Dental Technology (51.0601)   T-Chart

Calculate exposure time when using digital radiography	=	Use units as a way to understand & solve problems

Program Task: Calculate exposure time.

PA Core Standard: CC.2.1.HS.F.4

Description: Use units as a way to understand problems and to guide the solution of multi-step problems.

Program Associated Vocabulary:
kVp, mA, EXPOSURE TIME, IMPULSES

Math Associated Vocabulary:
RATE, DECIMAL, RATIO, DIMENSIONAL/UNIT ANALYSIS

Program Formulas and Procedures:
Digital radiography requires 50-80% LESS x-radiation than conventional radiography. This means less exposure to the patient. For example, the typical exposure time required to produce an image for digital radiography is 3 impulses compared to 12 impulses for traditional radiography.

Exposure time refers to the amount of time required to produce the x-ray. Exposure time is measured in impulses because x-rays are produced in bursts rather than in a continuous stream. One impulse occurs every 1/60 of a second. Therefore, 60 impulses occur in one second.

Example: Let's figure out how many seconds a patient will be exposed for the same type of picture. Two patients get a dental x-ray. The one uses digital and the second uses traditional radiography. Which person suffers the most exposure in 1 second?

Patient 1: Digital

Convert 3 impulses to seconds:

$$\frac{3\,\text{impulses}}{1} \text{ x } \frac{1\,\text{sec.}}{60\,\text{impulses}} = 0.05\,\text{seconds}$$

Patient 2: Traditional

Convert 12 impulses to seconds:

$$\frac{12\,\text{impulses}}{1} \text{ x } \frac{1\,\text{sec.}}{60\,\text{impulses}} = 0.2\,\text{seconds}$$

Patient 1 only has 0.05 seconds of exposure, while patient 2 has .2 seconds of exposure.

This can be significant over the course of the patient's lifetime, since dental x-rays are given on a regular basis.

Formulas and Procedures:
Dimensional or Unit Analysis can be used to solve problems using operations because by analyzing the units, one can determine whether or not the equation was set up correctly.

Basic Steps:
1.   Determine the unit given and the unit needed (answer).

2.   Write the number with the unit you are given as a fraction over one on the left hand side and write an equal sign followed by the unit you need on the far right hand side.

3.   Multiply by the rates you are given or conversion factors (write as fractions), making sure that the unit that was given in the numerator is also on the bottom (denominator) of the given rate or conversion factor.

4.   Remember, units cancel out just like numbers do! Continue to multiply by rates or conversion factors until the unit needed is the only unit that does not cancel.

5.   Perform the indicated operations.

Example: A snail can crawl 13 feet in 2.5 hours. How far can it crawl in 240 minutes**?**

1.   unit given = 240 minutes, unit needed = feet

2. $\dfrac{240\,\text{min.}}{1} = \text{feet}$

3. $\dfrac{240\,\text{min.}}{1} \text{ x } \dfrac{1\,\text{hr.}}{60\,\text{min.}} \text{ x } \dfrac{13\,\text{ft.}}{2.5\,\text{hrs.}} = \text{feet}$

4. $\dfrac{240\,\cancel{\text{min.}}}{1} \text{ x } \dfrac{1\,\cancel{\text{hr.}}}{60\,\cancel{\text{min.}}} \text{ x } \dfrac{13\,\text{ft.}}{2.5\,\cancel{\text{hrs.}}} = \text{feet}$

5. $\dfrac{240(1)(13)\text{ft.}}{(1)(60)(2.5)} = 20.8\text{ft.}$

Instructor's Script - Comparing and Contrasting

There are many opportunities in the dental field to convert between measurement units. The eligible content item appears to be similar to CC.2.1.HS.F.3 but there is a slight difference. Although this eligible content item can include proportional relationships, because the ratio itself is often a "rate", this eligible content item includes any operation using a rate or multiple rates and is often more complex.

Common Mistakes Made By Students

Use of incorrect conversion factors or omission of essential conversion factors

For instance, in the problem shown below, a conversion factor (60 minutes = 1 hour) was omitted from the solution.

What is 60 miles per hour in feet per second?

$$\frac{60 \text{ miles}}{1 \text{ hour}} \text{ x } \frac{5280 \text{ feet}}{1 \text{ mile}} \text{ x } \frac{1 \text{ minute}}{60 \text{ seconds}}$$

Incorrectly setting up the problem

For instance, in the problem shown below, the problem has been set up incorrectly. Instead of starting with the 60 miles per hour, the solution begins with the conversion factor.

What is 60 miles per hour in feet per second?

$$\frac{1 \text{ mile}}{5280 \text{ feet}} \text{ x } \frac{1 \text{ hour}}{60 \text{ miles}} \text{ x } \frac{60 \text{ minutes}}{1 \text{ hour}} \text{ x } \frac{60 \text{ seconds}}{1 \text{ minute}} = \frac{1}{88} \text{ feet}$$

CTE Instructor's Extended Discussion

It is very important for dental technicians, dentists, and any medical professions to understand the concept of exposure and radiation. Not only dental, but medical offices use this equipment also. Many patients are exposed to radiation through tests. Some examples are dental x-rays and mammograms. These two specific tests are done on a regular basis; therefore, exposure becomes important.

The other difference is that digital pictures can be stored on computer and are easily read. Dentists and doctors can see minute details better with digital pictures. That reduces the chance of error or a required "re-do". Dental professionals are also required to use hazardous chemicals to develop traditional x-rays.

	Problems Occupational (Contextual) Math Concepts Solutions
1.	Using digital radiography, how many impulses occur in 1.25 seconds?
2.	Calculate the time in seconds that would be equivalent to 18 impulses using digital radiology?
3.	How many impulses occur in .75 seconds using digital radiology?

	Problems Related, Generic Math Concepts Solutions
4.	One milliliter of ink can print 50 pages of text. If you have 10 gallons, how many pages can you print? (1 gallon = 3.79 L)
5.	Sandy is traveling at 97 km. on 102 minutes. What is her speed in miles per hour if 1 mile = 1.6 km.?
6.	A worker unloads 9 crates every 36 minutes and is paid $2 per crate. How much money does he make in an 8 hour shift?

	Problems PA Core Math Look Solutions
7.	Kathy and John are helping to create party favors for the school dance. Kathy can create 30 in one hour and John can create 40 in two hours. At that rate, how long will it take to create 500 party favors?
8.	Two trucks are plowing snow and moving in opposite directions. The first truck can plow snow at 23 mph and the other can plow at 17 mph. How long will it take them to plow 200 miles of road?
9.	A car can gets 35 miles per gallon of gas. If the cost of gas is $3.97 per gallon, how much will it cost to make a 485 mile trip?

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Problems	Occupational (Contextual) Math Concepts	Solutions
1. How many impulses occur in 1.25 seconds?		$\dfrac{1.25\,\text{sec.}}{1} \times \dfrac{60\,\text{impulses}}{1\,\text{sec.}} = 75\,\text{impulses}$
2. Calculate the time in seconds that would be equivalent to 18 impulses?		$\dfrac{18\,\text{impulses}}{1} \times \dfrac{1\,\text{sec.}}{60\,\text{impulses}} = 0.3\,\text{seconds}$
3. How many impulses occur in .75 seconds?		$\dfrac{0.75\,\text{sec.}}{1} \times \dfrac{60\,\text{impulses}}{1\,\text{sec.}} = 45\,\text{impulses}$

Problems	Related, Generic Math Concepts	Solutions
4. One milliliter of ink can print 50 pages of text. If you have 10 gallons, how many pages can you print? (1 gallon = 3.79 L)		$\dfrac{10\,\text{gallons}}{1} \times \dfrac{3.79\,\text{liters}}{1\,\text{gallon}} \times \dfrac{1000\,\text{ml.}}{1\,\text{liter}} \times \dfrac{50\,\text{pages}}{1\,\text{ml.}} =$ 1,895,000 pages
5. Sandy is traveling at 97 km on 102 minutes. What is her speed in miles per hour if 1 mile = 1.6 km?		$\dfrac{97\,\text{km.}}{102\,\text{min.}} \times \dfrac{1\,\text{mile}}{1.6\,\text{km.}} \times \dfrac{60\,\text{min.}}{1\,\text{hr.}} = 35\,\text{miles per hour}$
6. A worker unloads 9 crates every 36 minutes and is paid \$2 per crate. How much money does he make in an 8 hour shift?		$\dfrac{8\,\text{hrs.}}{1} \times \dfrac{60\,\text{min.}}{1\,\text{hr.}} \times \dfrac{9\,\text{crates}}{36\,\text{min.}} \times \dfrac{\$2}{1\,\text{crate}} = \$240$

Problems	PA Core Math Look	Solutions
7. Kathy and John are helping to create party favors for the school dance. Kathy can create 30 in one hour and John can create 40 in two hours. At that rate, how long will it take to create 500 party favors?		$\dfrac{40\,\text{pf}}{2\,\text{hr.}} = \dfrac{20\,\text{pf}}{1\,\text{hr.}}$ total rate $= \dfrac{20\,\text{pf}}{1\,\text{hr.}} + \dfrac{30\,\text{pf}}{1\,\text{hr.}} = \dfrac{50\,\text{pf}}{1\,\text{hr.}}$ $\dfrac{500\,\text{pf}}{1} \times \dfrac{1\,\text{hr.}}{50\,\text{pf}} = 10\,\text{hrs.}$
8. Two trucks are plowing snow and moving in opposite directions. The first truck can plow snow at 23 mph and the other can plow at 17 mph. How long will it take them to plow 200 miles of road?		Rate 1 + rate 2 = 23mph + 17mph = 40 mph $\dfrac{200\,\text{miles}}{1} \times \dfrac{1\,\text{hour}}{40\,\text{miles}} = 5\,\text{hours}$
9. A car gets 35 miles per gallon of gas. If the cost of gas is \$3.97 per gallon, how much will it cost to make a 485 mile trip?		$\dfrac{485\,\text{miles}}{1} \times \dfrac{1\,\text{gallon}}{35\,\text{miles}} \times \dfrac{\$3.97}{1\,\text{gallon}} = \$55.01$