

ANSWER BOOK

1 OF 36

A STUDY OF PULSE, TIME,
HISTORY & NUMBER

78 BEATS PER MINUTE

x 45 YEARS x 364 DAYS

1,839,801,600 BEATS

FREE MATH TUTOR - TEXTBOOK EDITION

THE PROBLEM, THE PREMISE & THE ANSWER

THE QUOTATION UNDER STUDY

"The uncle of Mr. W. D. FARD lived in the wilderness of North America and he lived other than his own self, therefore, his pulse beat seventy-eight times per minute and this killed him in forty-five years of age. How many times did his pulse beat in forty-five years?"

This volume treats the passage as a historical arithmetic prompt. It defines every unique word, studies the source context, constructs the required 364-day year, solves the rate problem, and develops arithmetic, algebra, geometry, calendar, and health-literacy exercises from the same figures.

FINAL NUMERICAL ANSWER

Under the stated assumptions of a constant 78 beats per minute and an exact 364-day year, the pulse beats **1,839,801,600 times** during 45 complete years. In words: **one billion eight hundred thirty-nine million eight hundred one thousand six hundred.**

READING LENS	WHAT THIS BOOK DOES	WHAT IT DOES NOT CLAIM
Mathematics	Uses exact conversion factors and checks the product four ways.	It does not treat an assumed constant rate as a real lifetime medical record.
History	Places W. D. Fard and the source lesson in early Nation of Islam history.	It does not pretend that disputed biographical details are settled.
Health	Compares 78 bpm with age-based resting ranges from clinical references.	It does not diagnose illness or determine a cause of death.
Calendar	Uses 13 months x 28 days and 4 seasonal transition days as directed.	It does not claim that this modern classroom model exactly reproduces every ancient 364-day calendar.

Educational note: A pulse can vary with age, sleep, movement, fever, emotion, medicine, hydration, fitness, and disease. Symptoms such as chest pain, fainting, severe shortness of breath, confusion, or a persistently unusual pulse require qualified medical attention.

CONTENTS & LEARNING MAP

PART	TOPIC	CORE LEARNING
1	Quotation and Visual Dictionary	Grammar, vocabulary, rate language, and 35 unique terms.
2	W. D. Fard and Historical Context	Founder, Detroit setting, Elijah Muhammad, source traditions, and disputed biography.
3	The 364-Day Holy Year	52 weeks, 13 equal months, four seasons, transition days, and historical distinction.
4	Meticulous Solution	Arithmetic ladder, dimensional analysis, algebra, long multiplication, and checks.
5	Pulse and Heart-Rate Science	What pulse means, age ranges, measurement, and cautious interpretation.
6	Arithmetic, Algebra & Geometry	Rates, formulas, graphs, areas, circles, sectors, and unit reasoning.
7	Exercises and Worksheets	Guided practice, independent practice, challenge problems, and source literacy.
8	Complete Answer Key	Worked answers, units, explanations, and verification.
9	Sources and Index	Historical, calendrical, medical, mathematical, and vocabulary references.

ESSENTIAL EQUATION

$B = r \times 60 \times 24 \times 364 \times y$
B = total beats; r = beats per minute; y = years. For r = 78 and y = 45, B = 1,839,801,600 beats.

Learning goals

BY THE END, THE STUDENT CAN...	EVIDENCE OF LEARNING
Translate ordinary language into a rate equation.	Label 78 beats/minute and cancel time units correctly.
Convert among seven units of time.	Move exactly from years to seconds under the 364-day model.
Explain the result in words and figures.	Read 1,839,801,600 accurately and estimate its size.

BY THE END, THE STUDENT CAN...	EVIDENCE OF LEARNING
Distinguish premise, inference, and evidence.	Separate the quotation's causal claim from the calculation and medical evidence.
Compare calendar structures.	Explain both 13 x 28 and 4 x 91 without claiming they are historically identical.
Apply the model.	Solve new rate, duration, algebra, and geometry problems.

CHAPTER 1

THE QUOTATION AS LANGUAGE

CHAPTER PURPOSE
Read the sentence closely before calculating. Identify people, places, quantities, units, claims, and the exact question.

Sentence map

FUNCTION	WORDS FROM THE QUOTE	MATHEMATICAL OR READING JOB
Subject	The uncle of Mr. W. D. Fard	Names the person whose pulse is counted.
Location	in the wilderness of North America	Adds historical and symbolic setting; it does not alter the arithmetic.
Claimed condition	lived other than his own self	A rhetorical moral/social claim; not a measurable variable in this problem.
Connector	therefore	Signals a claimed cause-and-effect. The logic must be evaluated separately from the arithmetic.
Rate	seventy-eight times per minute	Provides $r = 78$ beats/minute.
Duration	forty-five years	Provides $y = 45$ years.
Question	How many times did his pulse beat?	Requests a total count B in beats.

THE CENTRAL READING SKILL
The phrase <i>per minute</i> makes 78 a rate, not a lifetime total. To find the total, multiply the rate by the number of minutes in 45 years. The word <i>therefore</i> makes a causal claim, but multiplication alone cannot prove that the rate caused death.

Repeated words are defined once in the visual dictionary. Capitalization and punctuation do not create new vocabulary entries. The initials W. and D. are treated as name markers, and North America is also explained as a geographic phrase.

Vocabulary count

COUNT	RESULT
Total word tokens in the quotation	54
Unique case-normalized word forms	35
Hyphenated number expressions	seventy-eight; forty-five
Rate expression	seventy-eight times per minute
Question expression	How many times...?

VISUAL DICTIONARY - WORDS 1-6

**THE****article**

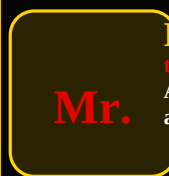
Points to a particular person, place, thing, or idea. Here it identifies one specific uncle described by the quotation.

**UNCLE****noun**

A parent's brother, or the husband of a parent's sibling. In the source lesson, scholars also read 'uncle' as a symbolic collective figure rather than a proven family relationship.

**OF****preposition**

Shows belonging, connection, source, or relation. 'Uncle of Mr. Fard' grammatically connects the uncle to the named person.

**MR.****title**

An honorific placed before a man's name. It is an abbreviation of 'Mister.'

**W.****initial**

The first initial in the written name W. D. Fard. An initial is a first letter used to represent a name.

**D.****initial**

The second initial in the written name W. D. Fard. Historical records use several name forms, so the initials should be reproduced carefully.

VISUAL DICTIONARY - WORDS 7-12

Fard**FARD****proper noun**

A family or chosen name used in W. D. Fard, also known in Nation of Islam tradition as Master Fard Muhammad.

**LIVED****verb - past tense**

Was alive or made a home during a past period. The word occurs twice and describes both location and manner of life.

**IN****preposition**

Inside, within, or during a place or condition. Here: within the wilderness of North America.

**WILDERNESS****noun**

A wild, uncultivated, or unsettled region. In the lesson's religious vocabulary, it can also operate as a symbolic description of social exile or separation.

**NORTH****proper adjective**

Located toward the northern direction. With 'America,' it forms the geographic name North America.

**AMERICA****proper noun**

A geographic name. In 'North America,' it refers to the continent containing Canada, the United States, Mexico, Central America, the Caribbean, and Greenland by common geographic convention.

VISUAL DICTIONARY - WORDS 13-18

**AND****conjunction**

Joins words, phrases, or clauses that are connected. It adds one fact or action to another.

**HE****pronoun**

A third-person singular subject pronoun. It stands in place of the male person previously named.

**OTHER****adjective/pronoun**

Different from the one already mentioned. In the phrase 'other than,' it signals difference or exception.

**THAN****conjunction/preposition**

Introduces the second part of a comparison or difference. 'Other than his own self' means different from his true or proper self within the quotation's rhetoric.

**HIS****possessive determiner**

Shows that something belongs or relates to the male person being discussed: his pulse, his self.

**OWN****adjective**

Belonging specifically to the person named; used for emphasis in 'his own self.'

VISUAL DICTIONARY - WORDS 19-24

**SELF****noun/pronoun**

A person's identity, nature, or individual being. The phrase in the quote is moral and rhetorical, not a medical diagnosis.

A + B**THEREFORE****adverb**

Introduces a claimed result: because of the preceding idea, the next statement is said to follow. A reader must still test whether the claimed cause-and-effect is supported.

**PULSE****noun**

The rhythmic pressure wave felt in an artery when the heart contracts. Pulse rate is commonly counted in beats per minute.

**BEAT****verb/noun**

To contract rhythmically, or one contraction in a repeating rhythm. In this problem, each pulse beat is counted as one event.

seventy**SEVENTY-EIGHT****number word**

The number 78: seven tens and eight ones. It is the stated constant pulse rate in beats per minute.

**TIMES****noun/mathematical word**

Occurrences or repeated events. It can also signal multiplication; 78 times each minute means 78 repeated beats per minute.

VISUAL DICTIONARY - WORDS 25-30

1**min****PER****preposition/rate word**

For each. '78 per minute' means 78 beats for every one minute, written 78 beats/minute.

**MINUTE****time unit**

A unit of time equal to 60 seconds. Under every calendar system used here, 60 minutes equal one hour.

**THIS****demonstrative pronoun**

Points back to a nearby statement or condition. Here it points to the preceding claim about lifestyle and pulse.

**KILLED****verb - past tense**

Caused death. The sentence makes this claim, but the arithmetic does not prove it; a rate of 78 beats per minute alone is not evidence of cause of death.

**HIM****object pronoun**

A third-person singular pronoun used as the object of a verb or preposition. It refers back to the man in the sentence.

FORTY-FIVE**number word**

The number 45: four tens and five ones. The problem treats it as a duration of 45 complete 364-day years.

VISUAL DICTIONARY - WORDS 31-35

364

YEARS

plural time unit

More than one year. In this textbook's model, each year is exactly 364 days, 13 months, or 52 weeks.

364

AGE

noun

The length of time a person has lived. 'Forty-five years of age' means the person was 45 years old.

?

HOW

question adverb

Asks for the manner, amount, or degree. With 'many,' it asks for a count.

?

MANY

quantity word

Asks for the number of countable things. 'How many times?' requests a whole-number total of pulse beats.

✓

DID

helping verb

Marks a question about a completed past action. The base verb remains 'beat': 'How many times did ... beat?'

LANGUAGE, LOGIC & MATHEMATICAL TRANSLATION

A sentence can contain facts, assumptions, symbols, and claims at the same time. Good mathematical reading sorts them before operating on numbers.

TEXT ELEMENT	CLASSIFICATION	REASON
78 times per minute	Numerical rate supplied by the prompt	It can be used directly after attaching the unit beats/minute.
45 years	Duration supplied by the prompt	It must be converted to minutes under the assigned calendar.

TEXT ELEMENT	CLASSIFICATION	REASON
364 days per year	Textbook assumption	It replaces the Gregorian average for every calculation in this volume.
lived other than his own self	Rhetorical or doctrinal language	It is not numerically defined and therefore is not a factor in the equation.
this killed him	Causal claim	The problem offers no clinical evidence connecting 78 bpm to death.
How many times?	Unknown total	Represent it by B, measured in beats.

TRANSLATION INTO SYMBOLS

Rate: $r = 78$ beats/minute. Duration: $y = 45$ years. Calendar: 364 days/year. Unknown: B beats. Equation: $B = r \times 60$ minutes/hour $\times 24$ hours/day $\times 364$ days/year $\times y$.

Logic check

The arithmetic conclusion follows if the numerical assumptions are accepted: a constant rate multiplied by elapsed minutes produces a total count. The medical conclusion does not follow from the arithmetic. A normal-range pulse can coexist with health or illness, and cause of death requires clinical evidence. This distinction is an example of critical literacy: respecting the source while testing different kinds of claims by the methods appropriate to them.

Grammar check

In the question, *did* carries the past tense, so the main verb is the base form *beat*. In the earlier clause, *beat* is itself past tense. The identical spelling has two grammatical jobs. Likewise, *times* means counted occurrences here, while in arithmetic instruction it can also name multiplication.

CHAPTER 2

W. D. FARD & THE FOUNDING OF THE NATION OF ISLAM

CHAPTER PURPOSE

A balanced historical summary distinguishes well-established events, Nation of Islam tradition, scholarly interpretation, and unresolved biography.

A founder in Depression-era Detroit

Wallace D. Fard, also called W. D. Fard and, in Nation of Islam tradition, Master Fard Muhammad, is widely identified as the founder of the Nation of Islam. Institutional histories date the movement's beginning in Detroit to 1930. Detroit's Black population had grown rapidly during the Great Migration, as African Americans moved from the South seeking industrial work and relief from Jim Crow oppression. The Great Depression then intensified unemployment, housing insecurity, racial conflict, and the search for institutions that could provide dignity, discipline, and community.

Accounts describe Fard teaching among Black residents, at first through personal visits and small meetings. His message joined religious instruction with Black identity, self-knowledge, economic self-reliance, dietary rules, moral discipline, education, and separation from degrading racial labels. These teachings differed sharply from mainstream Sunni and Shia Islam, even while using Islamic names and concepts.

Fard's work produced organized institutions, including temples and educational programs. The University of Islam became part of the movement's educational life, while classes for men and women emphasized study, discipline, family, health, and community responsibilities. The movement's language addressed Black Americans as a people whose history and identity had been obscured by slavery and racial domination.

HISTORICAL METHOD

A responsible history uses source labels. Nation tradition records the movement's own beliefs about Fard. Institutional history records dates and organizational facts. Scholarly interpretation compares documents and social context. Where records conflict, the honest conclusion is uncertainty.

NAME FORM	USE IN THIS BOOK
W. D. Fard	The form printed in the problem quotation.
Wallace Fard Muhammad	A common historical reference form.
Master Fard Muhammad	The honorific form used in Nation of Islam tradition.
Wallace D. Fard	Another common archival and reference form.

W. D. FARD: TEACHER, ORGANIZER & HISTORICAL MYSTERY

Elijah Poole and the movement's continuation

One of Fard's most consequential students was Elijah Poole, who became known as Elijah Muhammad. After encountering Fard's teaching in Detroit, Elijah Muhammad became an organizer and minister. When Fard left public view in 1934, Elijah Muhammad eventually became the central leader who expanded the movement nationally. Under his leadership, the Nation of Islam developed temples, schools, farms, businesses, a newspaper, and a public program centered on Black self-determination.

Fard's identity and fate

Fard's life before Detroit and his fate after 1934 remain disputed. Nation of Islam sources present a sacred biography and theological identity. Government files, newspapers, census records, court records, and later scholarship have proposed other names, birthplaces, and life histories. The records do not yield a single uncontested biography. For that reason, this book does not assign a certain birthplace, birth year, death year, or cause of death.

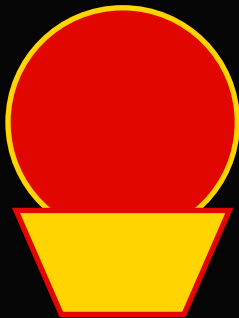
Legacy and later paths

The movement became a major force in twentieth-century Black religious and political history. Malcolm X, Muhammad Ali, and many less-famous members carried its language of dignity, discipline, self-defense, and independent institution-building into national life. After Elijah Muhammad died in 1975, his son Warith Deen Mohammed guided many followers toward mainstream Sunni Islam. Louis Farrakhan later rebuilt an organization retaining the name Nation of Islam and many earlier teachings. These paths share history but are not identical institutions.

WHY THE BIOGRAPHY REQUIRES CARE

The uncertainty surrounding Fard is itself historically important. It shows how migration, aliases, religious reverence, hostile surveillance, incomplete archives, and competing interpretations can shape the record of a public figure.

Historical-study illustration



FOUNDER - TEACHER - ORGANIZER

Documented public work: Detroit, early 1930s

Origins and later fate: disputed

STUDY SILHOUETTE

1930

1931

1934

AFTER

Detroit teaching

Elijah Poole studies

Fard leaves public view

Legacy expands

HISTORICAL TIMELINE & INSTITUTIONAL LEGACY

DATE/PERIOD	EVENT	WHY IT MATTERS
Before 1930	Fard's earlier biography remains disputed across religious, government, journalistic, and scholarly accounts.	The uncertainty warns historians not to turn a theory into a fact.
1930	The Nation of Islam is founded in Detroit; Fard begins public teaching among Black residents.	This is the best-established starting point for the organization.
1931	Elijah Poole encounters Fard's teaching and becomes a devoted student and organizer.	The relationship links the founder to the leader who later nationalized the movement.
1930-1934	Temples, lessons, and educational structures develop in Detroit and beyond.	The period creates the texts and teaching culture in which mathematical problems functioned.
1934	Fard leaves public view; accounts of what followed conflict.	The absence of conclusive records becomes part of the historical mystery.
1934-1975	Elijah Muhammad leads and expands the Nation of Islam.	The organization becomes a major Black religious, economic, and political force.
1950s-1960s	Malcolm X and other ministers bring the movement broad national attention.	The movement's critique of racism and call for self-determination enter national debate.
1975 onward	Warith Deen Mohammed and Louis Farrakhan lead different institutional paths.	The legacy branches into distinct communities and interpretations.

SOURCE PERSPECTIVE

The Nation of Islam describes Fard through sacred history and theology. Museums and encyclopedias generally describe him as the organization's founder. Scholars debate his origins. These statements answer different questions and must not be blended without labels.

The larger historical importance

Whatever view one takes of Fard's identity, the movement he initiated responded to real conditions: racial segregation, economic hardship, cultural displacement, and the desire for independent institutions. Its lessons joined cosmology, religion, health, history, discipline, and mathematical exercises. This combination made calculation part of a larger program of self-study and social interpretation.

THE PROBLEM BOOK: MATHEMATICS AS A FORM OF STUDY

The supplied quotation appears as Problem 1 in online transcriptions of *The Problem Book*, a set attributed to W. D. Fard and used within the Nation of Islam's lesson tradition. The problems combine ordinary arithmetic with the movement's specialized vocabulary, moral teaching, historical claims, geographic quantities, and questions about society. They therefore require two kinds of reading: calculation and interpretation.

What 'uncle' can mean in the lesson

A 1938 sociological account of the early movement reported that 'the uncle of Mr. Fard' functioned symbolically for Black people in North America. That reading is more consistent with the repeated problem-book figure than a literal family biography. The word should still be defined in its ordinary kinship sense, but historical interpretation must recognize the specialized source vocabulary.

LAYER	QUESTION TO ASK	EXAMPLE IN PROBLEM 1
Literal language	What do the words ordinarily mean?	Pulse means an arterial rhythm associated with heart contractions.
Specialized vocabulary	Does the source tradition give the word an additional meaning?	Uncle may operate as a collective symbolic figure.
Mathematics	Which values, units, and operations are required?	78 beats/minute multiplied by the total minutes in 45 years.
Historical claim	What can documents establish?	Fard founded the movement in Detroit around 1930 and left public view in 1934.
Medical claim	Does clinical evidence support causation?	A value of 78 bpm alone does not show what caused a death.

RESPECTFUL CRITICAL READING

Critical reading is not disrespect. It honors the text by identifying exactly what it says, what it assumes, what can be calculated, what requires historical evidence, and what remains a matter of belief or interpretation.

Primary-source practice

When citing the quotation, preserve its wording and punctuation or state that it has been modernized. When explaining it, label interpretation as interpretation. When solving it, state the calendar and constant-rate assumptions. When discussing health, use clinical references and avoid diagnosing a historical person from a single number.

CHAPTER 3

THE 364-DAY HOLY YEAR

CHAPTER PURPOSE

Study the ancient 364-day calendrical tradition, then build the exact 13-month classroom model required for this problem.

Why 364 is mathematically powerful

The number 364 is divisible by 7: $364 = 52 \times 7$. Therefore a 364-day year contains exactly 52 complete weeks. If the year begins on a particular weekday, the next modeled year begins on that same weekday. This fixed weekly pattern is one reason 364-day schemes are attractive for arranging recurring sacred observances.

Ancient Jewish calendrical traditions

Texts associated with 1 Enoch, Jubilees, and the Dead Sea Scrolls preserve or discuss schematic years of 364 days. The Leon Levy Dead Sea Scrolls Digital Library describes a prominent calendar divided into four seasons of 13 weeks each. That produces four 91-day quarters: $4 \times 91 = 364$. Scholarship examines how such fixed calendars related to priestly service, festivals, weekly cycles, solar observation, and competing Jewish calendar systems.

Why some people call it a holy year

The phrase 'holy year' emphasizes the calendar's religious use: ordering Sabbaths, priestly courses, festivals, and sacred time. It should not be read as proof that every ancient Jewish group used one identical 364-day system. Ancient sources differ, and later communities

interpret them differently. The historically safest statement is that influential ancient Jewish writings and Qumran materials attest prominent 364-day schemes.

HISTORICAL DISTINCTION

The ancient Qumran pattern commonly summarized as 4 seasons x 13 weeks is not the same as a 13-month calendar of 28 days each. Both total 364 days. This textbook uses the 13 x 28 arrangement as an exact teaching model while clearly labeling the difference.

STRUCTURE	CALCULATION	TOTAL
Weeks	52 weeks x 7 days	364 days
Qumran-style seasonal summary	4 seasons x 13 weeks	364 days
Qumran-style quarters	4 quarters x 91 days	364 days
This textbook's months	13 months x 28 days	364 days
This textbook's seasons	4 x 90 season days + 4 transition days	364 days

A 364-DAY CALENDAR: ONE YEAR AT A GLANCE



Each colored quarter contains 13 weeks = 91 days. In this book: 90 season days + 1 transition day.

MONTH	WEEK 1	WEEK 2	WEEK 3	WEEK 4	YEAR DAYS
Month 1	1-7	8-14	15-21	22-28	1-28
Month 2	29-35	36-42	43-49	50-56	29-56
Month 3	57-63	64-70	71-77	78-84	57-84
Month 4	85-91	92-98	99-105	106-112	85-112
Month 5	113-119	120-126	127-133	134-140	113-140
Month 6	141-147	148-154	155-161	162-168	141-168

MONTH	WEEK 1	WEEK 2	WEEK 3	WEEK 4	YEAR DAYS
Month 7	169-175	176-182	183-189	190-196	169-196
Month 8	197-203	204-210	211-217	218-224	197-224
Month 9	225-231	232-238	239-245	246-252	225-252
Month 10	253-259	260-266	267-273	274-280	253-280
Month 11	281-287	288-294	295-301	302-308	281-308
Month 12	309-315	316-322	323-329	330-336	309-336
Month 13	337-343	344-350	351-357	358-364	337-364

SEASONS, TRANSITION DAYS & MONTH ALIGNMENT

The model uses two coordinate systems over the same 364 numbered days. The month system assigns every day to one of thirteen 28-day months. The season system assigns four blocks of 90 ordinary season days and labels four additional days as transitions. A transition day remains inside a numbered month, even though it is outside the corresponding 90-day seasonal block.

PHASE	YEAR-DAY RANGE	LENGTH	MONTH POSITION OF TRANSITION
Season 1	Days 1-90	90 days	-
Transition 1	Day 91	1 day	Month 4, Day 7
Season 2	Days 92-181	90 days	-
Transition 2	Day 182	1 day	Month 7, Day 14
Season 3	Days 183-272	90 days	-
Transition 3	Day 273	1 day	Month 10, Day 21
Season 4	Days 274-363	90 days	-
Transition 4	Day 364	1 day	Month 13, Day 28

A BEAUTIFUL NUMBER PATTERN

The transition days fall 91 days apart. Because $91 = 13 \times 7$, each transition lands exactly 13 weeks after the previous one. In the 28-day month overlay, their month-day positions advance by 7: Month 4 Day 7; Month 7 Day 14; Month 10 Day 21; Month 13 Day 28.

Calendar consequences

PROPERTY	RESULT
Weeks per month	$28 / 7 = 4$ exact weeks
Months per year	$364 / 28 = 13$ exact months
Weeks per year	$364 / 7 = 52$ exact weeks
Days in four 90-day seasons	$4 \times 90 = 360$ days
Days remaining for transitions	$364 - 360 = 4$ days
Weekday repetition	The next modeled year begins on the same weekday

ALL TIME UNITS USED IN THIS BOOK

UNIT	EXACT DEFINITION IN THIS MODEL	EQUIVALENT SMALLER UNITS	45-YEAR TOTAL
Year	13 months = 52 weeks = 364 days	8,736 hours; 524,160 minutes; 31,449,600 seconds	45 years
Month	4 weeks = 28 days	672 hours; 40,320 minutes; 2,419,200 seconds	585 months
Week	7 days	168 hours; 10,080 minutes; 604,800 seconds	2,340 weeks
Day	24 hours	1,440 minutes; 86,400 seconds	16,380 days
Hour	60 minutes	3,600 seconds	393,120 hours
Minute	60 seconds	The rate unit: 78 beats per minute	23,587,200 minutes

UNIT	EXACT DEFINITION IN THIS MODEL	EQUIVALENT SMALLER UNITS	45-YEAR TOTAL
Second	Base time unit used here	78/60 = 1.3 beats per second on average	1,415,232,000 seconds
Season	90 season days	2,160 hours; 129,600 minutes	180 seasons if counted as 4 per year
Transition day	1 special phase day after each season	24 hours; 1,440 minutes	180 transition days



UNIT RULE

Multiply when converting from a larger unit to a smaller unit because each large unit contains many small units.
Divide when converting from a smaller unit to a larger unit.

CHAPTER 4

THE METICULOUS SOLUTION

CHAPTER PURPOSE

Solve the pulse problem step by step, track units, verify by alternate paths, and state the result in digits and words.

Step 0 - identify the model

SYMBOL	MEANING	VALUE
r	constant pulse rate	78 beats/minute
y	duration	45 years
d	days in each modeled year	364 days/year
h	hours in each day	24 hours/day
m	minutes in each hour	60 minutes/hour
B	total number of pulse beats	unknown

Step 1 - write the rate equation

MASTER FORMULA

$$B = r \times y \times 364 \times 24 \times 60$$

The factors convert years to days, days to hours, hours to minutes, and minutes to beats.

Step 2 - state assumptions

ASSUMPTION	EFFECT
Every year is exactly 364 days.	No leap days and no 365- or 366-day Gregorian years are used.
Every day is exactly 24 hours.	No daylight-saving clock adjustment changes elapsed physical time.
Every hour is 60 minutes; every minute is 60 seconds.	Ordinary clock conversion remains exact.
The pulse stays at 78 bpm without interruption.	This creates a mathematical constant-rate model, not a biological lifetime record.
Forty-five years means 45 complete durations.	The starting instant is not counted as an extra beat or extra day.

WHAT MUST BE FOUND

The requested answer is a count of events. Therefore the final unit must be beats, not minutes, years, bpm, or beats per year.

METHOD 1: CONVERT 45 YEARS TO MINUTES

Step 1 - years to days

$$45 \times 364 = 16,380$$

Break 364 into $300 + 60 + 4$:

$$45 \times 300 = 13,500$$

$$45 \times 60 = 2,700$$

$$45 \times 4 = 180$$

$$13,500 + 2,700 + 180 = 16,380 \text{ days.}$$

Step 2 - days to hours

$$16,380 \times 24 = 393,120$$

Use $24 = 20 + 4$:

$$16,380 \times 20 = 327,600$$

$$16,380 \times 4 = 65,520$$

$$327,600 + 65,520 = 393,120 \text{ hours.}$$

Step 3 - hours to minutes

$$393,120 \times 60 = 23,587,200$$

First multiply by 6: $393,120 \times 6 = 2,358,720$. Then multiply by 10: $2,358,720 \times 10 = 23,587,200$ minutes.

Step 4 - minutes to beats

$$23,587,200 \times 78 = 1,839,801,600$$

Use $78 = 70 + 8$:

$$23,587,200 \times 70 = 1,651,104,000$$

$$23,587,200 \times 8 = 188,697,600$$

$$\text{Sum} = 1,839,801,600 \text{ beats.}$$

METHOD 2: DIMENSIONAL ANALYSIS

Dimensional analysis treats units like algebraic labels. A unit that appears once above and once below a fraction cancels. Only the desired unit remains.

ONE CONTINUOUS CONVERSION CHAIN

$78 \text{ beats/min} \times 60 \text{ min/hour} \times 24 \text{ hour/day} \times 364 \text{ day/year} \times 45 \text{ year}$

Cancel minute, hour, day, and year. The surviving unit is beats.

Numerical product: $78 \times 60 \times 24 \times 364 \times 45 = 1,839,801,600 \text{ beats}$.

STAGE	FACTOR	RUNNING VALUE	RUNNING UNIT
Rate	78	78	beats/minute
Minutes per hour	$\times 60$	4,680	beats/hour
Hours per day	$\times 24$	112,320	beats/day
Days per year	$\times 364$	40,884,480	beats/year
Years	$\times 45$	1,839,801,600	beats

Why units matter

If a student multiplies 78×45 and stops, the result is 3,510, but its units are beats-years/minute, not beats. That mismatch exposes the missing conversion factors. Correct unit cancellation is both a method and an error detector.

Scientific notation

The result can be written as 1.8398016×10^9 beats. Rounded to three significant figures, it is 1.84×10^9 beats, or about 1.84 billion beats.

METHOD 3: BUILD FROM ONE MINUTE TO ONE YEAR

INTERVAL	CALCULATION	BEATS
1 second	$78 / 60$	1.3 beats on average
1 minute	given	78
1 hour	78×60	4,680
1 day	$4,680 \times 24$	112,320
1 week	$112,320 \times 7$	786,240
1 month	$112,320 \times 28$	3,144,960
1 season of 90 days	$112,320 \times 90$	10,108,800
1 transition day	$112,320 \times 1$	112,320
1 year by months	$3,144,960 \times 13$	40,884,480
1 year by seasons	$10,108,800 \times 4 + 112,320 \times 4$	40,884,480
45 years	$40,884,480 \times 45$	1,839,801,600

CROSS-CHECK

Months and seasons produce the same one-year total. That agreement confirms that $13 \times 28 = 4 \times 90 + 4 = 364$ days.

Method 4 - compare with an estimate

Round 78 to 80 and keep 45 years. Then $80 \times 60 \times 24 \times 364 \times 45 = 1,886,976,000$. Because the exact rate is 2 bpm lower, subtract $2 \times 23,587,200 = 47,174,400$. The difference gives 1,839,801,600. The exact answer is close to 1.9 billion, so its order of magnitude is

reasonable.

LONG MULTIPLICATION & INDEPENDENT CHECKS

Long multiplication of minutes by pulse rate

LINE	OPERATION	VALUE
Multiplicand	Total minutes	23,587,200
Ones row	$23,587,200 \times 8$	188,697,600
Tens row	$23,587,200 \times 70$	1,651,104,000
Add partial products	$188,697,600 + 1,651,104,000$	1,839,801,600

Check A - use $78 = 80 - 2$

PART	CALCULATION	RESULT
Eighty beats per minute	$23,587,200 \times 80$	1,886,976,000
Two beats per minute	$23,587,200 \times 2$	47,174,400
Subtract	$1,886,976,000 - 47,174,400$	1,839,801,600

Check B - last-digit test

The final nonzero digits come from $72 \times 78 = 5,616$, so a product ending in 600 is plausible after the place values in 23,587,200 are included. The result is even because both factors are even.

Check C - inverse division

$1,839,801,600 / 78 = 23,587,200$ minutes. Dividing again through the time ladder returns 45: $/60 = 393,120$ hours; $/24 = 16,380$ days; $/364 = 45$ years.

VERIFIED ANSWER

Digits: **1,839,801,600 beats**

Words: one billion eight hundred thirty-nine million eight hundred one thousand six hundred beats.

SECONDS, BEAT SPACING & PHYSICAL MEANING

Forty-five modeled years contain 1,415,232,000 seconds. A pulse of 78 beats per minute is equivalent to $78 / 60 = 1.3$ beats per second on average.

QUANTITY	FORMULA	EXACT VALUE	INTERPRETATION
Beats per second	$78 / 60$	1.3 beats/second	An average frequency.
Seconds per beat	$60 / 78$	10/13 second	About 0.7692308 second between beats if perfectly regular.
Seconds in 45 years	$45 \times 364 \times 24 \times 60 \times 60$	1,415,232,000 seconds	Total modeled duration.
Beats from seconds	$1,415,232,000 \times 1.3$	1,839,801,600 beats	Same total by frequency.

A frequency model

Frequency tells how many cycles occur per unit time. Pulse rate is a biological frequency. If $f = 1.3$ cycles/second and T is the time for one idealized cycle, then $T = 1/f = 10/13$ second. This reciprocal relationship is the same structure used for waves, rotation, vibration, and repeated machine cycles.

Real-life limitation

A real person's heart does not beat at exactly 78 bpm for 45 years. Rate changes from moment to moment, and periods before birth, sleep, exercise, illness, and daily activity differ. The result is therefore the exact answer to the stated constant-rate model, not a measurement of an actual lifetime.

GENERAL VARIABLE-RATE FORMULA

For a changing heart rate $r(t)$, the total number of beats over time is modeled by accumulation: $B = \text{integral of } r(t) \, dt$, with consistent time units. The multiplication $B = \text{rate} \times \text{time}$ is the special case where $r(t)$ is constant.

Discrete interpretation

Although the average model uses 1.3 beats per second, individual beats are countable whole events. Fractions such as 1.3 describe average density across time, not a physically fractional heartbeat.

NUMBER-TO-WORD TABLE - PART 1

Numbers in words appear on the left; figures appear on the right. The use column records where the number enters the calculation or calendar model.

NUMBER IN WORDS	NUMBER	USE OR ORIGIN
One	1	one transition day after each season; one beat as one event
Two	2	difference between 80 and 78; check factor
Four	4	weeks per month; seasons per year; transition days per year
Six	6	intermediate multiplier when multiplying by 60
Seven	7	days per week
Eight	8	ones digit of 78; partial-product factor
Ten	10	factor used after multiplying by 6 to multiply by 60
Thirteen	13	months per year; weeks per season; denominator in 10/13 second
Twenty	20	part of $24 = 20 + 4$
Twenty-Four	24	hours per day
Twenty-Eight	28	days per month
Forty-Five	45	years in the problem
Fifty-Two	52	weeks per year
Sixty	60	seconds per minute; minutes per hour
Seventy	70	tens part of 78
Seventy-Eight	78	beats per minute
Eighty	80	rounded rate used for checking
Ninety	90	ordinary days in each modeled season
Ninety-One	91	distance in days between transition-day positions
One Hundred Eighty	180	45×4 ; transition days or seasons in 45 years
Three Hundred	300	part of $364 = 300 + 60 + 4$
Three Hundred Sixty	360	season days per year
Three Hundred Sixty-Four	364	days per year
Five Hundred Eighty-Five	585	months in 45 years
One Thousand Four Hundred Forty	1,440	minutes per day
Two Thousand Three Hundred Forty	2,340	weeks in 45 years
Two Thousand Seven Hundred	2,700	45×60
Three Thousand Five Hundred Ten	3,510	incomplete product 78×45 used as an error example
Three Thousand Six Hundred	3,600	seconds per hour
Four Thousand Six Hundred Eighty	4,680	beats per hour
Eight Thousand Seven Hundred Thirty-Six	8,736	hours per year
Ten Thousand Eighty	10,080	minutes per week

NUMBER-TO-WORD TABLE - PART 2

Numbers in words appear on the left; figures appear on the right. The use column records where the number enters the calculation or calendar model.

NUMBER IN WORDS	NUMBER	USE OR ORIGIN
Thirteen Thousand Five Hundred	13,500	45 x 300
Sixteen Thousand Three Hundred Eighty	16,380	days in 45 years
Forty Thousand Three Hundred Twenty	40,320	minutes per month
Sixty-Five Thousand Five Hundred Twenty	65,520	16,380 x 4
Eighty-Six Thousand Four Hundred	86,400	seconds per day
One Hundred Twelve Thousand Three Hundred Twenty	112,320	beats per day
One Hundred Twenty-Nine Thousand Six Hundred	129,600	minutes per 90-day season
One Hundred Eighty-Eight Million Six Hundred Ninety-Seven Thousand Six Hundred	188,697,600	23,587,200 x 8
Three Hundred Twenty-Seven Thousand Six Hundred	327,600	16,380 x 20
Three Hundred Ninety-Three Thousand One Hundred Twenty	393,120	hours in 45 years
Four Hundred Forty-Nine Thousand Two Hundred Eighty	449,280	beats in four transition days
Five Hundred Twenty-Four Thousand One Hundred Sixty	524,160	minutes per year
Six Hundred Four Thousand Eight Hundred	604,800	seconds per week
Seven Hundred Eighty-Six Thousand Two Hundred Forty	786,240	beats per week
Two Million Three Hundred Fifty-Eight Thousand Seven Hundred Twenty	2,358,720	393,120 x 6
Two Million Four Hundred Nineteen Thousand Two Hundred	2,419,200	seconds per month
Three Million One Hundred Forty-Four Thousand Nine Hundred Sixty	3,144,960	beats per month
Six Million Seven Hundred Thirty-Nine Thousand Two Hundred	6,739,200	112,320 x 60
Ten Million One Hundred Eight Thousand Eight Hundred	10,108,800	beats per 90-day season
Twenty-Three Million Five Hundred Eighty-Seven Thousand Two Hundred	23,587,200	minutes in 45 years
Thirty-One Million Four Hundred Forty-Nine Thousand Six Hundred	31,449,600	seconds per year
Thirty-Three Million Six Hundred Ninety-Six Thousand	33,696,000	112,320 x 300
Forty Million Four Hundred Thirty-Five Thousand Two Hundred	40,435,200	beats in four 90-day seasons
Forty Million Eight Hundred Eighty-Four Thousand Four Hundred Eighty	40,884,480	beats per 364-day year
Forty-Seven Million One Hundred Seventy-Four Thousand Four Hundred	47,174,400	23,587,200 x 2
One Hundred Eighty-Eight Million Six Hundred Ninety-Seven Thousand Six Hundred	188,697,600	23,587,200 x 8
One Billion Six Hundred Fifty-One Million One Hundred Four Thousand	1,651,104,000	23,587,200 x 70
One Billion Four Hundred Fifteen Million Two Hundred Thirty-Two Thousand	1,415,232,000	seconds in 45 years
One Billion Eight Hundred Thirty-Nine Million Eight Hundred One Thousand Six Hundred	1,839,801,600	final beats
One Billion Eight Hundred Eighty-Six Million Nine Hundred Seventy-Six Thousand	1,886,976,000	check product at 80 bpm

FORMULA REFERENCE TABLE

FORMULA	PURPOSE	EXAMPLE
Total = rate x time	Counts repeated events at a constant rate.	78 beats/min x 23,587,200 min
B = 78(60)(24)(364)y	Total beats after y modeled years.	B(45) = 1,839,801,600
B = 40,884,480y	Simplified linear model in years.	Slope = 40,884,480 beats/year
y = B / 40,884,480	Solves for years when a beat total is known.	Use inverse operations.
r = B / [60(24)(364)y]	Solves for constant bpm.	Divide total beats by total minutes.
f = r/60	Converts bpm to beats per second.	78/60 = 1.3 Hz-like events/second
T = 60/r	Average seconds per beat.	60/78 = 10/13 second

FORMULA	PURPOSE	EXAMPLE
Days = 364y	Converts years to days.	364(45) = 16,380
Months = 13y	Converts years to 28-day months.	13(45) = 585
Weeks = 52y	Converts years to weeks.	52(45) = 2,340
Minutes = 524,160y	Converts years directly to minutes.	524,160(45) = 23,587,200
Rectangle area A = lw	Models years x days/year as total day-units.	A = 45 x 364 = 16,380
Circle angle = 360/52	Gives angle per week on a year wheel.	Approximately 6.923 degrees/week
Percent = part/whole x 100%	Compares a time segment with the year.	28/364 x 100% = 7.6923%

ORDER OF OPERATIONS

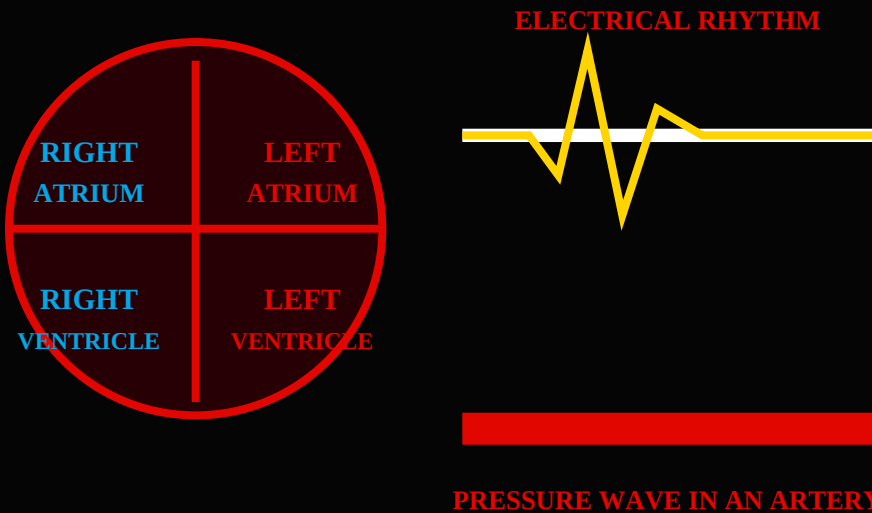
Multiplication factors may be regrouped because multiplication is associative and commutative. Units determine which factors belong in the model even when the numerical order changes.

CHAPTER 5

PULSE & HEART-RATE SCIENCE

CHAPTER PURPOSE

Understand what is being counted, compare 78 bpm with age-based resting ranges, and distinguish a rate from a diagnosis.



A pulse count estimates how often the heart contracts. One beat is one counted event.

The heart generates pressure waves as it pumps blood. A pulse can be felt where an artery lies near the skin, such as at the wrist or neck. Counting the waves for a measured time gives a pulse rate in beats per minute. In many situations pulse rate and heart rate are the same, but certain rhythm or circulation problems can make them differ, so clinical measurement may require more than touching an artery.

INTERPRETING 78 BPM

For a resting person age 10 or older, 78 bpm falls inside the 60-100 bpm reference interval published by MedlinePlus and the American Heart Association. It is not, by itself, evidence that the pulse caused death. Context, rhythm, symptoms, medical history, medicines, and examination matter.

RESTING HEART-RATE RANGES: INFANTS TO ADULTS

The table reproduces age-based reference intervals summarized by MedlinePlus. These are general resting ranges, not personal diagnoses. A child's rate changes with sleep, crying, fever, activity, stress, and illness. Different clinical references may use slightly different ranges.

AGE GROUP	GENERAL RESTING RANGE	LOWER THAN RANGE MAY BE CALLED...	HIGHER THAN RANGE MAY BE CALLED...
Newborn: 0-1 month	70-190 bpm	Bradycardia, depending on condition and context	Tachycardia, depending on condition and context
Infant: 1-11 months	80-160 bpm	Slower than expected for age	Faster than expected for age
Child: 1-2 years	80-130 bpm	Slower than expected for age	Faster than expected for age
Child: 3-4 years	80-120 bpm	Slower than expected for age	Faster than expected for age
Child: 5-6 years	75-115 bpm	Slower than expected for age	Faster than expected for age
Child: 7-9 years	70-110 bpm	Slower than expected for age	Faster than expected for age
Age 10+ and adults	60-100 bpm	Under 60 bpm may be called bradycardia	Over 100 bpm may be called tachycardia
Well-trained athletes	40-60 bpm may occur	Can be normal if asymptomatic and medically appropriate	Use adult context and symptoms

NORMAL DOES NOT MEAN IDENTICAL

A reference interval contains variation. A number inside the interval is not a guarantee of health; a number outside it is not automatically an emergency. Recheck at true rest and evaluate the whole person.

Average versus range

A range gives lower and upper reference boundaries. An average describes a center for a particular population and measurement method. Because age, activity, and sampling differ, one universal 'average heart rate' from infancy through adulthood would be misleading. The clinically useful comparison is age-specific and contextual.

HOW TO MEASURE A RESTING PULSE

STEP	ACTION	WHY IT MATTERS
1	Rest quietly for several minutes.	Movement and emotion can temporarily raise the rate.
2	Place the index and middle fingers over the radial artery at the thumb side of the wrist. Do not use the thumb.	The thumb has its own pulse and may confuse counting.
3	Count beats for 60 seconds when the rhythm seems irregular. For a regular rhythm, a shorter count can be scaled, but 60 seconds reduces rounding error.	A full minute directly measures bpm.
4	Record rate, rhythm, activity, symptoms, and time.	Context makes the number more useful.
5	Repeat if the result is surprising, and seek clinical advice when appropriate.	One measurement can be affected by technique or temporary conditions.

When a number deserves prompt attention

A persistently unusual resting pulse, especially with dizziness, fainting, chest pain, severe shortness of breath, confusion, weakness, or a markedly irregular rhythm, warrants medical evaluation. Emergency symptoms require emergency services. The numerical ranges in this textbook are educational and cannot replace a clinician.

Why 78 cannot establish cause of death

REASON	EXPLANATION
It is a single rate.	Cause of death cannot be inferred from one pulse value without history, symptoms, rhythm, and other evidence.
It is within a common adult resting interval.	MedlinePlus lists 60-100 bpm for people age 10 and older and adults.
Rate is not rhythm.	Two people can have the same bpm with different electrical rhythms.

REASON	EXPLANATION
Rate changes over time.	A lifetime constant-rate assumption is mathematical, not biological.
Causation requires evidence.	A statement that A occurred before B is not enough to prove that A caused B.

MATHEMATICAL TRUTH VS. MEDICAL TRUTH

The product 1,839,801,600 is exact within the assigned model. The claim that 78 bpm caused death is not established by that product.

CHAPTER 6

ARITHMETIC, ALGEBRA & GEOMETRY

CHAPTER PURPOSE

Use the same figures to study operations, variables, linear functions, area models, circles, sectors, and proportional reasoning.

Arithmetic structures

STRUCTURE	EXAMPLE	IDEA
Repeated addition	$78 + 78 + \dots$ for 60 minutes	Multiplication compresses repeated equal groups.
Place-value decomposition	$364 = 300 + 60 + 4$	Distributive property makes products easier.
Compensation	$78 = 80 - 2$	Multiply by a friendly number, then correct.
Unit conversion	45 years x 364 days/year	Conversion factors equal one in unit value.
Reciprocal	78 beats/60 sec and 60 sec/78 beats	Rate and period are inverse descriptions.
Estimation	1.84 billion is near 1.9 billion	Order-of-magnitude checks catch missing factors.

Algebraic structures

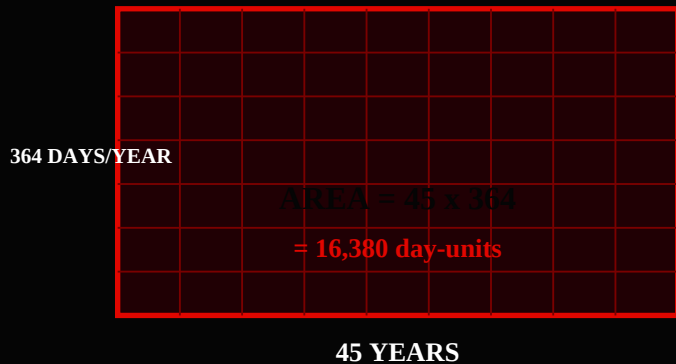
Let r be beats per minute and y be modeled years. Then $B(r,y) = 524,160ry$. Holding r constant gives a line in y ; holding y constant gives a line in r . If both rate and years double, the total becomes four times as large because B is proportional to the product ry .

UNKNOWN	REARRANGED FORMULA	OPERATION
Total beats B	$B = 524,160ry$	Multiply rate, time conversion, and years.
Rate r	$r = B/(524,160y)$	Divide total beats by total minutes.
Years y	$y = B/(524,160r)$	Divide total beats by annual beats.

Proportion

At constant rate, $B_1/y_1 = B_2/y_2 = 40,884,480$ beats/year. Therefore 10 years gives ten times the one-year total, while half a year gives half the one-year total. Proportional reasoning can solve many variants without rebuilding every conversion.

GEOMETRY GENERATED FROM THE PROBLEM

TIME RECTANGLE**RATE CIRCLE****ONE MINUTE AS A LENGTH**

Geometry makes multiplication visible as area, circumference, spacing, and slope.

1. Rectangle model

Use a rectangle with length 45 years and width 364 days per year. Its numerical area is $45 \times 364 = 16,380$ day-units. This is not physical land area; it is an array model showing 45 equal rows of 364 days.

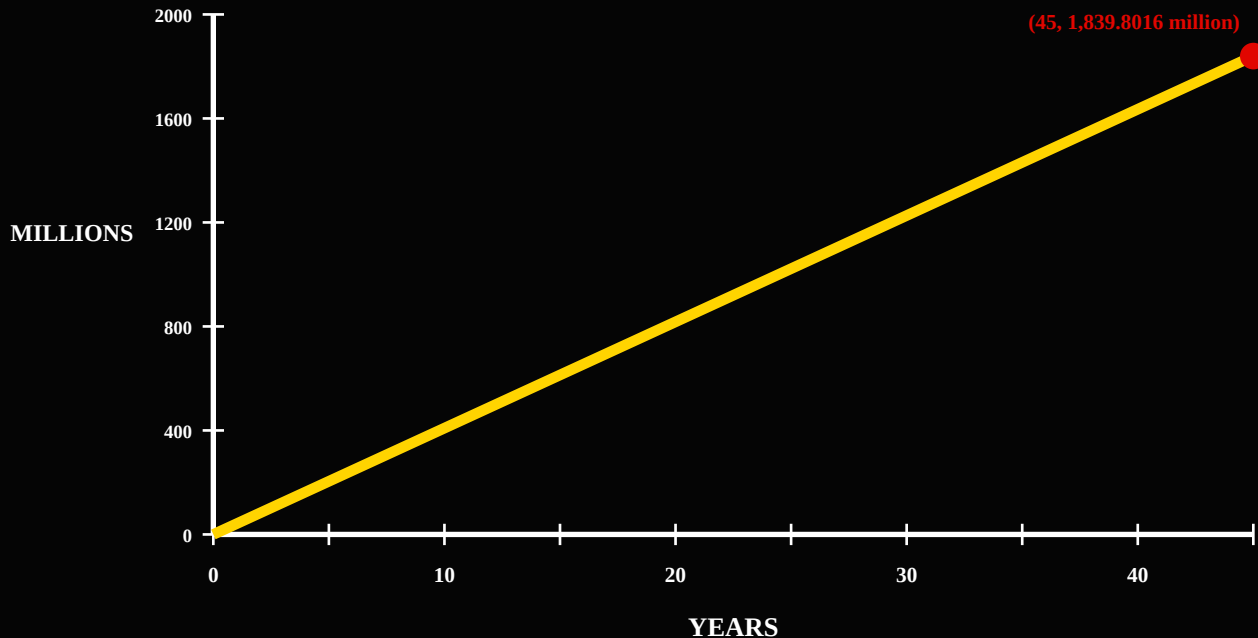
2. Calendar circle

Divide 360 degrees by 52 weeks: each week occupies about 6.923 degrees. Divide by 13 months: each month occupies about 27.692 degrees. Four weeks per month confirms 4×6.923 degrees is approximately 27.692 degrees.

3. Rate circle and segment pattern

Because $78 = 6 \times 13$, the 78 beats in one modeled minute can be grouped into 13 equal segments of 6 beats each. This factorization connects the pulse number to the 13-month structure, although the connection is mathematical rather than biological or historical.

THE LINEAR GRAPH OF TOTAL BEATS

$B(t) = 40,884,480t$ - A STRAIGHT-LINE CONSTANT-RATE MODEL

YEARS t	$B(t) = 40,884,480t$	IN WORDS
0	0	zero beats in zero elapsed time
1	40,884,480	forty million eight hundred eighty-four thousand four hundred eighty
5	204,422,400	two hundred four million four hundred twenty-two thousand four hundred
10	408,844,800	four hundred eight million eight hundred forty-four thousand eight hundred
25	1,022,112,000	one billion twenty-two million one hundred twelve thousand
45	1,839,801,600	one billion eight hundred thirty-nine million eight hundred one thousand six hundred

SLOPE AND INTERCEPT

The slope is 40,884,480 beats per year. The vertical intercept is 0 because the model counts zero elapsed beats at time zero. The straight line represents constant rate.

CHAPTER 7**EXERCISES & WORKSHEETS****CHAPTER PURPOSE**

Practice without a calculator where possible. Show units, write equations, and explain the reasoning behind each answer.

WORKSHEET A - ARITHMETIC & UNIT CONVERSION

1. Compute 13×28 by decomposing 28 into $20 + 8$.
2. Compute 52×7 by decomposing 52 into $50 + 2$.
3. Show that $4 \times 90 + 4 = 364$.
4. Convert 3 modeled years into months, weeks, days, hours, minutes, and seconds.
5. Find the number of beats in one hour at 78 bpm.
6. Find the number of beats in one 28-day month at 78 bpm.

7. Find the number of beats in one 90-day season and one transition day. Add four of each to verify the one-year total.
8. Use $78 = 80 - 2$ to calculate the beats in 100 minutes.
9. Explain why 78×45 is not the answer to the original problem.
10. Estimate the lifetime total by rounding 78 to 80 and 364 to 360. State whether the estimate should be high or low compared with the exact result.

WORK SPACE

WORKSHEET B - ALGEBRA & PROPORTIONS

Use $B = 524,160ry$, where r is bpm and y is modeled years.

1. Simplify the formula when $r = 78$.
2. Find B when $y = 10$ and $r = 78$.
3. Find B when $y = 45$ and $r = 60$.
4. A model produces 817,689,600 beats in 20 years. Solve for r .
5. At 78 bpm, how many modeled years produce 408,844,800 beats?
6. If the rate rises from 78 to 84 bpm, by what fraction and percent does the total rise?
7. If both r and y are doubled, prove algebraically that B becomes four times the original total.
8. Write a formula for total beats after m 28-day months.
9. Write a formula for total beats after w weeks.
10. Solve $B = 1,839,801,600$ for y when $r = 78$. Show every cancellation.

WORK SPACE

WORKSHEET C - GEOMETRY OF TIME

1. Draw a rectangle 45 units long and 364 units wide. State the area and interpret its units.
2. A year circle has radius 10 cm. Find its circumference in terms of π . Then find the arc length assigned to one of 52 equal weeks.
3. Find the central angle for one week, one 28-day month, one 91-day quarter, and one 90-day season.
4. What fraction and percent of a 364-day year is one 28-day month?
5. What fraction and percent is one transition day?
6. Place transition days 91, 182, 273, and 364 on a number line. What is the common difference?
7. Show why transition day k has year-day number $91k$ for $k = 1, 2, 3, 4$.
8. The graph $B(t)$ has slope 40,884,480. Explain the slope using units.

9. Factor 78 and use the factors to design at least two equal-sector pulse circles.
10. A 60-second line segment represents one minute. How far apart are idealized beats at 78 bpm? Give the spacing as a fraction of a second.

DRAWING SPACE

WORKSHEET D - HEART RATE & DATA LITERACY

Use the age-specific reference table. These questions teach comparison, not diagnosis.

1. Is 78 bpm inside the listed resting range for a person age 10 or older?
2. Is 78 bpm inside the listed range for a 1- to 2-year-old child?
3. A newborn has a measured resting pulse of 150 bpm. Is it inside the listed 70-190 interval?
4. Explain why 'inside the range' does not prove perfect health.
5. Explain why one pulse measurement cannot establish cause of death.
6. List four conditions that can temporarily change pulse rate.
7. A regular pulse counted for 30 seconds gives 39 beats. Convert to bpm.
8. An irregular pulse is suspected. Why is a full 60-second count preferable?
9. Distinguish rate from rhythm in one sentence each.
10. Write a safe response to a classmate who says, '78 bpm killed the man because the quote says so.'

SAFETY REMINDER

Classroom ranges cannot replace clinical judgment. Symptoms and persistent abnormalities deserve appropriate medical evaluation.

WORKSHEET E - CALENDAR & NUMBER PATTERNS

1. Prove that every 28-day month contains exactly four weeks.
2. If Month 1 Day 1 is a Wednesday, what weekday is Month 2 Day 1? Explain.
3. Find the month and day for year-day 91 by dividing by 28.
4. Repeat for year-days 182, 273, and 364.
5. Explain the pattern 7, 14, 21, 28 in the transition-day positions.
6. Compare 4×91 with 13×28 . What is equal, and what organizational feature differs?
7. Why does a 364-day year repeat the weekday of its first day in the next year?
8. After 45 modeled years, how many complete weeks have elapsed?
9. Find the total number of transition days in 45 modeled years.
10. Find the number of pulse beats occurring during all transition days in 45 years at 78 bpm.

CHALLENGE

If a civil solar year is approximated as 365.2422 days, estimate how many days the 364-day model falls behind after 45 years. Explain why an ancient fixed calendar would need some method of reconciliation with seasons if used indefinitely.

WORKSHEET F - VOCABULARY, HISTORY & SOURCE LITERACY

1. Define rate, duration, total, pulse, and transition day in your own words.
2. Explain the different jobs performed by 'beat' and 'times' in the quotation.
3. What does the word 'therefore' claim? Why must that claim still be tested?
4. Name two well-established facts about W. D. Fard and two biographical matters that remain disputed.
5. Explain how Nation of Islam tradition and academic history may describe Fard differently without being silently combined.
6. What role did Elijah Muhammad play after Fard left public view?
7. Explain how the Problem Book joins mathematical and interpretive study.
8. Why should the word 'uncle' be read at both a dictionary level and a source-tradition level?
9. Write a two-sentence summary distinguishing the ancient 364-day calendar from this book's 13-month model.
10. Label each as fact, assumption, calculation, interpretation, or unsupported causal claim: 78 bpm; 364 days/year; 1,839,801,600 beats; 'uncle' as collective symbol; '78 bpm killed him.'

SOURCE HABIT

Always record who produced a source, when it was produced, what kind of source it is, and which claim you are using it to support.

CHAPTER 8

COMPLETE ANSWER KEY

CHAPTER PURPOSE

Check reasoning, not merely final numbers. Equivalent correct methods are acceptable when units and assumptions are clear.

ANSWERS - WORKSHEET A

1. $13 \times 28 = 13 \times 20 + 13 \times 8 = 260 + 104 = 364$.
2. $52 \times 7 = 50 \times 7 + 2 \times 7 = 350 + 14 = 364$.
3. $4 \times 90 + 4 = 360 + 4 = 364$.
4. Three years = 39 months = 156 weeks = 1,092 days = 26,208 hours = 1,572,480 minutes = 94,348,800 seconds.
5. $78 \times 60 = 4,680$ beats/hour.
6. $78 \times 60 \times 24 \times 28 = 3,144,960$ beats/month.
7. Season: $112,320 \times 90 = 10,108,800$ beats. Transition: 112,320 beats. Four of each: $40,435,200 + 449,280 = 40,884,480$ beats/year.
8. $100 \times (80 - 2) = 8,000 - 200 = 7,800$ beats.
9. 78×45 omits the minutes contained in each year, so its units do not reduce to beats.
10. $80 \times 60 \times 24 \times 360 \times 45 = 1,866,240,000$. The rate rounding raises the estimate while the day rounding lowers it; combined, this estimate is about 26.4 million high.

A10 DIFFERENCE

$$1,866,240,000 - 1,839,801,600 = 26,438,400 \text{ beats.}$$

ANSWERS - WORKSHEET B

1. $B = 524,160(78)y = 40,884,480y$.
2. $B = 40,884,480(10) = 408,844,800 \text{ beats}$.
3. $B = 524,160(60)(45) = 1,415,232,000 \text{ beats}$.
4. $r = 817,689,600/[524,160(20)] = 817,689,600/10,483,200 = 78 \text{ bpm}$.
5. $y = 408,844,800/40,884,480 = 10 \text{ years}$.
6. Increase = $84 - 78 = 6 \text{ bpm}$. Fraction = $6/78 = 1/13$. Percent = $(1/13)100\% = \text{approximately } 7.6923\%$.
7. $B(2r, 2y) = 524,160(2r)(2y) = 4[524,160ry] = 4B$.
8. One month has 40,320 minutes, so $B = 40,320rm$. At $r = 78$, $B = 3,144,960m$.
9. One week has 10,080 minutes, so $B = 10,080rw$. At $r = 78$, $B = 786,240w$.
10. $y = 1,839,801,600/[524,160(78)] = 1,839,801,600/40,884,480 = 45$.

ALGEBRA CHECK

Substitute every solved value back into the original formula. A correct inverse solution reproduces the original total and keeps the requested unit.

ANSWERS - WORKSHEET C, 1-5

1. Area = $45 \times 364 = 16,380 \text{ day-units}$, representing 45 rows of 364 days.
2. Circumference = $2\pi(10) = 20\pi \text{ cm}$. One-week arc = $20\pi/52 = 5\pi/13 \text{ cm}$.
3. Week: $360/52 = 90/13 = \text{about } 6.923 \text{ degrees}$. Month: $360/13 = \text{about } 27.692 \text{ degrees}$. Quarter: 90 degrees. A 90-day season: $360(90/364) = \text{about } 89.011 \text{ degrees}$.
4. $28/364 = 1/13 = \text{about } 7.6923\%$.
5. $1/364 = \text{about } 0.2747\%$.

ANSWERS - WORKSHEETS C & D

Worksheet C, 6-10

6. The positions are 91, 182, 273, 364; the common difference is 91.
7. Each phase contains 90 season days plus 1 transition day, so each completed phase is 91 days. After k phases, the transition position is $91k$.
8. The slope means the model adds 40,884,480 beats for every additional 364-day year.
9. $78 = 2 \times 39 = 3 \times 26 = 6 \times 13$. Valid designs include 13 sectors with 6 dots each or 6 sectors with 13 dots each.
10. Spacing = $60/78 = 10/13 \text{ second}$, about 0.76923 second.

Worksheet D

1. Yes; 78 lies between 60 and 100. 2. No; it is below the listed 80-130 interval. This is comparison, not diagnosis. 3. Yes; 150 lies between 70 and 190.
4. Reference intervals describe populations and cannot rule out all disease, rhythm problems, symptoms, or measurement error. 5. Cause of death requires far more evidence than one rate.
6. Examples: exercise, sleep, fever, fear, pain, dehydration, medicine, fitness, or illness. Any four reasonable examples earn credit.
7. $39 \text{ beats}/30 \text{ sec} \times 60 \text{ sec}/\text{min} = 78 \text{ bpm}$. 8. A full minute captures variation and avoids doubling a short irregular sample.
9. Rate is the number of beats per time. Rhythm is the timing pattern and regularity of beats. 10. Safe response: "The arithmetic uses 78 bpm as a rate, but that number falls inside a common adult resting range. The quotation does not provide clinical evidence proving cause

of death.'

ANSWERS - WORKSHEETS E & F

Worksheet E

1. $28/7 = 4$ weeks. 2. The same weekday, because 28 is a multiple of 7. 3. $91 = 3(28) + 7$, so Month 4 Day 7. 4. $182 = 6(28) + 14$: Month 7 Day 14; $273 = 9(28) + 21$: Month 10 Day 21; $364 = 13(28)$: Month 13 Day 28.

5. Each 91-day advance equals three full months plus seven days, so the month-day remainder advances by 7. 6. Both totals equal 364; one organizes four 91-day seasons, while the other organizes thirteen 28-day months. 7. 364 is divisible by 7, so weekday position advances by zero modulo 7.

8. $45 \times 52 = 2,340$ weeks. 9. $45 \times 4 = 180$ transition days. 10. $180 \times 112,320 = 20,217,600$ beats.

Challenge: $(365.2422 - 364) \times 45 = 1.2422 \times 45 = 55.899$ days, or about 55 days 21 hours 34 minutes. A permanently fixed 364-day count would drift relative to the astronomical seasons unless reconciled by observation or an intercalation rule.

Worksheet F

1. Rate compares quantities by division; duration is elapsed time; total is accumulated quantity; pulse is an arterial pressure rhythm; transition day is one of four special days separating the 90-day seasonal blocks. 2. 'Beat' names an action/event; 'times' counts occurrences and suggests multiplication. 3. 'Therefore' claims that the next statement follows from the previous one; evidence must test that claimed connection.

4. Established: Fard founded the movement in Detroit around 1930 and left public view in 1934. Disputed: birthplace, birth year, earlier identity, and later fate. 5. Label each account's standpoint and evidence. 6. Elijah Muhammad became the major leader who expanded the movement nationally.

7. The problems combine computation with specialized historical, religious, and social language. 8. Dictionary meaning explains kinship; source context may give a collective symbolic meaning. 9. Ancient Qumran materials prominently use four 13-week seasons. This book overlays a distinct 13-month, 28-day teaching model on the same 364-day total.

10. 78 bpm = given fact within the prompt; 364 days/year = assigned assumption; $1,839,801,600$ = calculation; collective 'uncle' = historical interpretation; '78 bpm killed him' = unsupported causal claim on the evidence provided.

CHAPTER 9

SOURCES, NOTES & INDEX

CHAPTER PURPOSE

Trace the book's historical, calendrical, medical, mathematical, and linguistic foundations.

Historical and source-text references

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2. Smithsonian American Art Museum, *Glossary of Terms Associated with the Civil Rights Movement*, entry on Fard Muhammad. <https://americanart.si.edu/education/oh-freedom/resources/glossary>
3. National Museum of African American History and Culture, *Muslim Artifacts at the National Museum of African American History and Culture*. <https://nmaahc.si.edu/explore/stories/muslim-artifacts-national-museum-african-american-history-and-culture>
4. Nation of Islam, *Brief History on Origin of the Nation of Islam*. This is used as the movement's own account and is labeled accordingly. <https://noi.org/noi-history/>
5. Alam Khan Publications, *The Supreme Wisdom Lessons*, online transcription containing *The Problem Book* and Problem 1. <https://www.alamkhanpublications.com/supremewisdom/the-supreme-wisdom-lessons-w-d-fard>
6. Beynon, Erdmann D., *The Voodoo Cult Among Negro Migrants in Detroit*, *American Journal of Sociology* 43, no. 6 (1938), an early sociological account. Consulted through historical transcription and scholarly references.
7. Encyclopedia.com, *Fard, Wallace D.*, reference entry summarizing early Detroit activity and the uncertainty of biography. <https://www.encyclopedia.com/history/encyclopedias-almanacs-transcripts-and-maps/fard-wallace-d>

Calendar references

8. Leon Levy Dead Sea Scrolls Digital Library, Israel Antiquities Authority, *Scrolls Content*: the prominent calendar contains 364 days divided into four seasons of 13 weeks. https://www.deadseascrolls.org.il/learn-about-the-scrolls/scrolls-content?locale=en_US
9. Eshbal Ratzon and Jonathan Ben-Dov, *A Calendrical Scroll from Qumran*, study of 4Q324d and the 364-day calendar. University of Haifa, megillot.haifa.ac.il.
10. Cambridge University Press, *Harvard Theological Review*, research on the 364-day Qumran/Jubilees calendar, fixed weekday structure, and 4Q252. Cambridge Core, cambridge.org.

MEDICAL, MATHEMATICAL & LANGUAGE REFERENCES

Medical references

11. MedlinePlus Medical Encyclopedia, U.S. National Library of Medicine, *Pulse*. Provides the age-based resting pulse intervals used in the table.
<https://medlineplus.gov/ency/article/003399.htm>

12. American Heart Association, *Treating Arrhythmias in Children*. Notes that infant rates are higher and that older children/teens commonly rest at 60-100 bpm.
<https://www.heart.org/en/health-topics/arrhythmia/prevention--treatment-of-arrhythmia/treating-arrhythmias-in-children>

13. American Heart Association, *Tachycardia: Fast Heart Rate*. Discusses adult resting heart rate and tachycardia.
<https://www.heart.org/en/health-topics/arrhythmia/about-arrhythmia/tachycardia--fast-heart-rate>

14. UCSF Benioff Children's Hospitals, *Pulse*. Corroborates age-based pulse ranges and measurement context. <https://www.ucsfbenioffchildrens.org/medical-tests/pulse>

Mathematics and language

15. National Institute of Standards and Technology, SI unit principles: consistent units, multiplication by conversion factors, and dimensional reasoning. General reference:
<https://www.nist.gov/pml/owm/si-units>

16. Merriam-Webster Dictionary and Oxford English Dictionary were used only as general lexical cross-checks; definitions in this volume are newly written for the quotation's context.

SOURCE NOTE

Historical sources do not all agree about Fard's identity or theology. Medical ranges vary modestly by institution and clinical setting. This book states those limits rather than concealing them. Web references were checked October 1, 2026.

Mathematical audit

IDENTITY	VERIFICATION
13 x 28 = 364	month model
52 x 7 = 364	week model
4 x 90 + 4 = 364	season/transition model
78 x 60 x 24 x 364 x 45	1,839,801,600 beats
1,839,801,600 / 78	23,587,200 minutes

INDEX

TERM	WHERE TO LOOK	TERM	WHERE TO LOOK
364-day year	Calendar chapter; tables; worksheets E	Heart rate	Pulse chapter; worksheet D
Algebra	Formula reference; worksheet B	Historical uncertainty	W. D. Fard chapter
Arithmetic	Methods 1-4; worksheet A	Long multiplication	Meticulous solution
Calendar circle	Calendar and geometry chapters	Minutes	Unit table; solution
Cause and evidence	Language logic; pulse science	Nation of Islam	Historical chapter
Dimensional analysis	Method 2	Number words	Two-part number table
Elijah Muhammad	Historical article and timeline	Problem Book	Source-context chapter
Fard, W. D.	Visual dictionary; history; sources	Pulse	Visual dictionary; pulse chapter
Frequency	Seconds and beat spacing	Rate	Language map; formula table
Geometry	Time rectangle; year circle; worksheet C	Seasons	Calendar chapters
Graph	Linear graph of total beats	Transition days	Calendar model; worksheet E
Holy year	364-day historical article	Visual dictionary	Chapter 1
Units	All time units; dimensional analysis	Worksheets	Chapter 7

END OF ANSWER BOOK 1 OF 36 - VERIFIED RESULT: 1,839,801,600 BEATS