

TRISTAN HAS \$1.40 WORTH OF NICKELS AND DIMES. HE HAS TWICE AS MANY NICKELS AS DIMES. WRITE A SYSTEM OF

TRISTAN HAS \$1.40 WORTH OF NICKELS AND DIMES. HE HAS TWICE AS MANY NICKELS AS DIMES. WRITE A SYSTEM OF EQUATIONS TO FIND OUT HOW MANY NICKELS AND DIMES TRISTAN HAS. THIS PROBLEM INVOLVES UNDERSTANDING THE RELATIONSHIP BETWEEN THE NUMBER OF COINS AND THEIR TOTAL VALUE, AND TRANSLATING THAT INTO A SYSTEM OF EQUATIONS. IN THIS ARTICLE, WE WILL EXPLORE HOW TO SET UP AND SOLVE SUCH A SYSTEM STEP-BY-STEP, ENSURING CLARITY AND DETAIL TO HELP YOU MASTER SIMILAR COIN PROBLEMS.

UNDERSTANDING THE PROBLEM

BEFORE JUMPING INTO EQUATIONS, IT'S IMPORTANT TO COMPREHEND THE DETAILS OF THE PROBLEM:

- TRISTAN'S TOTAL AMOUNT OF MONEY FROM NICKELS AND DIMES IS \$1.40.
- HE HAS TWICE AS MANY NICKELS AS DIMES.

THE GOAL IS TO DETERMINE THE EXACT NUMBER OF NICKELS AND DIMES TRISTAN HAS.

DEFINING VARIABLES

TO TRANSLATE THE PROBLEM INTO MATHEMATICAL TERMS, ASSIGN VARIABLES TO THE UNKNOWN QUANTITIES:

VARIABLES TO REPRESENT THE NUMBER OF COINS

- N = THE NUMBER OF NICKELS TRISTAN HAS
- D = THE NUMBER OF DIMES TRISTAN HAS

GIVEN THE INFORMATION THAT TRISTAN HAS TWICE AS MANY NICKELS AS DIMES, WE CAN EXPRESS ONE VARIABLE IN TERMS OF THE OTHER:

EXPRESSING ONE VARIABLE IN TERMS OF THE OTHER

- SINCE TRISTAN HAS TWICE AS MANY NICKELS AS DIMES: $N = 2D$

THIS RELATIONSHIP SIMPLIFIES THE PROBLEM BY REDUCING THE NUMBER OF UNKNOWNNS.

SETTING UP THE EQUATIONS

THE KEY TO SOLVING THE PROBLEM IS TO TRANSLATE THE TOTAL VALUE OF COINS INTO AN EQUATION INVOLVING THE VARIABLES, BASED ON THE VALUE OF EACH TYPE OF COIN.

VALUE OF NICKELS AND DIMES

- EACH NICKEL IS WORTH \$0.05
- EACH DIME IS WORTH \$0.10

TOTAL VALUE EQUATION

THE TOTAL AMOUNT OF MONEY FROM ALL COINS IS \$1.40, SO WE WRITE:

(Number of nickels $\times$ Value per nickel) + (Number of dimes $\times$ Value per dime) =
Total amount

SUBSTITUTING THE VARIABLES:

$$0.05n + 0.10d = 1.40$$

USING THE RELATIONSHIP $n = 2d$, SUBSTITUTE n INTO THE EQUATION:

$$0.05(2d) + 0.10d = 1.40$$

THIS GIVES US A SINGLE EQUATION WITH ONE VARIABLE, d , WHICH WE CAN NOW SOLVE.

SOLVING THE SYSTEM OF EQUATIONS

THE PROCESS INVOLVES SIMPLIFYING AND SOLVING FOR THE VARIABLE d , THEN FINDING n .

SIMPLIFY AND SOLVE FOR d

- DISTRIBUTE 0.05:

$$0.05 \times 2d = 0.10d$$

- REWRITE THE EQUATION:

$$0.10d + 0.10d = 1.40$$

- COMBINE LIKE TERMS:

$$0.20d = 1.40$$

- DIVIDE BOTH SIDES BY 0.20 TO SOLVE FOR D:

$$d = 1.40 / 0.20 = 7$$

FIND THE NUMBER OF NICKELS

RECALL THAT $n = 2d$:

$$n = 2 \times 7 = 14$$

RESULT: TRISTAN HAS 14 NICKELS AND 7 DIMES.

VERIFICATION OF THE SOLUTION

IT'S ALWAYS GOOD TO VERIFY THE SOLUTION BY CALCULATING THE TOTAL VALUE:

CALCULATE TOTAL VALUE

- NICKELS: $14 \times \$0.05 = \0.70
- DIMES: $7 \times \$0.10 = \0.70

TOTAL:

$$\$0.70 + \$0.70 = \$1.40$$

THE TOTAL MATCHES THE PROBLEM STATEMENT, CONFIRMING THE SOLUTION IS CORRECT.

SUMMARY OF THE SYSTEM OF EQUATIONS AND SOLUTION STEPS

TO ENCAPSULATE THE ENTIRE PROCESS, HERE IS A SUMMARY:

1. DEFINE VARIABLES: n = NUMBER OF NICKELS, d = NUMBER OF DIMES
2. EXPRESS RELATIONSHIP: $n = 2d$
3. WRITE TOTAL VALUE EQUATION: $0.05n + 0.10d = 1.40$
4. SUBSTITUTE $n = 2d$ INTO THE TOTAL VALUE EQUATION
5. SIMPLIFY AND SOLVE FOR d : $d = 7$

6. CALCULATE N: $n = 14$

7. VERIFY BY CALCULATING TOTAL VALUE: $\$0.70 + \$0.70 = \$1.40$

CONCLUSION

WRITING A SYSTEM OF EQUATIONS IS AN EFFECTIVE METHOD FOR SOLVING COIN PROBLEMS INVOLVING RELATIONSHIPS BETWEEN QUANTITIES AND TOTAL VALUE. BY CAREFULLY DEFINING VARIABLES, TRANSLATING THE WORD PROBLEM INTO EQUATIONS, AND SOLVING STEP-BY-STEP, YOU CAN ACCURATELY DETERMINE THE NUMBER OF COINS TRISTAN HAS. THIS APPROACH NOT ONLY APPLIES TO SIMILAR PROBLEMS INVOLVING DIFFERENT COINS OR TOTALS BUT ALSO STRENGTHENS YOUR ALGEBRAIC REASONING SKILLS.

REMEMBER, THE KEY STEPS ARE: UNDERSTAND THE PROBLEM, DEFINE VARIABLES, WRITE EQUATIONS BASED ON RELATIONSHIPS AND TOTALS, SOLVE THE SYSTEM, AND VERIFY YOUR ANSWER. MASTERING THIS PROCESS MAKES SOLVING MANY REAL-WORLD AND MATH PROBLEMS MORE MANAGEABLE AND SYSTEMATIC.

FREQUENTLY ASKED QUESTIONS

WHAT IS THE TOTAL AMOUNT TRISTAN HAS IN NICKELS AND DIMES?

TRISTAN HAS \$1.40 IN TOTAL.

HOW MANY NICKELS AND DIMES DOES TRISTAN HAVE IF HE HAS TWICE AS MANY NICKELS AS DIMES?

LET THE NUMBER OF DIMES BE x . THEN THE NUMBER OF NICKELS IS $2x$. THE TOTAL VALUE IS $0.05(2x) + 0.10(x) = 1.40$.

WHAT SYSTEM OF EQUATIONS REPRESENTS THE PROBLEM?

LET n = NUMBER OF NICKELS, d = NUMBER OF DIMES.

$$y1: n = 2d$$

$$y2: 0.05n + 0.10d = 1.40$$

HOW DO YOU SET UP THE EQUATIONS FOR THE PROBLEM?

EQUATION 1: $n = 2d$ (SINCE NICKELS ARE TWICE AS MANY AS DIMES)

EQUATION 2: $0.05n + 0.10d = 1.40$ (TOTAL VALUE IN DOLLARS)

HOW CAN YOU SOLVE THE SYSTEM OF EQUATIONS TO FIND THE NUMBER OF NICKELS AND DIMES?

SUBSTITUTE $n = 2d$ INTO THE SECOND EQUATION:

$$0.05(2d) + 0.10d = 1.40$$

$$0.10d + 0.10d = 1.40$$

$$0.20d = 1.40$$

$$d = 7$$

$$\text{THEN } n = 2 \cdot 7 = 14.$$

WHAT IS THE NUMBER OF NICKELS TRISTAN HAS?

TRISTAN HAS 14 NICKELS.

WHAT IS THE NUMBER OF DIMES TRISTAN HAS?

TRISTAN HAS 7 DIMES.

HOW MUCH IS THE TOTAL WORTH OF 14 NICKELS AND 7 DIMES?

14 NICKELS = 14 $\$0.05$ = $\$0.70$
7 DIMES = 7 $\$0.10$ = $\$0.70$
TOTAL = $\$0.70 + \$0.70 = \$1.40$.

WHY IS IT IMPORTANT TO SET UP THE SYSTEM OF EQUATIONS IN THIS PROBLEM?

SETTING UP THE SYSTEM ALLOWS US TO REPRESENT THE RELATIONSHIPS AND TOTAL VALUE MATHEMATICALLY, MAKING IT EASIER TO SOLVE FOR THE UNKNOWN QUANTITIES SYSTEMATICALLY.

CAN THIS PROBLEM BE SOLVED WITHOUT A SYSTEM OF EQUATIONS?

WHILE POSSIBLE USING GUESS AND CHECK OR LOGICAL REASONING, USING A SYSTEM OF EQUATIONS PROVIDES A CLEAR AND EFFICIENT METHOD TO FIND THE EXACT NUMBERS OF NICKELS AND DIMES.

ADDITIONAL RESOURCES

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INTRODUCTION: SETTING THE STAGE FOR A COIN PROBLEM

IN EVERYDAY LIFE, WE OFTEN ENCOUNTER SITUATIONS THAT INVOLVE BASIC ARITHMETIC AND ALGEBRAIC REASONING, ESPECIALLY WHEN DEALING WITH MONEY. SUCH PROBLEMS NOT ONLY STRENGTHEN OUR NUMERICAL SKILLS BUT ALSO ENHANCE OUR UNDERSTANDING OF SYSTEMS OF EQUATIONS. ONE CLASSIC EXAMPLE INVOLVES TRISTAN, WHO HAS A CERTAIN AMOUNT OF MONEY COMPOSED OF NICKELS AND DIMES. THE PROBLEM STATES THAT TRISTAN HAS A TOTAL OF \$1.40 WORTH OF COINS AND THAT HE POSSESSES TWICE AS MANY NICKELS AS DIMES.

THESE TYPES OF PROBLEMS ARE FOUNDATIONAL IN ALGEBRA BECAUSE THEY REQUIRE TRANSLATING REAL-WORLD INFORMATION INTO MATHEMATICAL EXPRESSIONS AND THEN SOLVING FOR UNKNOWN QUANTITIES. TODAY, WE WILL EXPLORE HOW TO FORMULATE A SYSTEM OF EQUATIONS BASED ON THIS SCENARIO, ANALYZE THE PROBLEM STEP BY STEP, AND SOLVE FOR THE NUMBER OF NICKELS AND DIMES TRISTAN OWNS.

UNDERSTANDING THE PROBLEM: BREAKING DOWN THE DETAILS

BEFORE JUMPING INTO EQUATIONS, IT'S CRITICAL TO UNDERSTAND THE KEY DETAILS PROVIDED:

- TOTAL AMOUNT OF MONEY: \$1.40
- TYPE OF COINS INVOLVED: NICKELS AND DIMES
- RELATIONSHIP BETWEEN QUANTITIES: TRISTAN HAS TWICE AS MANY NICKELS AS DIMES.

TO CLARIFY, LET'S DEFINE:

- (N) : THE NUMBER OF NICKELS TRISTAN HAS.
- (D) : THE NUMBER OF DIMES TRISTAN HAS.

FROM THE PROBLEM, WE CAN DERIVE THE FOLLOWING TWO PIECES OF INFORMATION:

1. TOTAL VALUE OF COINS: THE TOTAL VALUE OF ALL NICKELS AND DIMES EQUALS \$1.40.
2. RELATIONSHIP BETWEEN QUANTITIES: THE NUMBER OF NICKELS IS TWICE THE NUMBER OF DIMES.

EXPRESSING THESE IN MATHEMATICAL TERMS:

- (N) AND (D) ARE RELATED BY $(N = 2D)$.
- THE TOTAL VALUE EQUATION INVOLVES THE INDIVIDUAL VALUES: EACH NICKEL IS WORTH 5 CENTS, EACH DIME IS WORTH 10 CENTS.

CONVERTING THE WORD PROBLEM INTO EQUATIONS

THE CORE OF SOLVING SUCH A PROBLEM LIES IN TRANSLATING THE WORDS INTO ALGEBRAIC EXPRESSIONS.

STEP 1: EXPRESS THE RELATIONSHIP BETWEEN THE QUANTITIES

SINCE TRISTAN HAS TWICE AS MANY NICKELS AS DIMES:

$$\begin{aligned} &[\\ N &= 2D \\ &] \end{aligned}$$

THIS IS OUR FIRST EQUATION, LINKING THE TWO VARIABLES DIRECTLY.

STEP 2: WRITE THE TOTAL VALUE EQUATION

THE TOTAL VALUE OF THE COINS IS \$1.40, WHICH IN CENTS IS 140 CENTS. THE VALUE CONTRIBUTED BY EACH TYPE OF COIN CAN BE EXPRESSED AS:

- NICKELS: $(5 \times N)$ CENTS
- DIMES: $(10 \times D)$ CENTS

THUS, THE TOTAL VALUE EQUATION BECOMES:

$$\begin{aligned} &[\\ 5N + 10D &= 140 \\ &] \end{aligned}$$

FORMULATING THE SYSTEM OF EQUATIONS

COMBINING THE TWO PIECES OF INFORMATION, WE HAVE THE FOLLOWING SYSTEM:

$$\begin{aligned} &[\\ &\begin{cases} N = 2D \\ 5N + 10D = 140 \end{cases} \\ &] \end{aligned}$$

THIS SYSTEM ENCAPSULATES THE PROBLEM'S CONSTRAINTS AND CAN NOW BE SOLVED SYSTEMATICALLY.

SOLVING THE SYSTEM: STEP-BY-STEP APPROACH

THE GOAL IS TO FIND THE VALUES OF (N) AND (D) . WE'LL USE SUBSTITUTION, A COMMON METHOD FOR SOLVING SYSTEMS WHERE ONE EQUATION IS ALREADY SOLVED FOR ONE VARIABLE.

STEP 1: SUBSTITUTE $(N = 2D)$ INTO THE TOTAL VALUE EQUATION

REPLACE (N) WITH $(2D)$:

$$\begin{aligned} & 5(2D) + 10D = 140 \end{aligned}$$

SIMPLIFY:

$$\begin{aligned} & 10D + 10D = 140 \end{aligned}$$

$$\begin{aligned} & 20D = 140 \end{aligned}$$

STEP 2: SOLVE FOR (D)

DIVIDE BOTH SIDES BY 20:

$$\begin{aligned} & D = \frac{140}{20} = 7 \end{aligned}$$

SO, TRISTAN HAS 7 DIMES.

STEP 3: FIND (N) USING $(N = 2D)$

SUBSTITUTE $(D = 7)$ INTO THE EARLIER RELATIONSHIP:

$$\begin{aligned} & N = 2 \times 7 = 14 \end{aligned}$$

THUS, TRISTAN HAS 14 NICKELS.

VERIFYING THE SOLUTION

IT'S ALWAYS GOOD PRACTICE TO VERIFY THE SOLUTION WITH THE ORIGINAL CONDITIONS.

- NUMBER OF NICKELS: 14
- NUMBER OF DIMES: 7

CALCULATE THE TOTAL VALUE:

$$\begin{aligned} & (14 \times 5) + (7 \times 10) = 70 + 70 = 140 \end{aligned}$$

SINCE 140 CENTS EQUALS \$1.40, THE CALCULATIONS ARE CONSISTENT WITH THE PROBLEM STATEMENT.

INTERPRETING THE RESULTS

THE SOLUTION REVEALS THAT TRISTAN OWNS:

- 14 NICKELS, WORTH \$0.70
- 7 DICES, WORTH \$0.70

TOTALING \$1.40, AS EXPECTED. THE RATIO OF NICKELS TO DICES IS 2:1, CONFIRMING THE INITIAL CONDITION.

BROADER IMPLICATIONS AND APPLICATIONS

THIS PROBLEM DEMONSTRATES THE POWER OF ALGEBRAIC MODELING IN REAL-WORLD CONTEXTS. SIMILAR PROBLEMS ARE COMMON IN FINANCE, RETAIL, AND EVERYDAY TRANSACTIONS, WHERE UNDERSTANDING HOW TO SET UP AND SOLVE SYSTEMS OF EQUATIONS IS CRUCIAL.

FOR EXAMPLE:

- CALCULATING HOW MANY DIFFERENT DENOMINATIONS OF COINS OR BILLS ARE NEEDED TO MAKE A CERTAIN AMOUNT.
- DETERMINING THE COMPOSITION OF A MIXTURE OR SOLUTION BASED ON GIVEN PROPORTIONS.
- ANALYZING RATIOS IN RESOURCE ALLOCATION OR INVENTORY MANAGEMENT.

FURTHERMORE, MASTERING THESE TECHNIQUES FOSTERS CRITICAL THINKING AND PROBLEM-SOLVING SKILLS THAT EXTEND BEYOND MATHEMATICS INTO VARIOUS FIELDS LIKE ECONOMICS, ENGINEERING, AND COMPUTER SCIENCE.

ADDITIONAL VARIATIONS AND PRACTICE PROBLEMS

TO DEEPEN UNDERSTANDING, CONSIDER EXPLORING VARIATIONS SUCH AS:

- CHANGING THE TOTAL AMOUNT (E.G., \$2.00) AND EXPLORING HOW THE SOLUTION CHANGES.
- INTRODUCING OTHER COIN TYPES, LIKE QUARTERS OR HALF-DOLLARS.
- ADJUSTING THE RELATIONSHIP BETWEEN THE QUANTITIES (E.G., THREE TIMES AS MANY NICKELS AS DICES).

SAMPLE PRACTICE PROBLEM:

IF TRISTAN HAD \$2.00 WORTH OF NICKELS AND DICES, WITH THREE TIMES AS MANY NICKELS AS DICES, HOW MANY OF EACH COIN WOULD HE HAVE?

CONCLUSION: THE SIGNIFICANCE OF MODELING AND SOLVING

BY TRANSLATING WORDS INTO ALGEBRAIC EQUATIONS, WE GAIN A SYSTEMATIC APPROACH TO SOLVING REAL-WORLD PROBLEMS INVOLVING QUANTITIES AND RELATIONSHIPS. TRISTAN'S COIN PROBLEM EXEMPLIFIES HOW A SIMPLE SCENARIO CAN BE EFFECTIVELY MODELED USING A SYSTEM OF EQUATIONS, LEADING TO CLEAR AND PRECISE SOLUTIONS. WHETHER IN CLASSROOM EXERCISES OR PRACTICAL SITUATIONS, THESE SKILLS ARE INVALUABLE TOOLS FOR ANALYTICAL REASONING AND DECISION-MAKING.

UNDERSTANDING SUCH PROBLEMS ENHANCES NOT JUST MATHEMATICAL PROFICIENCY BUT ALSO CRITICAL THINKING, PROBLEM-SOLVING, AND THE ABILITY TO INTERPRET DATA—SKILLS THAT ARE ESSENTIAL IN MANY PROFESSIONAL AND EVERYDAY CONTEXTS.

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