

# Draft Lesson Plan

## Tentative Outline 4th-6th Grades

### 1. Welcome to the Depot (at plaque outside ticket office)

- A. Discussion as to what the depot consisted of in 1863 and where it was originally located. Architectural awareness of construction and construction materials.
- B. Discussion of SBHRS volunteer labor that renovated the depot for the betterment of the community.

### 2. Safety about railroad property (move to east dock)

- A. Not a playground—climbing on railroad cars
- B. Laws concerning trespass, vandalism, train wrecking, etc.
- C. Playing on tracks—train mass and stopping distance
- D. Remote control switches. All electric switches in this area are controlled in San Jose or Denver. Dangerous to be around.
- E. Slippery rails—employee fired for stepping on rail

### 3. Move to inside the Depot

- A. Five to ten minute “free” period to look at the content of the display cases.
- B. Setting the time period of the depot construction
  - 1. Who was the president of the U.S. in 1863?
  - 2. What event was taking place in American History
  - 3. First train from San Francisco to San Jose 1864
  - 4. State of transportation in California prior to the operation of the railroad. Influence of the College of Santa Clara on the depot. (Politics)

### 4. Discussion of the railroad on the community

- A. Center of commerce—Freight and passenger movement
  - Individual personal freedom as never before.
- B. Telegraph center
- C. Mail and parcel distribution—Speed of service
  - Idea of Sears and Roebuck
- D. Efficiency in transportation. Time of travel; rates; damage free
- E. Largest employer in America
  - 80,000 people employed by SP in 1900; today 18,000

## **5. Demonstration of lanterns and other RR signaling devices**

- A. Lighting of signals before battery electricity
- B. Progression of patents in making the lantern and lamps more efficient and/or less costly to produce.
- C. Physics of lenses
- D. Trimming wicks/physics of fire off a wick. Flat and round wick and its advantages and drawbacks

## **6. Standard time concept**

- A. Origin of time zones in the U.S. (Railroad in 1883)
- B. Math involving rate of apparent movement of the sun on the earth's surface. Concept of "High Noon" as to railroad and city time (see example [A1a](#))
- C. Conflicts as to railroad time with competing railroads (see example [A1b](#))
- D. Use of railroad telegraph to "Standardize time". Math using speed of electricity concept. (see examples [A2a](#) and [A2b](#))

## **7. Demonstration as to weights of rails and tool usage**

- A. Manual labor that entails early railroad work—velocipede
- B. Standard 39 foot rail. Rail weights per yard
  - Using math to compute rail weight for a 10 man track laying team (see example [A3a](#))
- C. Use of machines today (see example [A3b](#))
- D. Gross weight and tare weight concept. Math using "tons" as used in today's railroading (see examples [A4a](#) and [A4b](#))

## **8. Demonstration of signal mechanism**

- A. Simple electrical concepts: use of + and - currents to change magnetic poles
- B. Lens use and magnification with low voltages

## **9. Discussion of technological and political events that have taken place since the depot was built**

- A. Make a time line involving the transcontinental railroad, radio, women's vote, Arizona, California, and New Mexico Statehood, Custer's "last stand," telephone, automobile, airplane, electricity, TV, manned space travel, atomic energy, computers, flying at the speed of sound, etc.

## **10. Discussion of railroads in the 21st Century**

- A. Passenger uses/public money for support
- B. Bulk freight—coal, autos, lumber, grain, minerals
- C. Container transport —Pacific Rim concept

**11. Future uses of the Santa Clara Depot**

- A. Ticket machines and elimination of agent
- B. Transportation hub—train, bus, BART
- C. Learning center—museum district

**12. Westinghouse air brake**

- A. Concept of brake
- B. Contribution to modern train movement
- C. Brakeman's duties prior to this invention

**13. Discussion of the railroad paper display**

- A. Old way bills
- B. Old tickets
- C. Old maps

These items give an insight as to the way things were

**14. Questions and review of the session so far**

**15. Santa Clara Control tower tour**

- A. Use of the tower in railroad operation
- B. Tower interlocking machine as an example of the early computer.
- C. Communication with train crews, other towers, and depots
- D. Timetable usage
- E. Rail safety looking over yard

The Appendix contains examples that the students can work as part of the field trip. These examples can be done at the depot or in class afterwards. The students should bring paper, pencil, and calculators if the examples will be completed at the depot so they may take down the necessary information. This should be an excellent learning experience for the students.

**Teachers' Guide**

You might want to make assignments from the following list of ideas concerning this field trip.

- A. What a railroad depot meant to a community 100 years ago.
- B. Life in the Santa Clara Valley before the coming of the railroad.
- C. The importance of a switch tower in the operation of a railroad.
- D. Write a fictionalized story of someone who took a trip with one of the tickets that were on display. Where they went, what they saw, methods of transportation, etc.

# Appendix

This appendix contains some examples the students can work as basic math problems when appropriate.

## A1a. Sun's apparent rate of travel

The concept of standard time (Pacific Standard Time—PST, Eastern Standard Time—EST, or even Pacific Daylight Time—PDT) is fairly modern. The concept of “High Noon” was used to identify midday in the olden days. This was OK when the coordination of time from one place to the next was not important. The railroads used the telegraph which allowed people to communicate almost instantly with each other. Once the telegraph was in common use, midday at one place was not the same as at another further east or west. Do you know why is this true?

The earth rotates on its axis a full rotation once every 24 hours. This makes the sun appear to move relative to a person standing in one place on the earth's surface. The sun's light moves from the east to the west producing apparent motion. How do we calculate the speed of this motion?

24 hours	length of day
24,000 miles	approximate distance around earth

r	rate
t	time
d	distance

$$d = r \times t$$

$$r = \frac{d}{t}$$

$$1,000 \text{ miles per hour} = \frac{24,000 \text{ miles}}{24 \text{ hours}} \quad \text{apparent speed of sun across earth}$$

which is also

$$16.66 \text{ miles per minute} = \frac{1,000 \text{ miles per hour}}{60 \text{ minutes per hour}}$$

or,

0.06 minute per mile (which equates to 3.6 seconds per mile—do you know how to convert miles per minute to minutes per mile?)

### A1b. Problem Using Time Differences

Two competing railroad companies have their division headquarters 150 miles apart. The division headquarters for railroad A is due east of division headquarters for railroad B. The tracks of the two railroads cross at a town half way between the two headquarters. Each railroad uses its own standard for time. What problems arise when coordinating rail traffic that crosses the other company's rail line at the town half way between the two headquarters? What is the apparent time difference between the two headquarters based on using the sun's apparent position?

Ans. If the two railroads use a different time standard, a train wreck could occur if two trains arrived at the crossing at the same time thinking that they had plenty of time to spare.

Calculate the time difference by the following method:

$$\text{time difference} = \frac{\text{distance}}{\text{rate}}$$

$$9 \text{ minutes} = \frac{150 \text{ miles}}{16.66 \text{ miles per minute}}$$

high noon happens 9 minutes later in railroad B's headquarters than for railroad A.

## A2a. Speed of electricity

We can send information by foot, horse, boat, car, train, airplane, or by electronic means (this includes telegraph, telephone, radio, and television). The information will get to the person who wants it at different times depending on the method of transmission. Sending information by foot is relatively slow while sending it by electronic means is very fast. Even electronic transmissions are not received instantly. Do you know the relative speed of each method? How fast does it take to go 50 miles by foot, horse, boat, airplane, and electronically?

$$d = r \times t$$

$$t = \frac{d}{r}$$

<b>Method</b>	<b>Speed</b>	<b>Time</b>
Foot	13 miles per day	3.8 days
Horse	25 miles per day	2 days
Boat	30 miles per hour	1.67 hours
Car	55 miles per hour	54.5 minutes
Train	70 miles per hour	42.8 minutes
Airplane	600 miles per hour	5 minutes
Electronic	186,000 miles per second	.00027 seconds (270 microseconds)

## A2b. Speed of electricity (calculation)

The speed of light and the speed of electricity (as in a telegraph wire) are nearly the same. How many times can electrical signal go around the earth in one second? This can be broken down into two problems. First calculate how far the electrical signal will travel in one second.

$$d = r \times t$$

$$d_{traveled} = 186,000 \text{ miles per second} \times 1 \text{ second}$$

$$d_{traveled} = 186,000 \text{ miles}$$

Now the second part, how many times is that around the earth?

$$\text{number of times} = \frac{\text{distance traveled}}{\text{distance around the earth}}$$

$$\text{number of times} = \frac{186,000 \text{ miles}}{24,000 \text{ miles}}$$

$$\text{number of times} = 7.75 \text{ times}$$

The average distance to the moon is 240,000 miles. How long does it take light or radio waves to go to the moon and back to earth? It takes 2.58 seconds. How about to the sun and back if the average distance to the sun is 93,000,000 miles? It takes 1000 seconds or 16.67 minutes. While light and radio waves are very fast, they still take time to go long distances.

### A3a. Rail weights

The railroads used different “weights” of rail for different purposes and as they modernized. The weight of rail is an important consideration to the planning of all rail lines. Examples of rail weights are 60-pound rail, 100-pound rail, or 136 pound rail. This meant that a yard (3 feet) of rail weighed 60, 100, or 136 pounds. Rail originally came in lengths of 39 feet (13 yards). How much did a section of 60-pound rail weigh?

$$\text{weight of 60-lb rail section} = 13 \text{ yards} \times 60 \text{ pounds per yard}$$

$$\text{weight of section} = 780 \text{ pounds}$$

If a crew of 10 people lift the section into place, how much weight must each of them lift? What if only 8 people lifted it into place?

$$\text{weight per person} = \frac{780 \text{ pounds}}{10 \text{ people}}$$

$$\text{weight per person} = 78 \text{ pounds per person for 10 people}$$

$$\text{weight per person} = \frac{780 \text{ pounds}}{8 \text{ people}}$$

$$\text{weight per person} = 97.5 \text{ pounds per person for 8 people}$$

### A3b. Rail weights (continued)

Modern railroads need the trains to carry more weight. To do this, the rail needs to be sturdier which also means that it weighs more. Make the same calculations using 136-pound rail for 10 people and 15 people lifting a section of rail.

$$\text{weight of section} = 13 \text{ yards} \times 136 \text{ pounds per yard}$$

$$\text{weight of section} = 1,768 \text{ pounds}$$

$$\text{weight per person} = \frac{1,768 \text{ pounds}}{10 \text{ people}}$$

$$\text{weight per person} = 176.8 \text{ pounds per person for 10 people}$$

$$\text{weight per person} = \frac{1,768 \text{ pounds}}{15 \text{ people}}$$

$$\text{weight per person} = 117.86 \text{ pounds per person for 15 people}$$

How many people does it take so each one doesn't lift any more than 50 pounds for 136-pound rail?

$$\text{weight per person} = \frac{\text{total weight}}{\text{number of people}}$$

$$\text{number of people} = \frac{\text{total weight}}{\text{weight per person}}$$

$$\text{number of people} = \frac{1,768 \text{ pounds}}{50 \text{ pounds}}$$

$$\text{number of people} = 35.36, \text{ or rather, } 36 \text{ people}$$

Can you guess why railroads are using machines to lay rail now?

## A4a. Weights

On a railroad, large and heavy items are moved. Goods and materials moved by a railroad are usually measured by their weight. Tonnage is a common term used for shipping, but what is a ton? A ton is 2,000 pounds. The locomotive at the front of a very long train must pull all the goods and material that follow, but that is not all. The locomotive must pull the weight of the freight cars also. All of this pulling costs the railroad money for fuel. You need to know how to calculate all the parts of the puzzle that make up the equation for pulling power when you want to ship material by rail. We can make some simple calculations just for starters. First, some definitions.

*Tare weight* (the railroads refer to this as light weight) is the empty weight of a container.

*Gross weight* is the weight of the container plus the material it carries.

*Load limit* is the maximum weight of the container plus the material it carries.

What is the weight of 100 tons in pounds? 200,000 pounds (100 tons x 2,000 pounds per ton)

### A4b. Weights (continued)

Here are some examples from freight cars found in the Santa Clara yard.

	Tank Car	Box Car	Hopper Car
Load Limit	189,000 lbs	148,000 lbs	208,000 lbs
Light Weight	73,000 lbs	72,000 lbs	55,000 lbs

Now, say we have a rock train that leaves the Santa Clara yard with 50 hopper cars loaded with rocks. Each hopper car weighs 100 tons gross weight. How many tons of rock does each car carry? Does it meet the load limit?

$$\text{rock weight} = \text{gross weight} - \text{light weight}$$

$$\text{gross weight} = 100 \text{ tons}$$

$$\text{light weight} = \frac{55,000 \text{ pounds}}{2,000 \text{ pounds per ton}} \quad (\text{convert to tons})$$

$$\text{light weight} = 27.5 \text{ tons}$$

$$\text{rock weight} = 100 \text{ tons} - 27.5 \text{ tons} = 72.5 \text{ tons of rock per car}$$

Yes it does meet the load limit (100 tons x 2,000 lbs per ton = 200,000 lbs which is less than the 208,000 pounds for the load limit)

Each locomotive can pull 750 tons over the intended route. How many locomotives will it take to pull our train?

$$\text{total weight of train} = \text{number of cars} \times \text{weight per car}$$

$$\text{total weight of train} = 50 \text{ cars} \times 100 \text{ tons}$$

$$\text{total weight of train} = 5,000 \text{ tons}$$

$$\text{number of locomotives} = \frac{\text{train weight}}{\text{pulling weight per locomotive}}$$

$$= \frac{5,000 \text{ tons}}{750 \text{ tons per locomotive}}$$

$$\text{number of locomotives} = 6.67 \text{ thus we need } 7 \text{ locomotives (rounding up)}$$