STUDENT WORKBOOK • 2026–27

Digital Information & Encoding

Unit 2 · Seven lessons · Suggested 9–11 blocks of 85 minutes

Why do photos, songs, messages, and numbers all become bits?

Explore how computers represent information, why encodings must be shared, and how storage, accuracy, and compression create design tradeoffs.

Essential questions

- How can the same bits mean different things?
- How do resolution, sampling and bit depth affect fidelity?
- When should we favor compression, accuracy or compatibility?

Unit deliverables

- ☐ Seven STRIDES lesson cycles
- ☐ Hands-on binary, text, pixel, sampling and compression labs
- ☐ Digital Encoding Studio investigation + evidence-based recommendation
- ☐ Unit reference sheet and 20-point workbook classwork submission

Student: _____ Block: _____

GUIDE

How the four learning resources connect

Your course website determines the learning sequence—even when CodeHS lists lessons in a different order.

COURSE WEBSITE: start here

Read notes, investigate models, locate today’s numbered lesson.

↓

CODEHS

Videos, encoding exercises and self-checks

AP CLASSROOM

AP Daily and Topic Questions assigned by your teacher

↓

STUDENT WORKBOOK

STRIDES → diagrams → predictions → pseudocode

↓

TEST → EXPLAIN → REVISE

Use evidence from the website simulations or CodeHS exercises.

A **What should you open first when you start lesson 2.4?**

GUIDE

Your repeatable lesson workflow

Follow the same process during every lesson. The loop is intentional.

OPEN WEBSITE LESSON + WORKBOOK PAGE

READ NOTES / WATCH ASSIGNED VIDEOS

COMPLETE STRIDES + VOCABULARY

PREDICT + DRAW + WRITE PSEUDOCODE

RUN WEBSITE LAB / CODEHS ACTIVITY

OBSERVATION MATCH PREDICTION?

NO → TRACE / REVISE / RETEST

Return to the prediction step.

YES → EXPLAIN RESULT

Finish reflection and tracker.

A **When should you check the observed output against your prediction?**

B **Why should you revisit the prediction when the result is unexpected?**

GUIDE

STRIDES: a complete Unit 2 model

Use the seven STRIDES headings as your notes structure. This example is already completed.

S · Subject	AP Computer Science Principles
T · Topic	Binary number representations
R · Rules	Each position doubles from right to left; an unsigned 8-bit value spans 0–255.
I · Illustrations	00101101 → 32 + 8 + 4 + 1 = 45
D · Definitions	Bit: one binary digit. Byte: eight bits. Encoding: rules connecting data and patterns.
E · Example	00101101 = 45_{10}. 45_{10} in 8 bits is 00101101.
S · Steps	Label powers of two, mark active bits, add weights, verify with a second method.

GUIDE

Visual models & pseudocode

Representations are rules. Models make those rules visible before any code is written.

MODEL A: PLACE VALUES

128 | 64 | 32 | 16 | 8 | 4 | 2 | 1 (8 bits)

MODEL B: INPUT → ENCODER → PAYLOAD → DECODER → OUTPUT

Encoder and decoder must agree on the format. Include needed dimensions or character encoding in metadata.

MODEL C: ANALOG → SAMPLE → QUANTIZE → STORE

Measure at times determined by the sample rate, then assign each value to one allowed digital level.

MODEL D: LOSSLESS VS. LOSSY

Lossless restores the exact original; lossy deliberately accepts some change to reduce data.

Pseudocode model: encode a bit using a threshold

```
SET weight to 128
IF remaining value ≥ weight: OUTPUT 1; subtract weight
OTHERWISE: OUTPUT 0
REPEAT using weights 64, 32, 16, 8, 4, 2, 1
```

A **What is the difference between a value and the bits used to represent it?**

GUIDE

Quality notes, predictions & reflections

These are models of the level of explanation expected—not extra questions to memorize.

WEAK → STRONG EXPLANATION

Weak: “The computer makes it binary.” Strong: “8-bit unsigned binary has 256 patterns, representing 0 to 255; the pattern 00001101 represents 13.”

WEAK → STRONG PREDICTION

Weak: “It should work.” Strong: “At 4 bits, 15 + 1 cannot fit, so a simple wraparound model will show 0000.”

WEAK → STRONG REFLECTION

Weak: “It was easy.” Strong: “My 4-bit model overflowed at 16 because I needed 5 bits; retesting at 15 confirmed the boundary.”

A
B

What two numerical pieces of evidence make a compression comparison convincing? Why must a claim about fidelity be supported by a reconstruction test?

GUIDE

Unit 2 assignment tracker

Check each resource only after you have completed it. AP Daily assignments are selected in your teacher account.

Lesson	CodeHS	AP Classroom	Workbook
2.1	8.1.1, 8.1.5; 8.2.1, 8.2.4, 8.2.6	2.1 Binary Numbers	☐ Notes ☐ Lab
2.2	8.2.7, 8.2.8; 8.5.1, 8.5.3, 8.5.4	2.1 Binary Numbers	☐ Notes ☐ Lab
2.3	8.3.1, 8.3.4, 8.3.6, 8.3.8, 8.3.9	2.1 Binary Numbers (representation)	☐ Notes ☐ Lab
2.4	8.4.1, 8.4.5, 8.4.7; 8.6.1, 8.6.6, 8.6.9	2.1 Binary Numbers (images and representation)	☐ Notes ☐ Lab
2.5	8.9.5 Analog to Digital; 8.9.6 Respond: Analog to Digital	2.1 Binary Numbers (analog and digital)	☐ Notes ☐ Lab
2.6	8.8.1, 8.8.3, 8.8.5, 8.8.7; 8.9.1, 8.9.4	2.2 Data Compression	☐ Notes ☐ Lab
2.7	8.3.8; 8.4.7; 8.6.9; 8.8.7; optional 8.11.1 after assigned lessons	2.1 and 2.2 synthesis	☐ Notes ☐ Lab

IMPORTANT ASSIGNMENT NOTE

CodeHS numbers refer to selected activities inside CodeHS Digital Information (module 8), not the order in which your website teaches them. 8.10 Cryptography belongs with the later security unit.

LESSON 2.1 • LEARN & RECORD

Binary Numbers & Place Value

Learning target: Represent unsigned whole numbers using bits and explain why computers use binary.

RESOURCE PATH

WEBSITE 2.1 | CodeHS 8.1.1, 8.1.5; 8.2.1, 8.2.4, 8.2.6 | AP 2.1 Binary Numbers

Vocabulary: define and give a specific example

bit

byte

binary

place value

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **Explain what changes between decimal place values and binary place values.**

B **Why does a computer need an agreed-upon encoding to interpret a bit pattern?**

LESSON 2.1 • VISUALIZE & PLAN

Binary Numbers & Place Value

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Convert 00101101 from unsigned binary to decimal. Show the weights you add.

A Work through the model with your own reasoning

B Diagram your thinking

Draw an 8-bit place-value strip. Label 128, 64, 32, 16, 8, 4, 2, 1 and shade the 1-bits for 45.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.1 • APPLY & REFLECT

Binary Numbers & Place Value

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Use the website Binary Explorer and CodeHS Binary Game. Try 13, 45 and 127; record a prediction before checking.

A Predict then test

For bits 00010110, calculate the decimal value and predict its binary value after adding 1.

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Explain the largest unsigned value representable with 5 bits without writing all 32 possible patterns.

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.2 • LEARN & RECORD

Capacity, Overflow & Hexadecimal

Learning target: Predict fixed-width overflow and translate among binary, decimal, and hexadecimal.

RESOURCE PATH

WEBSITE 2.2 | CodeHS 8.2.7, 8.2.8; 8.5.1, 8.5.3, 8.5.4 | AP 2.1 Binary Numbers

Vocabulary: define and give a specific example

overflow

hexadecimal

nibble

capacity

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **What is the maximum value in an unsigned 6-bit system? Explain.**

B **Why is hexadecimal a convenient shorthand for a long binary pattern?**

LESSON 2.2 • VISUALIZE & PLAN

Capacity, Overflow & Hexadecimal

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Convert hex 3A to 8-bit binary and decimal, then explain what 1111 + 1 means in a fixed 4-bit unsigned register.

A Work through the model with your own reasoning

B Diagram your thinking

Draw two groups of four bits for 3A. Use a carry arrow to illustrate 4-bit overflow.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.2 • APPLY & REFLECT

Capacity, Overflow & Hexadecimal

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Set Bit Explorer to 4 bits and test 14, 15, 16; then use CodeHS Overflow Error and Binary to Hex Game.

A Predict then test

Predict 4-bit outcomes of 14+1 and 15+1 under unsigned wraparound.

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

How many different patterns can 10 bits store? Does that automatically mean signed numbers 0..1023?

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.3 • LEARN & RECORD

Encoding Text & Unicode

Learning target: Encode characters as bits and distinguish ASCII, Unicode code points, and UTF-8 bytes.

RESOURCE PATH

WEBSITE 2.3 | CodeHS 8.3.1, 8.3.4, 8.3.6, 8.3.8, 8.3.9 | AP 2.1 Binary Numbers (representation)

Vocabulary: define and give a specific example

character

ASCII

Unicode

UTF-8

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **Why can the bits 01000001 represent A in one context and 65 in another?**

B **Why is it inaccurate to say every Unicode character takes eight bits?**

LESSON 2.3 • VISUALIZE & PLAN

Encoding Text & Unicode

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Encode CAB using 8-bit ASCII-compatible bytes. Use the values C=67, A=65, B=66.

A Work through the model with your own reasoning

B Diagram your thinking

Draw a three-column message packet with character, decimal code and 8-bit representation for CAB.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.3 • APPLY & REFLECT

Encoding Text & Unicode

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Compare the byte lengths of "DATA", "café", and "□" in the Text Encoder. Record one surprise and explain it.

A Predict then test

How many UTF-8 bytes are in A, é and □ individually? Use the website encoder.

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Describe why a decoder also needs to know which encoding was used.

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.4 • LEARN & RECORD

Pixels, RGB & Image Resolution

Learning target: Explain raster images and estimate raw storage for images with different dimensions and color depths.

RESOURCE PATH

WEBSITE 2.4 | CodeHS 8.4.1, 8.4.5, 8.4.7; 8.6.1, 8.6.6, 8.6.9 | AP 2.1 Binary Numbers (images and representation)

Vocabulary: define and give a specific example

pixel

resolution

color depth

RGB

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **What information is lost when a 16×16 image is reduced to 4×4 pixels?**

B **Why can an RGB color be represented by three 0..255 values?**

LESSON 2.4 • VISUALIZE & PLAN

Pixels, RGB & Image Resolution

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Estimate the raw bits and bytes for an 8×8 image at 24 bits/pixel (ignore headers).

A Work through the model with your own reasoning

B Diagram your thinking

Color a 4×4 pixel grid with three colors; label sample RGB triples and one 24-bit raw pixel.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.4 • APPLY & REFLECT

Pixels, RGB & Image Resolution

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Create a pattern in the Pixel Lab, change the RGB sliders and record a raw file-size prediction.

A Predict then test

Compare raw storage for 8×8 1-bit monochrome and 8×8 24-bit RGB.

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Describe how doubling both image dimensions changes the number of pixels.

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.5 • LEARN & RECORD

Sampling Analog Information

Learning target: Model sampling and quantization, and explain how choices affect precision and storage.

RESOURCE PATH

WEBSITE 2.5 | CodeHS 8.9.5 Analog to Digital; 8.9.6 Respond: Analog to Digital | AP 2.1 Binary Numbers (analog and digital)

Vocabulary: define and give a specific example

analog

sample

sampling rate

quantization

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **How is sampling rate different from the number of bits per sample?**

B **Why might a small sampling rate miss rapid changes?**

LESSON 2.5 • VISUALIZE & PLAN

Sampling Analog Information

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Estimate raw mono audio size at 8000 samples/s, 8 bits/sample, for 3 seconds.

A Work through the model with your own reasoning

B Diagram your thinking

Sketch one continuous wave and two sets of sample points, one sparse and one dense.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.5 • APPLY & REFLECT

Sampling Analog Information

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Use Sampling Lab at 4, 12 and 32 samples/cycle, and 2, 3, 5 quantization bits; predict which reconstruction is closer.

A Predict then test

At 1000 samples/s and 8 bits/sample, how many bytes are stored in 2 seconds (mono, raw)?

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Why might raising bit depth not solve an undersampling problem?

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.6 • LEARN & RECORD

Lossless & Lossy Compression

Learning target: Compare lossless and lossy approaches using file-size calculations and reconstruction tests.

RESOURCE PATH

WEBSITE 2.6 | CodeHS 8.8.1, 8.8.3, 8.8.5, 8.8.7; 8.9.1, 8.9.4 | AP 2.2 Data Compression

Vocabulary: define and give a specific example

compression

lossless

lossy

run-length encoding

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **Which method is appropriate for a text document that must be recovered exactly? Why?**

B **Why is it impossible to know which method is smaller without considering the data?**

LESSON 2.6 • VISUALIZE & PLAN

Lossless & Lossy Compression

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

Encode AAAAAABBBCC with count-symbol RLE and compare the number of characters.

A Work through the model with your own reasoning

B Diagram your thinking

Draw a before/after run diagram for AAABBBBBCCCC. Label run count, original length and encoded length.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.6 • APPLY & REFLECT

Lossless & Lossy Compression

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Try two messages in RLE Studio, then compare lossless restoration to a deliberately reduced-resolution pixel image.

A Predict then test

Encode ABABAB with count-symbol RLE. Does this example compress?

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Give one real-world case where a loss of fine detail is acceptable and one where it is not.

D Reflection

What assumption changed after testing? What result convinced you?

LESSON 2.7 • LEARN & RECORD

Digital Encoding Studio: Design Challenge

Learning target: Choose and justify a representation given a data type, storage budget, and quality requirement.

RESOURCE PATH

WEBSITE 2.7 | CodeHS 8.3.8; 8.4.7; 8.6.9; 8.8.7; optional 8.11.1 after assigned lessons | AP 2.1 and 2.2 synthesis

Vocabulary: define and give a specific example

constraint

tradeoff

metadata

fidelity

Rules and big ideas from your videos

1.

2.

Conceptual understanding

A **Why must a receiver know the dimensions and encoding of an image?**

B **Which evidence is needed to defend a compression decision?**

LESSON 2.7 • VISUALIZE & PLAN

Digital Encoding Studio: Design Challenge

Draw and predict before testing. You may use a flowchart, table, or labeled diagram.

MODELED PROBLEM

A 4×4 black/white icon must be transmitted. Compare raw 1-bit pixels with a defined RLE format; explain what you would send.

A Work through the model with your own reasoning

B Diagram your thinking

Draw an encoder → packet + metadata → decoder diagram. Label exactly where bits are interpreted.

C Write pseudocode for the related algorithm

ALGORITHM • INPUT / PROCESS / OUTPUT

LESSON 2.7 • APPLY & REFLECT

Digital Encoding Studio: Design Challenge

Use the assigned website experiment and CodeHS activities to verify and explain your predictions.

INVESTIGATION INSTRUCTIONS

Complete the Unit 2 Digital Encoding Studio and compare your final choices against a hard size budget.

A Predict then test

A 4×4 1-bit icon is sent as raw bits. How many bits are data? Why may a real file require more bytes?

PREDICTED RESULT → OBSERVED RESULT

B Evidence table

Test / input	Predicted	Observed	Explanation

C Reason beyond this activity

Explain why the smallest possible payload may not be the best solution.

D Reflection

What assumption changed after testing? What result convinced you?

PROJECT • PAGE 1 / 4

Digital Encoding Studio: design brief

Your goal is to deliver data reliably while controlling size and preserving the needed information.

SCENARIO

A science field station must send small images and short text status messages across a slow data link. Your team will compare alternative representations and recommend an encoding scheme.

Constraints to use in your model

- Image: one 8×8 black-and-white icon.
- Text: one eight-character ASCII-only status code of your choice.
- Payload budget: at most 10 bytes (80 bits), excluding metadata and transport headers.
- Lossless recovery is required for the status code; document whether the icon is lossless.

A Establish a baseline

1 **How many raw data bits does the 8×8 1-bit icon need?**

2 **How many bytes are required for eight ASCII characters in UTF-8?**

3 **Do the two uncompressed payloads fit together into 10 bytes?**

PROJECT • PAGE 2 / 4

Design the data representation

Invent your 8×8 icon. Try a run-length encoding and define every aspect of your format.

A Sketch the icon (black = 1, white = 0)

B Define your encoding and a decoder

Choose a count-symbol format, define the pixel order, and explain how the receiver knows where each row starts.

ENCODER → PACKET + METADATA → DECODER

PROJECT • PAGE 3 / 4

Evaluate file size and fidelity

Use the website compression and pixel investigations to test your representation.

A Record your results

Design	Payload size (bits)	Reconstruct exactly?	Why / evidence

B The metadata question

1 **What information must your decoder know to reconstruct the picture?**

2 **If your compressed image exceeds 2 bytes, can the combined transmission meet the 10-byte payload budget?**

PROJECT • PAGE 4 / 4

Recommendation and reflection

Write a defensible recommendation. It is acceptable to conclude that your design cannot meet every constraint.

A Engineering claim, evidence and reasoning

CLAIM — State the encoding approach you recommend, including whether it meets the 10-byte payload budget.

EVIDENCE — State your measured bit counts and whether the decoded data matched the original.

REASONING — Explain what the evidence demonstrates about exact reconstruction, overhead and tradeoffs.

UNIT REVIEW • 1 / 4

Vocabulary, representations & meaning

Do this without looking at the notes; then check the STRIDES pages you need to revisit.

1 **Explain the difference between a bit, byte, and encoding.**

2 **What is the greatest unsigned value in 7 bits?**

3 **Why can UTF-8 text use more than one byte per character?**

4 **What is the difference between pixels and samples?**

5 **What does lossless compression guarantee?**

UNIT REVIEW • 2 / 4

Quantitative reasoning & tracing

Show your computation and label units (bits, bytes, pixels, samples).

1 **Convert unsigned binary 101101 to decimal.**

2 **What is the unsigned 8-bit binary representation of decimal 19?**

3 **A 12×10 image has 8 bits per pixel. How many raw bytes?**

4 **Mono audio: 2000 samples/s, 8 bits/sample, 5 s. Raw bytes?**

5 **What happens to 1111 + 1 in fixed-width 4-bit unsigned wraparound?**

UNIT REVIEW • 3 / 4

Independent algorithm & data diagram

Transfer the ideas to a new message rather than copying the Unit 2 project.

DESIGN CHALLENGE

A weather station logs temperature samples once per second for 60 seconds. Each stored sample uses 12 bits. Design a record, calculate raw data size, and explain what metadata a decoder needs.

A **Calculate the raw sample data size in bits and bytes.**

B Draw a data pipeline: SENSOR → SAMPLE → QUANTIZE → STORE → DECODE

C Write pseudocode for the encoding process

PSEUDOCODE

UNIT REVIEW • 4 / 4

My Unit 2 reference sheet + submission

Build a one-page study resource you can use when the AP exam revisits representation and compression.

Five rules I want to remember

BINARY / TEXT / IMAGES / SAMPLING / COMPRESSION

My most useful model or flowchart

One AP-style comparison I can now explain

☐ **Seven lessons** ☐ **Five website labs** ☐ **CodeHS activities** ☐ **Project** ☐ **Review** ☐ **Ready to submit**

Suggested classwork grade (20): vocabulary/video notes 4; conceptual/STRIDES 4; diagrams/pseudocode 4; lab evidence 4; review/reflection 4.