

QQQ – Further Pure 2 – Chapter 1 – Number Theory (Version 1)

Total Marks: 24

(24 = Platinum, 22 = Gold, 19 = Silver, 16 = Bronze)

1.

In this question you must show detailed reasoning.

Use Fermat's Little Theorem to determine the least positive residue of

$$21^{80} \pmod{23}$$

(Total 4 marks)

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2.

(i) Explain why the congruence equation

$$21x \equiv 11 \pmod{36}$$

has no solutions.

(2)

(ii) Use modular arithmetic to solve the congruence equation

$$36y \equiv 192 \pmod{40}$$

(4)

(Total 6 marks)

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3. The highest common factor of 963 and 657 is c .

(a) Use the Euclidean algorithm to find the value of c .

(3)

(b) Hence find integers a and b such that

$$963a + 657b = c$$

(3)

(Total 6 marks)

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4.

- (i) The polynomial $F(x)$ is a quartic such that

$$F(x) = px^4 + qx^3 + 2x^2 + rx + s$$

where p, q, r and s are distinct constants.

Determine the number of possible quartics given that

- (a) the constants p, q, r and s belong to the set $\{-4, -2, 1, 3, 5\}$ (1)

- (b) the constants p, q, r and s belong to the set $\{-4, -2, 0, 1, 3, 5\}$ (1)

- (ii) A 3-digit positive integer $N = abc$ has the following properties

- N is divisible by 11
- the sum of the digits of N is even
- $N \equiv 8 \pmod{9}$

- (a) Use the first two properties to show that

$$a - b + c = 0$$

(2)

- (b) Hence determine all possible integers N , showing all your working and reasoning.

(4)

(Total 8 marks)