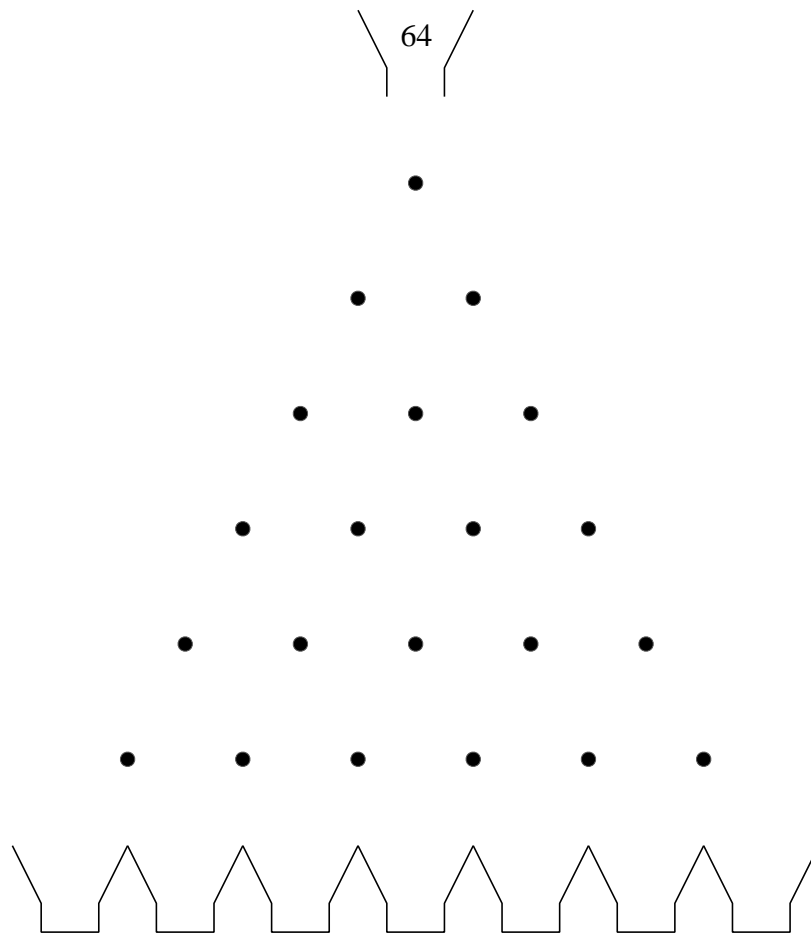
Question 4

Use the table below to summarize your results

Starting Number of Balls	Distribution of Balls in Baskets
4	
8	
16	1 4 6 4 1
32	

[4 marks]

Question 5



(i) Write down a prediction of the distribution that would result, on average, if 64 steel ball bearings were run through the above machine.

[2 marks]

(ii) **Optional**

If you feel it would be helpful in checking your part (i) answer, work through the intricate details of what happens at each pin.

[0 marks]

Question 6

Investigate expanding the following sequence of brackets.

To help you get started the first three results are given.

There is a connection with the pinball machines !

$$(1 + x)^0 = 1$$

$$(1 + x)^1 = 1 + x$$

$$(1 + x)^2 = 1 + 2x + x^2$$

$$(1 + x)^3 =$$

$$(1 + x)^4 =$$

$$(1 + x)^5 =$$

$$(1 + x)^6 =$$

[6 marks]

Question 7

Find out about “Pascal's Triangle” and briefly explain its relevance to the pinball machines of this lesson and the expansion of $(1 + x)^n$

[4 marks]