

# Admissions Pack September 2017



The National Mathematics  
and Science College



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# 1 Personal information

Name: \_\_\_\_\_

Date of birth: \_\_\_\_ / \_\_\_\_ / \_\_\_\_

Address: \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_

Email: \_\_\_\_\_

Telephone: \_\_\_\_\_

# 2 Academic information

Please complete the form below to the best of your knowledge, giving your most recent grades. We will require to see evidence of your final academic results before enrolment. For mathematics, please give any international AS modules studied separately (e.g. C12, S1).

Current school/college: \_\_\_\_\_

Subject	Grade	Exam board	Date awarded



Name: \_\_\_\_\_

### 3 Mathematics Entrance Examination

This assessment is designed to determine your potential for studying mathematics at The National Mathematics and Science College. The use of a calculator is not permitted. You may use additional paper for rough working, but do ensure that you show all of the important steps in your working on the exam paper. Section A will be graded according to a mark scheme and you should attempt all questions in this section. You are expected to respond to at least one question from Section B, and you are invited to respond to as many as you can. You do not need to answer all questions in Section B. Marks will be awarded for style, persistence and creativity. Good luck.

**Time allowed: 60 minutes**

#### Formulae

##### Trigonometry

- The cosine rule states that:

$$a^2 = b^2 + c^2 - 2bc \cos A$$

- The sine rule states that:

$$\frac{\sin A}{a} = \frac{\sin B}{b} = \frac{\sin C}{c}$$

- The area of a triangle may be given by:

$$\text{Area} = \frac{1}{2} ab \sin C$$

##### Quadratic Equations

- The solution to the equation

$$ax^2 + bx + c = 0$$

is given by

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

##### Geometry

- The volume of a cone of radius  $r$  and height  $h$  is given by

$$\frac{1}{3} \pi r^2 h$$



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### 3.1 Section A

1. (a) Expand and simplify:  $p(q - 2p) - 3q(p - 2q)$  [1]

(b) Factorise fully:

i.  $14x^2y - 2xy^2$  [2]

ii.  $a^2 - 25b^2$  [2]

iii.  $x^2 - 6x + 9$  [2]

(c) i. Solve the equation, expressing your solution as a fraction in simplest form: [3]

$$\frac{3}{x-2} - \frac{5}{3x-6} = 2$$

ii. Prove, by substituting into the left-hand side, that your solution is correct. [2]

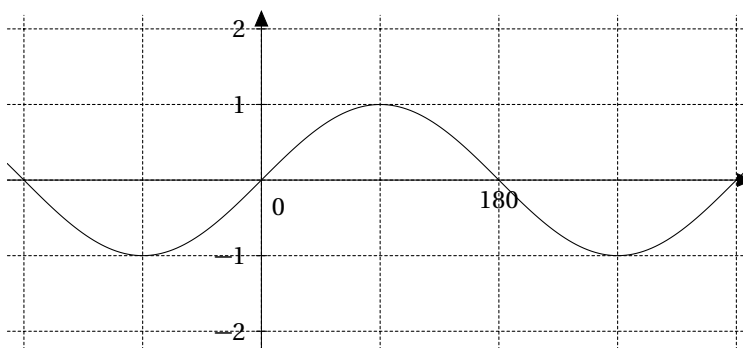


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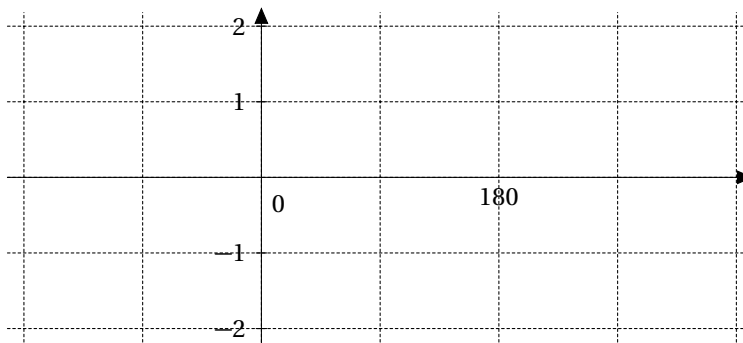
2. A **cone** is completely filled with water. The radius of the cone is 0.3m and the height of the cone is 1.2m. The water is pumped out of the cone at a rate of  $10\pi\text{cm}^3$  per second. Work out how many hours it takes for the cone to empty completely. [4]

3. The line  $2x + y = 5$  and the line  $3y - x = 1$  intersect at the point A. Find the coordinates of the point A. [4]

4. Below is a graph of the curve  $y = \sin(x)$  [3]



On the axes given, draw a sketch of the curve  $y = \sin(x + 90) + 1$





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5. Simplify each of the following:

[4]

(a)  $(x^3)^{\frac{5}{6}}$

(b)  $\frac{1}{3}x^{-2} \times 6x^4$

(c)  $\frac{6x^4-12}{3x^2}$

(d)  $\left(\frac{27}{8}\right)^{-\frac{2}{3}}$

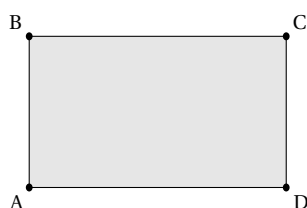
6. Rationalise the denominator of

[3]

$$\frac{3}{2-\sqrt{5}}$$

7. In the rectangle below, the width, BC is 2cm longer than the height, AB.

[4]



Given that the area of the rectangle is equal to its perimeter, find the height of the rectangle, leaving your answer in surd form.



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8. (a) i. Factorise the quadratic: [2]

$$4x^2 - 11x - 3$$

- ii. Hence write down the solutions to the equation [1]

$$4x^2 - 11x - 3 = 0$$

- (b) Cancel the following fraction, leaving it in its simplest form: [3]

$$\frac{x^4 - 4x^2}{2x^4 + 2x^3 - 12x^2}$$

9. (a) In a triangle ABC, the length of  $a$  is 16cm, the length of  $b$  is 10cm and angle B is  $30^\circ$ . Find the two possible lengths of side  $c$ . [5]

- (b) Find the area of the triangle. [3]





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### 3.2 Section B

1.  $A$  is the set of positive integers less than 1000 which are not divisible by 2 or 5. What is the mean value of the integers in  $A$ ?



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2. (a) Prove that  $3^8 - 2^8$  is divisible by 5
- (b) State and prove an equivalent theorem for  $a^{2^k} - b^{2^k}$ , where  $a > b$ .



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3. In the array of numbers below, the coordinates of the number 1 are  $(0, 0)$ , the coordinates of the number 19 are  $(-2, 0)$  and the coordinates of the number 13 are  $(2, -2)$ .

21	22	23	24	25	26
20	7	8	9	10	27
19	6	1	2	11	28
18	5	4	3	12	29
17	16	15	14	13	30
		...	33	32	31

If the pattern were continued, what would be the coordinates of the number 2016?



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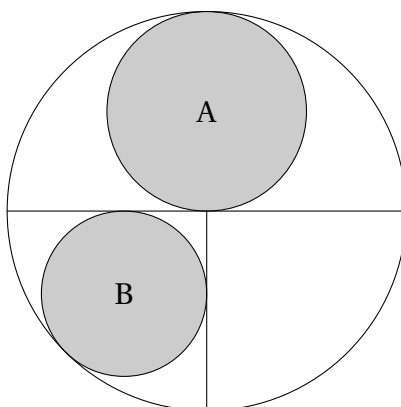
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4. Suppose that  $a > b > 1$  are two integers, and that the greatest common divisor of  $a$  and  $b$  is 1. Show that 1 is also the greatest common divisor of

$$\frac{a+b}{2} \text{ and } \frac{a-b}{2}$$



5. Consider the diagram below:



The larger shaded circle has area  $A$ . The smaller shaded circle has area  $B$ . Find the value of  $\frac{B}{A}$ .



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## 4 English Entrance Examination

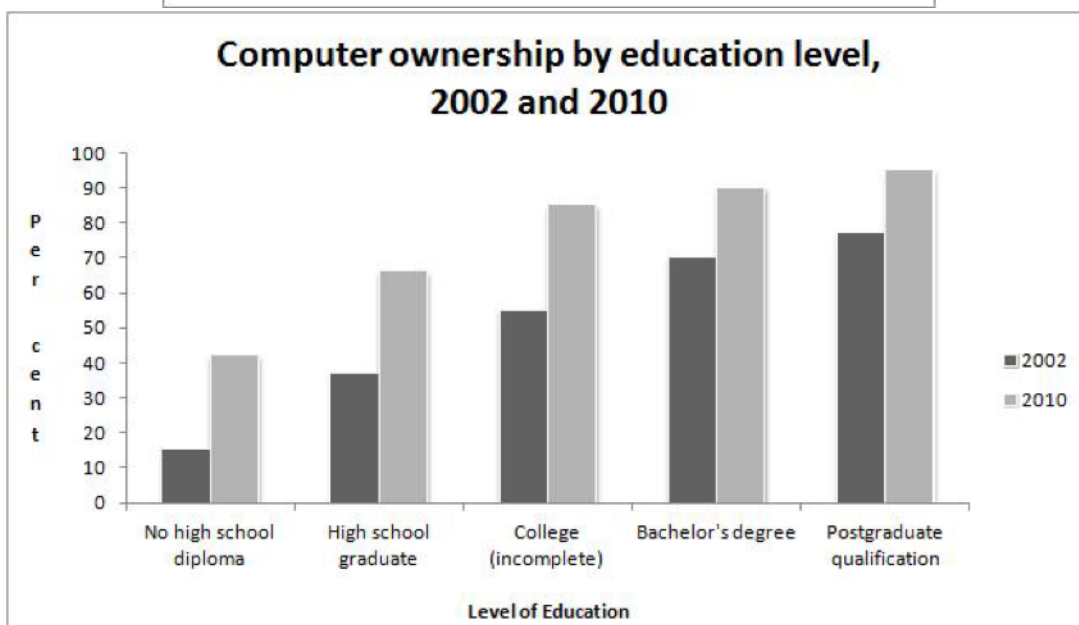
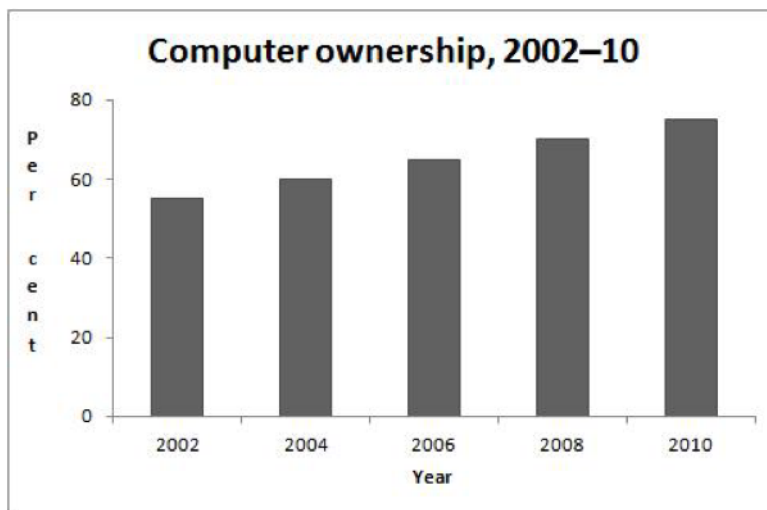
### 4.1 Section A

You should spend about 20 minutes on this section.

The graphs below give information about computer ownership as a percentage of the population between 2002 and 2010, and by level of education for the years 2002 and 2010.

Summarise the information by selecting and reporting the main features, and make comparisons where relevant.

Write at least 150 words.





## 4.2 Section B

You should spend about 40 minutes on this section.

Read the passage below and then respond to the questions.

### Excerpt from *The Psychology of Study*

Study and the pursuit of knowledge is normally pleasurable. The efficient exercise of any function is normally pleasurable. If the practice of study is painful, something is almost certainly wrong - an unfortunate choice of subjects, defective methods of work or faulty working conditions. The best results are never secured by feverish energy born of fear of failure. Most commonly, perhaps, the student is worried by the 'difficulty' of his subject; but difficulties looked at the right way up may be a source of pleasure. The sense of difficulty is by no means always to be attributed to personal limitations. In fact, all our studies should be 'difficult', full of problems, and the process of solving them the normal source of pleasure in intellectual pursuits. Perhaps the reason why students do not more frequently take their pleasures in this way is partly because they are apt to be harassed by an overcrowded syllabus which leaves no time for thought, and partly, because the sense of difficulty has come through faulty educational methods to be associated with a sense of subjective limitation.

There are, however, intrinsically difficult subjects - subjects essentially consisting of a set of problems. These never can and never should be easy. They are inherently difficult, not only to the student but also to the teacher. If the novice thinks he understands a work on the first casual reading, this in itself is sufficient proof that he hasn't. He is only beginning to understand it when he finds it difficult. This applies to some parts of most subjects. It is a misunderstanding of the situation when difficulty of this kind is introjected as a sense of personal incompetence.

The trouble is aggravated by the application of inappropriate standards of progress and by the pursuit of inappropriate ideals. Commonly, the student expects progress to be at the same rate in these subjects, and failing to do so blames himself or complains of the limitations of his powers. But there is a fundamental difference between progress in 'easy' and progress in 'difficult' subjects. The characteristic of an 'easy' subject is that its facts, individually, are not difficult of comprehension. The only problem is how to assimilate, organise, and apply. Under such conditions progress may be perceptibly rapid, and this engenders confidence. In the 'difficult' subject (and the difficult parts of an easy subject) the facts themselves, through the abstractness of their complexity, require an effort of thought merely to be understood. The process of mere assimilation is slow and gradual. The student, obsessed by the ideal of erudition, is discouraged by his apparent lack of progress, even where progress may be all the greater by reason of being slow. In such subjects, independent judgements are almost certain to be wrong. He is accustomed to being told what he should believe, and to the arbitration of authority. What 'it says' in the book tends to be taken as final. That the book was written by some human and fallible hand is a late and devastating revelation. Apart from the special stimulus of encouragement, the measure of independence appropriate to intellectual maturity is liable to be delayed. Ultimately self-confidence requires a rational foundation. Non-rational sug-



gestions may be useful in countering equally non-rational causes of diffidence; but in the last resort it is desirable that we should face our tasks with confidence based upon a dispassionate appreciation of attested merits. It is something gained if we at least escape the domination of inhibiting ideas. There has been a tendency in recent years to underestimate the influence of mere ideas upon the emotional life.

It is true that we cannot awaken idealism merely by preaching abstract principles. Nevertheless, there are some ideas, which are naturally congruent with enthusiasm, and there are some that stultify. The remedy is to make the most of powers with which we are endowed, to find rational ground for self-confidence by doing as well as we can what we can do best. Moreover, we might be a little more exacting in our demand for proof of our own incompetence. Incidentally it may be noted that the proof of the absence of ability is always longer than the proof that we can do it. A single failure, on the other hand, is not sufficient proof that we cannot.

C. A. Mace, *The Psychology of Study*

**Your answers should be in your own words, as far as possible.**

1. What might lead to a 'painful' practice of study with poor results? [5]
2. Why might some students fail to find pleasure in 'difficult' studies? [3]
3. In what ways might a student misjudge an 'intrinsically difficult' subject? [4]
4. Explain in your own words the writer's comments on the study of 'easy' subjects. [6]
5. What are the problems a student faces with a 'difficult' subject? [7]
6. What reasons are offered for a lack of self-assurance within a student? [4]
7. What remedies are suggested for a lack of confidence? [7]
8. Give the meaning of the following words as they appear in the passage: [4]
  - (a) Inherently
  - (b) Introjected
  - (c) Assimilate
  - (d) Stultify

**Total marks: [40]**