

- 1
- (a)
- Uses binomial expansion formula:  $(2)^6 + {}^6C_1(2)^5\left(\frac{x}{2}\right) + {}^6C_2(2)^4\left(\frac{x}{2}\right)^2$  (M1)
  - Simplifies terms:  $64 + 6(32)\left(\frac{x}{2}\right) + 15(16)\left(\frac{x^2}{4}\right)$  (M1)
  - Correct first two terms:  $64 + 96x$  (A1)
  - Correct third term:  $60x^2$  (A1)
- (b)
- Sets  $2 + \frac{x}{2} = 2.05 \Rightarrow x = 0.1$  (M1)
  - Substitutes  $x = 0.1$  into expansion:  $64 + 96(0.1) + 60(0.1)^2 = 74.2$  (A1)
- (Total for question 1 is 6 marks)

- 2
- (a)
- Expansion:  $2^7 + {}^7C_1(2)^6\left(-\frac{x}{8}\right) + {}^7C_2(2)^5\left(-\frac{x}{8}\right)^2$  (M1)
  - Simplifies to  $128 - 56x + \frac{21}{2}x^2$  (A3)
- (b)
- Multiplies expansion by  $(ax + b)$ :  $(ax + b)(128 - 56x + \dots) = 128ax + 128b - 56bx$  (M1)
  - Equates constant term:  $128b = 384 \Rightarrow b = 3$  (A1)
  - Equates  $x$  term:  $128a - 56b = -104$  (M1)
  - Solves for  $a$ :  $128a - 56(3) = -104 \Rightarrow 128a = 64 \Rightarrow a = \frac{1}{2}$  (A1)
- (Total for question 2 is 8 marks)

- 3
- (a)
- Expansion:  $p^5 + 5p^4q + 10p^3q^2 + 10p^2q^3 + 5pq^4 + q^5$  (A4)
- (b)
- Identifies  $p = 0.1$  and  $q = 0.9$  (B1)
  - Uses terms for 1 late and 0 late:  $5pq^4 + q^5$  (M1)
  - Calculation:  $5(0.1)(0.9)^4 + 0.9^5 = 0.91854$  (A1)
- (Total for question 3 is 7 marks)

- 4
- (a)
- Expansion:  $1^8 + {}^8C_1(1)^7(4x) + {}^8C_2(1)^6(4x)^2 + {}^8C_3(1)^5(4x)^3$  (M1)
  - Simplifies terms:  $1 + 8(4x) + 28(16x^2) + 56(64x^3)$  (M1)
  - Final expansion:  $1 + 32x + 448x^2 + 3584x^3$  (A3)
- (b)
- Sets  $1 + 4x = 1.04 \Rightarrow x = 0.01$  (M1)
  - Substitutes  $x = 0.01$ :  $1 + 32(0.01) + 448(0.01)^2 + 3584(0.01)^3 = 1.368384$
  - Rounds to 5 sig figs: 1.3684 (A1)
- (Total for question 4 is 7 marks)
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- 5
- (a)
- Expansion:  $(2)^6 + {}^6C_1(2)^5(kx) + {}^6C_2(2)^4(kx)^2 + {}^6C_3(2)^3(kx)^3$  (M1)
  - Simplifies:  $64 + 192kx + 240k^2x^2 + 160k^3x^3$  (A3)
- (b)
- Equates coefficient:  $160k^3 = -20$  (M1)
  - Solves for  $k^3$ :  $k^3 = -\frac{1}{8}$  (M1)
  - Final answer:  $k = -\frac{1}{2}$  (A1)
- (Total for question 5 is 7 marks)
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- 6
- (a)
- Expansion:  $1 + 5(-2x) + 10(-2x)^2$  (M1)
  - Simplifies:  $1 - 10x + 40x^2$  (A3)
- (b)
- Multiplies expansion by  $(1 + x)$ :  $(1 + x)(1 - 10x + 40x^2)$  (M1)
  - Expands:  $1 - 10x + 40x^2 + x - 10x^2$  (M1)
  - Simplifies:  $1 - 9x + 30x^2$  (A1)
- (Total for question 6 is 7 marks)
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- 7
- (a)
- Expansion:  $2^8 + {}^8C_1(2)^7(\frac{x}{8}) + {}^8C_2(2)^6(\frac{x}{8})^2$  (M1)
  - Simplifies:  $256 + 128x + 28x^2$  (A3)
- (b)
- Multiplies expansion by  $(ax + b)$ :  $(ax + b)(256 + 128x + 28x^2) = 256ax + 256b + 128bx$  (M1)
  - Equates constant term:  $256b = 28 \Rightarrow b = \frac{7}{64}$  (A1)
  - Equates  $x$  term:  $256a + 128b = 62$  (M1)
  - Solves for  $a$ :  $256a + 128(\frac{7}{64}) = 62 \Rightarrow 256a = 48 \Rightarrow a = \frac{3}{16}$  (A1)
- (Total for question 7 is 8 marks)
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8

- (a)
- Expansion:  $3^6 + {}^6C_1(3)^5(\frac{2x}{5}) + {}^6C_2(3)^4(\frac{2x}{5})^2$  (M1)
  - Simplifies:  $729 + 6(243)(\frac{2x}{5}) + 15(81)(\frac{4x^2}{25})$  (M1)
  - Final terms:  $729 + \frac{2916}{5}x + \frac{972}{5}x^2$  (A2)
- (b)
- Set  $3 + \frac{2x}{5} = 2.92$  (B1)
  - Solve for  $x$  ( $x = -0.2$ ) and substitute into expansion. (B1)

(Total for question 8 is 5 marks)

9

- (a)
- Expansion:  $1 + {}^{10}C_1kx + {}^{10}C_2(kx)^2 + {}^{10}C_3(kx)^3$  (M1)
  - Simplifies:  $1 + 10kx + 45k^2x^2 + 120k^3x^3$  (A2)
- (b)
- Equates coefficients:  $120k^3 = 2(10k)$  (M1)
  - Simplifies:  $120k^3 = 20k \Rightarrow 6k^3 - k = 0$  (M1)
  - Solves for  $k$  (given  $k \neq 0$ ):  $6k^2 = 1 \Rightarrow k = \pm\sqrt{\frac{1}{6}}$  (A1)

(Total for question 9 is 6 marks)

10

- (a)
- Identifies  $x^3$  term:  ${}^6C_3(2)^3(kx)^3 = 160k^3x^3$  (M1)
  - Equates to 2500:  $160k^3 = 2500$  (M1)
  - Solves for  $k^3$ :  $k^3 = \frac{125}{8}$  (M1)
  - Final answer:  $k = \frac{5}{2}$  (A1)
- (b)
- Identifies constant term comes from  $2 \times$  (constant term of  $f(x)$ ) and  $\frac{4}{x} \times$  ( $x$  term of  $f(x)$ ) (M1)
  - Constant term of  $f(x) = 2^6 = 64$ ;  $x$  term of  $f(x) = 192kx$  (B1)
  - Calculation:  $2(64) + 4(192k) = 128 + 768(2.5) = 2048$  (A1)

(Total for question 10 is 7 marks)

11

- (a)
- Expansion:  $1 + 5(-4x) + 10(-4x)^2$  (M1)
  - Simplifies:  $1 - 20x + 160x^2$  (A2)
- (b)
- Sets  $1 - 4x = 0.992 \Rightarrow 4x = 0.008 \Rightarrow x = 0.002$  (M1)
  - Substitutes  $x = 0.002$ :  $1 - 20(0.002) + 160(0.002)^2 = 0.96064$  (A1)

(Total for question 11 is 5 marks)

- 12
- Identifies coefficients:  $x^2$  coeff is  ${}^nC_2 = \frac{n(n-1)}{2}$ ;  $x^4$  coeff is  ${}^nC_4 = \frac{n(n-1)(n-2)(n-3)}{24}$  (M1)
  - Sets up equation:  $\frac{n(n-1)(n-2)(n-3)}{24} = 7.5 \times \frac{n(n-1)}{2}$  (M1)
  - Simplifies:  $(n-2)(n-3) = 90$  (M1)
  - Solves quadratic:  $n^2 - 5n - 84 = 0 \Rightarrow (n-12)(n+7) = 0$  (M1)
  - Final answer:  $n = 12$  (since  $n > 4$ ) (A1)

(Total for question 12 is 5 marks)

- 13
- Expands  $(3+2x)^4 = 81 + 216x + 216x^2 + 96x^3 + 16x^4$  (M1)
  - Expands  $(3-2x)^4 = 81 - 216x + 216x^2 - 96x^3 + 16x^4$  (M1)
  - Adds expansions:  $162 + 432x^2 + 32x^4$  (M1)
  - Justification:  $x^2 \geq 0$  and  $x^4 \geq 0$  for all real  $x$  (M1)
  - Conclusion: Therefore  $162 + 432x^2 + 32x^4 \geq 162$  (A2)

(Total for question 13 is 6 marks)

- 14
- Expansion:  $(\sqrt{5})^4 + 4(\sqrt{5})^3(\sqrt{3}) + 6(\sqrt{5})^2(\sqrt{3})^2 + 4(\sqrt{5})(\sqrt{3})^3 + (\sqrt{3})^4$  (M1)
  - Identifies irrational terms:  $4(5\sqrt{5})(\sqrt{3}) = 20\sqrt{15}$  and  $4(\sqrt{5})(3\sqrt{3}) = 12\sqrt{15}$  (M1)
  - Difference:  $20\sqrt{15} - 12\sqrt{15} = 8\sqrt{15}$  (A1)

(Total for question 14 is 3 marks)

- 15
- Expansion:  $2^7 + {}^7C_1(2)^6(-5x) + {}^7C_2(2)^5(-5x)^2 + {}^7C_3(2)^4(-5x)^3$  (M1)
  - Simplifies:  $128 + 7(64)(-5x) + 21(32)(25x^2) + 35(16)(-125x^3)$  (M1)
  - Final answer:  $128 - 2240x + 16800x^2 - 70000x^3$  (A2)

(Total for question 15 is 4 marks)

- 16
- Identifies term:  ${}^5C_1(4)^4(-x)$  (M1)
  - Calculation:  $5 \times 256 \times (-1) = -1280$  (A1)

(Total for question 16 is 2 marks)

- 17
- Expansion:  $1^6 + {}^6C_1(1)^5(-3x) + {}^6C_2(1)^4(-3x)^2$  (M1)
  - Simplifies:  $1 - 18x + 135x^2$  (A2)

(Total for question 17 is 3 marks)

18

- (a)
- Expansion:  $2^5 + {}^5C_1(2)^4(3x) + {}^5C_2(2)^3(3x)^2$  (M1)
  - Simplifies:  $32 + 5(16)(3x) + 10(8)(9x^2)$  (M1)
  - Final terms:  $32 + 240x + 720x^2$  (A1)
- (b)
- Identifies  $x^2$  terms:  $1(720x^2) + ax(240x) = 752x^2$  (M1)
  - Sets up equation:  $720 + 240a = 752$  (M1)
  - Solves for  $a$ :  $240a = 32 \Rightarrow a = \frac{32}{240} = \frac{2}{15}$  (A1)

(Total for question 18 is 6 marks)

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19

- (a)
- Expansion:  $1^4 + 4(1)^3(-2x) + 6(1)^2(-2x)^2 + 4(1)(-2x)^3 + (-2x)^4$  (M1)
  - Simplifies:  $1 - 8x + 24x^2 - 32x^3 + 16x^4$  (A1)
- (b)
- Sets  $1 - 2x = 0.98 \Rightarrow x = 0.01$  (M1)
  - Substitutes  $x = 0.01$ :  $1 - 8(0.01) + 24(0.01)^2 - 32(0.01)^3 + 16(0.01)^4$  (M1)
  - Calculation:  $1 - 0.08 + 0.0024 - 0.000032 + 0.00000016 = 0.92236816$  (A1)

(Total for question 19 is 5 marks)

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20

- Expansion:  $5^3 + 3(5)^2(-2x) + 3(5)(-2x)^2 + (-2x)^3$  (M1)
- Simplifies:  $125 + 3(25)(-2x) + 3(5)(4x^2) - 8x^3$  (M1)
- Final answer:  $125 - 150x + 60x^2 - 8x^3$  (A1)

(Total for question 20 is 3 marks)

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