1. The transitive closure of the relation $R = \{(1,2),(2,3),(3,3)\}$ on the set $A = \{1,2,3\}$ equals

   A. $\{(1,2),(1,3)\}$

   B. $\{(1,3),(2,3),(3,3)\}$

   C. $\{(1,2),(1,3),(2,3),(3,3)\}$

   D. $\{(1,2),(1,3),(2,3)\}$

   ANSWER: C

2. Consider a relation $R = \{(1,1),(2,1),(2,2),(2,3),(3,3)\}$ defined on $A = \{1,2,3\}$. The complement R' equals

   A. $\{(1,2),(3,2)\}$

   B. $\{(1,1),(2,2),(3,3)\}$

   C. $\{(1,2),(1,3),(3,1)\}$

   D. $\{(1,2),(1,3),(3,1),(3,2)\}$

   ANSWER: D

3. If $f : Z \to N$ is defined by $f(x) = \begin{cases} 2x-1, & x > 0 \\ -2x, & x \leq 0 \end{cases}$ then

   A. $f^{-1}(x) = \begin{cases} x/2, & x = 1,3,5,\cdots \\ -x/2, & x = 0,2,4,6,\cdots \end{cases}$

B. $f^{-1}(x) = \begin{cases} \frac{x+1}{2}, & x = 1, 3, 5, \cdots \\ -\frac{x}{2}, & x = 0, 2, 4, 6, \cdots \end{cases}$

C. $f^{-1}(x) = \begin{cases} \frac{x-1}{2}, & x = 1, 3, 5, \cdots \\ \frac{x+1}{2}, & x = 0, 2, 4, 6, \cdots \end{cases}$

D. $f^{-1}(x) = \begin{cases} \frac{x+1}{2}, & x = 1, 3, 5, \cdots \\ \frac{x-1}{2}, & x = 0, 2, 4, 6, \cdots \end{cases}$

ANSWER: B

4. If there are 5 points inside a square of side length 2, then two of the points are within a distance of ——- of each other

   A. $\sqrt{2}$

   B. $\sqrt{3}$

   C. $\sqrt{5}$

   D. $\sqrt{7}$

   ANSWER: A

5. If $M_R = \begin{pmatrix} 0 & 1 & 0 \\ 1 & 1 & 1 \\ 1 & 0 & 0 \end{pmatrix}$ and $M_S = \begin{pmatrix} 0 & 1 & 0 \\ 0 & 1 & 1 \\ 1 & 1 & 1 \end{pmatrix}$ then $M_{R \circ S}$ is

   A. $\begin{pmatrix} 1 & 0 & 1 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

B. $\begin{pmatrix} 0 & 1 & 1 \\ 1 & 0 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

C. $\begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}$

D. $\begin{pmatrix} 0 & 1 & 1 \\ 1 & 1 & 1 \\ 0 & 1 & 0 \end{pmatrix}$

ANSWER: D

6. If $f, g, h : R \to R$ are defined by $f(x) = x^3 - 4x, g(x) = \frac{1}{x^2+1}$ and $h(x) = x^4$, then $\{(f \circ g) \circ h\}(x)$ equals

A. $(x^8+1)^3 - 4(x^8+1)$

B. $(x^8+1)^{-3} - 4(x^8+1)^{-1}$

C. $(x^7+1)^{-3} - 4(x^7+1)^{-1}$

D. $(x^7+1)^3 - 4(x^7+1)$

ANSWER: B