

## DISTANCE, RATE AND TIME



Students will gain a basic understanding of math applications used in flight to include calculating distance, rate and time. Students will solve a series of problems using this information.

## LESSON PLAN

#### **Lesson Objectives**

The students will:

- Be introduced to formulas used in flight related to speed, distance, range and aircraft performance.
- Learn to calculate distances using rate and time.

#### Goal

In this lesson, students will gain an understanding of common calculations performed by flight personnel.

#### Distance, Rate and Time

In flight applications, distance is usually measured in miles. Rate or speed is usually measured in knots (nautical miles per hour.) Time is usually measured in hours. The distance formula is:

> Distance = rate x time or d = rt

It can also be used to calculate speed of an aircraft when distance and time are given or to find the time when the distance and speed are given.

#### **Example:**

A jet travels at 690 knots (nautical miles per hour) for 6 hours. How many nautical miles will the plane travel?

#### Solution:

distance = rate x time

d = 690 knots/hour x 6 hours

d = 4,140 nautical miles

## **Grade Level:** 5-6

#### Ohio Learning Standards/Science (2018)

*Physical Science* <u>5.PS.1</u> Light, Sound and Motion <u>6.PS.4</u> Matter and Motion

Ohio Learning Standards/Mathematics (2017)

Mathematical Practices MP.1 Make sense of problems MP.4 Model with Mathematics MP.5 Use appropriate tools strategically

Mathematical Standards 5.NBT.5 Multiply multi-digit whole numbers 6. EE.9 Using variables to represent two quantities that change in relationship to one another

#### **Materials Required:**

- One pencil per student
- Appendix A: one student worksheet per student
- Appendix B: Distance, Rate and Time Presentation
- Appendix C: Distance, Rate and Time Teacher Guide

#### **Exercise 1**

The P-51 aircraft travels at a cruising speed of 275 knots and has a range (maximum distance) of 1,000 miles. Can it fly for three hours before running out of fuel? Can it fly for 4 hours before running out of fuel?

#### Solution:

- d = r times t
- d = 275 knots times 3 hours
- d = 825 nautical miles—yes, it is within the range of 1,000 nautical miles
- d = r times t
- d = 275 knots times 4 hours
- d = 1,100 nautical miles no, it cannot fly for four hours if its range is 1,000 nautical miles

#### **Exercise 2**

The F-80C has a cruising speed of 437 knots and a range of 1,090 nautical miles. How many hours can it fly before running out of fuel?

#### Solution:

d = r times tso t = d/r t = 1.09 t = 2.49

t = 1,090/437 t = 2.49 hours

#### **Exercise 3**

The A-10 has a range of 800 miles and a maximum speed of 450 knots. If it flew at its maximum speed throughout the flight, how many hours can it fly before running out of fuel? What is the answer in minutes?

#### Solution:

d = r  times  t	t = 800/450
so	
t = d/r	t = 1.7 hours

To convert hours to minutes, multiply by 60

1.7 hours x 60 minutes/hour = 106.6 minutes

#### **Exercise 4**

The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to aerial refueling. If it flew for three hours, how far did it fly?

#### Solution:

d = r times t

d = 684 knots times 3 hours = 2,052 nautical miles

## Student worksheet and presentation examples are from the collection of the National Museum of the U.S. Air Force

#### **Resources:**

National Museum of the United States Air Force - https://www.nationalmuseum.af.mil/

- North American P-51 Mustang: <u>https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196263/north-american-p-51d-mustang/</u>
- Lockheed F-80C Shooting Star: <u>https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196116/lockheed-f-80c-shooting-star/</u>
- Fairchild Republic A-10A Thunderbolt II: <u>https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195855/fairchild-republic-a-10a-thunderbolt-ii/</u>
- Lockheed F-117A Nighthawk: <u>https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198056/lockheed-f-117a-nighthawk/</u>



## Appendix A: MATHEMATICS OF FLIGHT: DISTANCE, RATE AND TIME

## STUDENT WORKSHEET

#### d = r times t

#### **Exercise 1**

The P-51 aircraft travels at a cruising speed of 275 knots and has a range (maximum distance) of 1,000 miles. Can it fly for three hours before running out of fuel? Can it fly for 4 hours before running out offuel?

#### Exercise 2

The F-80C has a cruising speed of 437 knots and a range of 1,090 miles. How many hours can it fly before running out of fuel?

#### Exercise 3

The A-10 has a range of 800 miles and a maximum speed of 450 knots. If it flew at its maximum speed throughout the flight, how many hours can it fly before running out of fuel? What is the answer in minutes?

#### **Exercise 4**

The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to aerial refueling. If it flew for three hours, how far did it fly?

## Next section = Appendix B

## Distance, Rate and Time Presentation

# **Mathematics of Flight**

## **Distance, Rate and Time**



In flight applications, **distance** is usually measured in miles.

Rate or speed is usually measured in knots (nautical miles per hour.)

Time is usually measured in hours.

The distance formula is:

# Distance = rate x time or d = rt

It can also be used to calculate speed of

an aircraft when distance and time are

given, or to find the time when the

distance and speed are given.

The Mustang was among the best and most well-known fighters used by the U.S. Army Air Forces during World War II. Possessing excellent range and maneuverability, the P-51 operated primarily as a long- range escort fighter and also as a ground attack fighter-bomber. The Mustang served in nearly every combat zone during WWII, and later fought in the Korean War



Maximum speed: 437 mph Cruising speed: 275 mph Range: 1,000 miles

## **Exercise 1**

The P-51 aircraft travels at a cruising speed of 275 knots and has a range (maximum distance) of 1,000 miles.

Can it fly for three hours before running out of fuel?

Can it fly for 4 hours before running out of fuel?

## **Exercise 1**

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## **Solution:**

- d = r times t
- d = 275 knots x 3 hours
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The Shooting Star was the first American aircraft to exceed 500 mph in level flight, the first American jet airplane manufactured in large quantities and the first U.S. Air Force jet used in combat.

Although designed as a high-altitude interceptor, the F-80C was flew as a day fighter, fighter-bomber and photo reconnaissance aircraft during the Korean War. On Nov. 8, 1950, an F-80C flown by 1st Lt. Russell J. Brown shot down a Russian-built MiG-15 in the world's first all-jet fighter air battle.



Maximum speed: 580 mph Cruising speed: 437 mph Range: 1,090 miles



## **Exercise 2**

The F-80C has a cruising speed of 437 knots and a range of 1,090 nautical miles.

How many hours can it fly before running out of fuel?

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The F-80C has a cruising speed of 437 knots and a range of 1,090 nautical miles. How many hours can it fly before running out of fuel?

Solution: d = r times t <u>d</u> = <u>r</u> t r r	<u>1,090</u> = <u>437</u> x time 437 437
<u>d</u> =t	<u>1.090</u> = time
r	437

2.49 hours = time

The A-10 is the first U.S. Air Force aircraft designed specifically for close air support of ground forces. It is very maneuverable at low speeds and low altitudes to ensure accurate weapons delivery, and it carries the systems and armor needed to survive in this environment. It is intended for use against all ground targets, but specifically tanks and other armored vehicles.



Maximum speed: 450 nautical mph Range: 800 miles

## **Exercise 3**

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## Solution:

d = r times t d = r times t  $\frac{d}{r} = r \text{ t} \qquad \frac{800}{450} = \frac{450}{450} \text{ x time}$   $r \qquad r \qquad \frac{450}{450} = \text{ time}$   $r \qquad \frac{800}{450} = \text{ time}$ 

1.7 hours = time (To convert hours to minutes, multiply by 60)1.7 hours x 60 minutes/hour = 106.6 minutes

The Lockheed F-117A was developed in response to an Air Force request for an aircraft capable of attacking high value targets without being detected by enemy radar. By the 1970s, new materials and techniques allowed engineers to design an aircraft with radar-evading or "stealth" qualities. The result was the F-117A, the world's first operational stealth aircraft.



## Maximum cruise speed: 684 mph Range: Unlimited with aerial refueling

**Exercise 4** 

The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to air-to-air refueling. If it flew for three hours, how far did it fly?



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The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to air-to-air refueling. If it flew for three hours, how far did it fly?

## **Solution:**

- d = r times t
- d = 684 knots X 3 hours
- d = 2,052 nautical miles



Additional resources are available online at:

www.nationalmuseum.af.mil/education/ teacher/index.asp



## Next section = Appendix C

## Distance, Rate and Time Teacher's Guide



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#### Example:

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Solution:

distance = rate x time

d = 690 knots/hour x 6 hours d = 4,140 nautical miles



https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196263/north-american-p-51dmustang/

Exercise 1

The P-51 aircraft travels at a cruising speed of 275 knots and has a range (maximum distance) of 1,000 miles.

Can it fly for three hours before running out of fuel?

**<** 

Can it fly for 4 hours before running out of fuel?







https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196116/lockheed-f-80c-shooting-star/

# Distance, Rate and Time Exercise 2 The F-80C has a cruising speed of 437 knots and a range of 1,090 nautical miles. How many hours can it fly before running out of fuel? VATIONAL MUSEUM OF THE UNITED STATES AIR FORCE\*





https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195855/fairchild-republic-a-10a-thunderbolt-ii/







https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198056/lockheed-f-117anighthawk/



# Distance, Rate and Time Exercise 4 The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to air-to-air refueling. If it flew for three hours, how far did it fly? Solution: d = r times t d = 684 knots X 3 hours d = 2,052 nautical miles MATIONAL MUSEUM MATIONAL MUSEUM

