EXERCISE 4.1 - Question No. 1

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1 + 3 + 3^2 + \ \vdots \ + 3^{n-1} = \frac{(3^n - 1)}{2}$$

EXERCISE 4.1 - Question No. 2

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1^3 + 2^3 + 3^3 + \ \vdots \ + n^3 = \left(\frac{n(n+1)}{2}\right)^2$$

EXERCISE 4.1 - Question No. 3

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1 + \frac{1}{(1+2)}\frac{1}{(1+2+3)} + \vdots + \frac{1}{\left(1+2+3+\vdots n\right)} = \frac{2n}{(n+1)}$$

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EXERCISE 4.1 - Question No. 4

Prove the following by using the principle of mathematical induction for all

$n \in N$:

$$1.2.3 + 2.3.4 + \ldots + n(n+1)(n+2) = \frac{n(n+1)(n+2)(n+3)}{4}$$

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EXERCISE 4.1 - Question No. 5

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1.3 + 2.3^2 + 3.3^3 + \vdots + n.3^n = \frac{(2n-1)3^{n+1}+3}{4}$$

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EXERCISE 4.1 - Question No. 6

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1.2 + 2.3 + 3.4 + \dot{+} n(n+1) = \left[\frac{n(n+1)(n+2)}{3}\right]$$

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EXERCISE 4.1 - Question No. 7

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1.3 + 3.5 + 5.7 + \dot{+} (2n1)(2n+1) = \frac{n\left(4n^2+6n-1\right)}{3}$$

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EXERCISE 4.1 - Question No. 8

Prove the following by using the principle of mathematical induction for all $n \in N : 1.2 + 2.2^2 + 3.2^2 + \ \vdots \ + n.2^n = (n-1)2^{n+1} + 2$

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EXERCISE 4.1 - Question No. 9

Prove the following by using the principle of mathematical induction for all $n \in N : \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \ \vdots \ + \frac{1}{2^n} = 1 - \frac{1}{2^n}$

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EXERCISE 4.1 - Question No. 10

Prove the following by using the principle of mathematical induction for all

$$n \in N : \frac{1}{2.5} + \frac{1}{5.8} + \frac{1}{8.11} + \vdots + \frac{1}{(3n-1)(3n+2)} = \frac{n}{(6n+4)}$$

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EXERCISE 4.1 - Question No. 11

Prove the following by using the principle of mathematical induction for all

$$n \in N :$$

$$\frac{1}{1.2.3} + \frac{1}{2.3.4} + \frac{1}{3.4.5} + \vdots + \frac{1}{n(n+1)(n+2)} = \frac{n(n+3)}{4(n+1)(n+2)}$$

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EXERCISE 4.1 - Question No. 12

Prove the following by using the principle of mathematical induction for all

$$n \in N : a + ar + ar^2 + \vdots + ar^{n-1} = \frac{a(r^n - 1)}{r - 1}$$

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EXERCISE 4.1 - Question No. 13

Prove the following by using the principle of mathematical induction for all

$$n \in N : \left(1+\frac{3}{1}\right)\left(1+\frac{5}{4}\right)\left(1+\frac{7}{9}\right)\vdots 1+\frac{(2n+1)}{n^2} = (n+1)^2$$

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EXERCISE 4.1 - Question No. 14

Prove the following by using the principle of mathematical induction for all

$$n \in N : \left(1+\frac{1}{1}\right)\left(1+\frac{1}{2}\right)\left(1+\frac{1}{3}\right)\vdots 1+\frac{1}{n} = (n+1)$$

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EXERCISE 4.1 - Question No. 15

Prove the following by using the principle of mathematical induction for all

$$n \in N : 1^2 + 3^2 + 5^2 + \vdots + (2n-1)^2 = \frac{n(2n-1)(2n+1)}{3}$$

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EXERCISE 4.1 - Question No. 16

Prove the following by using the principle of mathematical induction for all

$$n \in N : \frac{1}{1.4} + \frac{1}{4.7} + \frac{1}{7.10} + \vdots + \frac{1}{(3n-1)(3n+1)} = \frac{n}{(3n+1)} .$$

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EXERCISE 4.1 - Question No. 17

Prove the following by using the principle of mathematical induction for all

$$n \in N : \frac{1}{3.5} + \frac{1}{5.7} + \frac{1}{7.9} + \vdots + \frac{1}{(2n+1)(2n+3)} = \frac{n}{3(2n+3)} .$$

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EXERCISE 4.1 - Question No. 18

Prove the following by using the principle of mathematical induction for all $n \in N : 1 + 2 + 3 + \dot{+} n < \frac{1}{8}(2n + 1)^2$.

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EXERCISE 4.1 - Question No. 19

Prove the following by using the principle of mathematical induction for all $n \in N : n(n + 1)(n + 5)$ is a multiple of 3.

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EXERCISE 4.1 - Question No. 20

Prove the following by using the principle of mathematical induction for all

$n \in N : 10^{2n-1} + 1$ is divisible by 11.

EXERCISE 4.1 - Question No. 21

Prove the following by using the principle of mathematical induction for all

$n \in N : x^{2n} - y^{2n}$ is divisible by $x + y$.

EXERCISE 4.1 - Question No. 22

Prove the following by using the principle of mathematical induction for all

$n \in N : 3^{2n+2} - 8n - 9$ is divisible by 8.

EXERCISE 4.1 - Question No. 23

Prove the following by using the principle of mathematical induction for all $n \in N : 41^n - 14^n$ is a multiple of 27.

EXERCISE 4.1 - Question No. 24

Prove the following by using the principle of mathematical induction for all $n \in N : (2n + 7) < (n + 3)^2$.

SOLVED EXAMPLES - Question No. 1

For all $n \geq 1$, prove that $1^2 + 2^2 + 3^2 + 4^2 + \vdots + n^2 = \frac{n(n+1)(2n+1)}{6}$

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SOLVED EXAMPLES - Question No. 2

Prove that $2^n > n$ for all positive integers n.

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SOLVED EXAMPLES - Question No. 3

For all $n \geq 1$, prove that $\frac{1}{1.2} + \frac{1}{2.3} + \frac{1}{3.4} + \vdots + \frac{1}{n(n+1)} = \frac{n}{n+1}$

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SOLVED EXAMPLES - Question No. 4

For every positive integer n, prove that $7^n - 3^n$ is divisible by 4.

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SOLVED EXAMPLES - Question No. 5

Prove that $(1+x)^n \geq (1+nx)$, for all natural number n, where $x > -1$.

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SOLVED EXAMPLES - Question No. 6

Prove that $2.\ 7^n + 3.\ 5^n - 5$ is divisible by 24, for all $n \in N$.

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SOLVED EXAMPLES - Question No. 7

Prove that $1^2 + 2^2 + \vdots + n^2 > \frac{n^3}{3},\ n \in N$

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SOLVED EXAMPLES - Question No. 8

Prove the rule of exponents $(ab)^n = a^n b^n$ by using principle of mathematical induction for every natural number.

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