MARKING SCHEME — APPLIED MATHEMATICS CLASS XI (80 MARKS)

SET B

SECTION A (Q.1 – Q.20 : 1 mark each)

Q.1 (B) 6 [$n(A \times B) = 3 \times 2$] 1

Q.2 (B) 31 [$2^5 - 1$] 1

Q.3 (B) 20 [$150 - (92 + 63 - 25) = 20$] 1

Q.4 (A) $\{15\}$ **[multiples of LCM** $= 15$**]** 1

Q.5 (C) 40 [$20 + 28 - 8$] 1

Q.6 (D) an equivalence relation 1

Q.7 (D) 2^{12} 1

Q.8 (B) the range of R **has exactly 12 elements** 1

Q.9 (C) $R - \{-3, 3\}$ 1

Q.10 (C) ₹ 800 [$200 + 150 \times 4$] 1

Q.11 (B) $(-\infty, 5])$ 1

Q.12 (A) 3 [$4d = 12 \Rightarrow d = 3$; $a + 2d = 9 \Rightarrow a = 3$] 1

Q.13 (B) a GP with common ratio 1.1 1

Q.14 (A) 990 [$S_{20} = \frac{20}{2}[8 + 19 \times 5]$] 1

Q.15 (C) 600 [${}^5P_3 \times {}^4P_2 = 60 \times 12$] 1

Q.16 (B) 48 [$2 \times 4!$] 1

Q.17 (B) $\frac{9!}{2! \times 2! \times 2!}$ **[M, T, E each repeat twice]** 1

Q.18 (B) 3^4 1

Q.19 (A) Both true, (R) correctly explains (A) [${}^5P_3 = 60$] 1

Q.20 (A) Both true, (R) correctly explains (A) [$5 \times 2^5 = 160$] 1

SECTION B (Q.21 – Q.25 : 2 marks each)

Q.21 $A \times B = \{(1,a),(1,b),(1,c),(2,a),(2,b),(2,c)\}$ **..... 1** 2

$n(A \times B) = 6$ **, so the number of relations from** A **to** B **is** $2^6 = 64$ **..... 1**

OR

$n(G \times H) = 6 \times 3 = 18$ **..... 1**

Each element of $G \times H$ **is an ordered pair (card design, bag size), i.e. one possible design–size combination the shop can offer 1**

Q.22 $n(T \cup W) = 62 + 45 - 20 = 87$ **..... 1** 2

Members using exactly one facility $= 87 - 20 = 67$ **..... 1**

Q.23 $a = 6000$, $d = 500$, $n = 10$ **..... ½** 2

$a_{10} = 6000 + 9 \times 500$ **..... 1**

$= ₹\,10{,}500$ **..... ½**

Q.24 $BASKETBALL$ **has 10 letters with B repeating twice, A twice and L twice 1** 2

Number of arrangements $= \frac{10!}{2! \times 2! \times 2!} = 453600$ **..... 1**

Q.25 The first digit cannot be 0, so it can be filled in 5 ways ; the remaining two places in 2

${}^5P_2 = 20$ **ways ; total** $= 5 \times 20 = 100$ **..... 2**

OR

Total arrangements $= 5! = 120$ **; arrangements with the two friends together** $= 2 \times 4! = 48$ **..... 1**

Required number $= 120 - 48 = 72$ **..... 1**

SECTION C (Q.26 – Q.31 : 3 marks each)

Q.26 (a) $R = \{(2,2),(2,4),(2,6),(2,8),(2,10),(4,4),(4,8),(6,6)\}$ **..... 1½** 3

(b) Domain $= \{2,4,6\}$ **, Range** $= \{2,4,6,8,10\}$ **..... 1**

(c) $n(A \times B) = 30$ **, so the number of relations from** A **to** B **is** 2^{30} **..... ½**

OR

(a) $R = \{(1,2),(2,4),(3,6),(4,8),(5,10)\}$ **; Domain** $= \{1,2,3,4,5\}$ **, Range** $= \{2,4,6,8,10\}$ **..... 1½**

(b) Yes ; every element of A **has exactly one image in** B **under the rule** $b = 2a$ **..... 1**

(c) $n(A \times B) = 25$ **, so the number of relations from** A **to** B **is** 2^{25} **..... ½**

Q.27 Correct Venn diagram with the three overlapping regions marked 1 3

$n(F \cup N \cup P) = 30 + 32 + 28 - 10 - 12 - 8 + 4 = 64$ **..... 1½**

Readers reading none of the three $= 70 - 64 = 6$ **..... ½**

Q.28 (a) $f(x) = 50 + 15(x - 2)$ **, i.e.** $f(x) = 20 + 15x$ **,** $x \in N$**,** $x \geq 2$ **..... 1** 3

(b) $f(11) = 20 + 165 = ₹\,185$ **..... 1**

(c) $20 + 15x = 185 \Rightarrow x = 11$ **; the distance travelled was 11 km 1**

Q.29 $ar^3 = 24$ **and** $ar^6 = 192 \Rightarrow r^3 = 8 \Rightarrow r = 2$ **..... 1½** 3

$a = 3$ **, so the GP is** $3, 6, 12, 24, \ldots$ **..... ½**

$S_5 = \frac{3(2^5 - 1)}{2 - 1} = 3 \times 31 = 93$ **..... 1**

Q.30 $EQUATION$ **has 8 letters ; treating the vowels E, U, A, I, O as one unit gives 4 units 1** 3

Arrangements $= 4! \times 5! = 24 \times 120 = 2880$ **..... 1**

Those beginning with a vowel : the first place can be filled by a vowel in 5 ways, the remaining 7 letters in $7!$ **ways** $\Rightarrow 5 \times 7! = 25200$ **..... 1**

Q.31 ${}^5P_r = 2 \times \{\}^6P_{r-1}$ **; testing** $r = 3$ **:** ${}^5P_3 = 60$ **and** $2 \times \{\}^6P_2 = 2 \times 30 = 60$ **..... 1½** 3

Hence $r = 3$ **satisfies the equation 1**

(Values $r = 1, 2, 4, 5$ **do not satisfy the equation on verification) ..... ½**

OR

Total 4-digit numbers $= 6 \times 6 \times 5 \times 4 = 720$ **..... 1½**

Even numbers (last digit 0, 2, 4 or 6) :

last digit 0 : $6 \times 5 \times 4 = 120$ **; last digit 2, 4 or 6 :** $5 \times 5 \times 4 = 100$ **each 1**

Total even $= 120 + 3 \times 100 = 420$ **..... ½**

SECTION D (Q.32 – Q.35 : 5 marks each)

Q.32 (a) Correct Venn diagram with all seven regions marked 1 5

(b) $n(F \cup G \cup E) = 100 + 85 + 60 - 40 - 25 - 30 + 12 = 162$ **..... 1½**

(c) Only game zone $= 85 - 40 - 25 + 12 = 32$ **..... 1½**

(d) None of the three $= 180 - 162 = 18$ **; these 18 visitors came to the fair but visited none of the three attractions, so the organisers may promote these attractions more actively to walk-in visitors 1**

Q.33 (a) $M = \{3, 6, 9, 12, 15, 18, 21, 24\}$ **,** $E = \{8, 16, 24\}$ **..... 1** 5

(b) $M \cap E = \{24\}$ **— the seat shared by both batches ;** $M \cup E = \{3, 6, 8, 9, 12, 15, 16, 18, 21, 24\}$ **— all seats allotted 1½**

(c) $M - E = \{3, 6, 9, 12, 15, 18, 21\}$ **;** $E' = U - E$ **, i.e. all seats except 8, 16 and 24 ..... 1½**

(d) $(M \cup E)' = U - \{24\}$ **and** $M' \cap E' = U - \{24\}$ **; hence verified 1**

OR

(a) $R = \{(1, 2), (1, 4), (2, 1), (2, 3), (3, 2), (3, 4)\}$ **..... 1½**

(b) Domain $= \{1, 2, 3\}$ **, Range** $= \{1, 2, 3, 4\}$ **..... 1**

(c) $n(A \times B) = 12$ **, so the number of relations from** A **to** B **is** 2^{12} **..... 1½**

(d) R **is not a function, since** 1 **is related to both** 2 **and** 4 **(more than one image) 1**

Q.34 (a) $f(x) = 150 + 10x$ **for** $0 \le x \le 8$ **and** $f(x) = 230 + 15(x - 8)$ **for** $x > 8$ **..... 1½** 5

(b) $f(5) = 150 + 50 = ₹\,200$ **..... 1**

(c) $f(15) = 230 + 15(7) = ₹\,335$ **..... 1**

(d) $335 > 230$ **, so** $230 + 15(x - 8) = 335 \Rightarrow x = 15$ **rides 1**

(e) $f(0) = 150$ **and** $f(20) = 230 + 180 = 410$ **, so range** $= [150, 410]$ **..... ½**

Q.35 The instalments $2000, 2200, 2400, \ldots$ **form an AP with** $a = 2000$ **,** $d = 200$ **..... 1** 5

(a) $a_{15} = 2000 + 14 \times 200 = ₹\,4{,}800$ **..... 1**

(b) $S_{15} = \frac{15}{2}[4000 + 14 \times 200] = 15 \times \frac{6800}{2} = ₹\,51{,}000$ **..... 1½**

(c) Since $51000 < 84000$ **, the loan is not cleared ; amount still due** $= 84000 - 51000 =$ $₹\,33{,}000$ **..... 1½**

OR

(a) Each year the value is 0.8 times the previous value, so the values form a GP with $a =$ $6{,}00{,}000 \times 0.8 = ₹\,4{,}80{,}000$ **and** $r = 0.8$ **..... 2**

(b) Value after 3 years $= 600000 \times (0.8)^3 = ₹\,3{,}07{,}200$ **..... 1½**

(c) After 5 years the value $= 600000 \times (0.8)^5 = ₹\,1{,}96{,}608$ **, which is less than** $₹\,2{,}00{,}000$ **(one-third of the purchase price) ; hence the value does fall below one-third of the purchase price by the end of the 5th year 1½**

SECTION E (Q.36 – Q.38 : case study, 4 marks each)

Q.36 (i) $f(x) = 40 + 12x$ **and** $g(x) = 18x$ **..... 1** 4

(ii) $f(5) = ₹\,100$ **and** $g(5) = ₹\,90$ **..... 1**

(iii) $40 + 12x = 18x \Rightarrow x = \frac{20}{3} \approx 6.67$ **kg 1**

For 10 kg : $f(10) = ₹\,160$ **and** $g(10) = ₹\,180$ **, so Plan A is cheaper 1**

OR

(iii) $40 + 12x \le 160 \Rightarrow x \le 10$ **, so the greatest whole number of kg is 10 ..... 1**

$f(0) = 40$ **and** $f(15) = 220$ **, so the range for** $0 \le x \le 15$ **is** $[40, 220]$ **..... 1**

Q.37 (i) Saplings planted form an AP with $a = 25$ **,** $d = 5$ **;** $a_8 = 25 + 35 = 60$ **..... 1** 4

(ii) $S_8 = \frac{8}{2}[50 + 7 \times 5] = 4 \times 85 = 340$ **saplings 1**

(iii) Costs form a GP with $a = 40$ **,** $r = 1.05$ **; cost in the 4th month** $= 40(1.05)^3 = ₹\,46$ **..... 1**

It is a GP because each cost is a constant multiple (1.05) of the previous one, not a constant addition 1

OR

(iii) $25 + (n - 1)5 > 80 \Rightarrow 5n > 60 \Rightarrow n > 12$ **..... 1**

Hence the number first exceeds 80 in the 13th week 1

Q.38 (i) $FESTIVAL$ **has 8 distinct letters ; number of arrangements of 3 letters** $= {}^8P_3 = 336$ **..... 1** 4

(ii) Two distinct digits from 1 to 5 can be arranged in ${}^5P_2 = 20$ **ways ; total codes** $=$ $336 \times 20 = 6720$ **..... 1**

(iii) Treating the two guests as one unit : $5! \times 2! = 120 \times 2 = 240$ **arrangements 2**

OR

(iii) $COMMITTEE$ **has 9 letters with M repeated twice, T repeated twice and E repeated twice ; arrangements** $= \frac{9!}{2! \times 2! \times 2!} = 45360$ **..... 1**

It is smaller than $9! = 362880$ **because interchanging identical letters (M's, T's or E's) does not create a new arrangement 1**

Note : Competency-based / application questions (Q.3, 5, 8, 10, 13, 15, 19, 20, 22, 23, 25, 27, 28, 32, 34, 35, 36–38) ≈ 51 marks (64%), well above the CBSE requirement of at least 50% competency-focused assessment.