## 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:

$$
\begin{gathered}
\text { Distance }=\text { rate } \mathbf{x} \text { time } \\
\text { or } \\
\mathbf{d}=\mathbf{r t}
\end{gathered}
$$

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:

$$
\begin{aligned}
\text { distance } & =\text { rate } \times \text { time } \\
d & =690 \text { knots/hour } \times 6 \text { hours } \\
d & =4,140 \text { nautical miles }
\end{aligned}
$$

Grade Level: 5-6

Ohio Learning Standards/Science (2018)

Physical Science
5.PS. 1 Light, Sound and Motion
6.PS. 4 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:

$\mathrm{d}=\mathrm{r}$ times t
d $=275$ knots times 3 hours
$d=825$ nautical miles-yes, it is within the range of 1,000 nautical miles
$\mathrm{d}=\mathrm{r}$ times t
$\mathrm{d}=275$ knots times 4 hours
$\mathrm{d}=1,100$ 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:

| $\mathrm{d}=\mathrm{r}$ times t <br> so <br> $t=\mathrm{d} / \mathrm{r}$ | $t=1,090 / 437$ <br> $t=2.49$ 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:


$$
\begin{aligned}
& t=800 / 450 \\
& t=1.7 \text { hours }
\end{aligned}
$$

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:

$\mathrm{d}=\mathrm{r}$ times t
$\mathrm{d}=684$ 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: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196263/north-american-p-51d-mustang/
- Lockheed F-80C Shooting Star: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/196116/lockheed-f-80c-shooting-star/
- Fairchild Republic A-10A Thunderbolt II: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/195855/fairchild-republic-a-10a-thunderbolt-ii/
- Lockheed F-117A Nighthawk: https://www.nationalmuseum.af.mil/Visit/Museum-Exhibits/Fact-Sheets/Display/Article/198056/lockheed-f-117a-nighthawk/


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

## STUDENT WORKSHEET

$$
\mathbf{d}=\mathbf{r} \text { times } \mathbf{t}
$$

## 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.

## Distance, Rate and Time

## The distance formula is:

## Distance = rate x time

> or
> $\mathbf{d}=\mathbf{r t}$

## Distance, Rate and Time

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.

## Distance, Rate and Time

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

## Distance, Rate and Time

## 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?

## Distance, Rate and Time

## 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

## Distance, Rate and Time

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

## 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?

## 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?

## Solution:

$$
\begin{array}{ll}
d=r \text { times } t \\
\frac{d}{r}=\frac{r t}{r} & \frac{1,090}{437}=\frac{437}{437} x \text { time } \\
\frac{d}{r}=t & \frac{1.090}{437}=\text { time }
\end{array}
$$

2.49 hours $=$ time

## Distance, Rate and 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

## Distance, Rate and Time

## 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?

## Distance, Rate and Time

## 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 $t$
$\frac{d}{r}=\frac{r}{r} \quad \frac{800}{450}=\frac{450}{450} \times$ time
$\frac{d}{r}=t \quad \frac{800}{450}=$ time
1.7 hours $=$ time (To convert hours to minutes, multiply by 60) 1.7 hours x 60 minutes/hour $=106.6$ minutes

## Distance, Rate and Time

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

## 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?

## Distance, Rate and Time

## Exercise 4

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

Solution:

$$
\begin{aligned}
& d=r \text { timest } \\
& d=684 \text { knots } \times 3 \text { hours } \\
& d=2,052 \text { nautical miles }
\end{aligned}
$$

## More Resources

Additional resources are available online at:
www.nationalmuseum.af.mil/education/ teacher/index.asp

OF THE UNITED STATES AIR FORCE"'

# Next section = Appendix C 

## Distance, Rate and Time Teacher's Guide



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.


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 (or speed) times time


The distance formula is: Distance = rate (or speed) times time

## Distance, Rate and Time

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.

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE*
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 $\mathbf{x} 6$ hours $d=4,140$ nautical miles

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

## Distance, Rate and Time

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?

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

## Distance, Rate and Time

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?
lution:
$d=r$ timest
$d=275$ knots $\times 3$ hour
$d=825$ nautical miles
yes, it is within the range of 1,000 nautical miles
$d=r$ tmest
$\mathrm{d}=275$ knots x 4 hours
$d=1,100$ nautical miles
no, it can not fly for four hours if its range is 1,000 nautical miles
( NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

## Distance, Rate and Time

```
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-altitud interceptor, the F-80C was flew as a day fighter, fighter-bomber and phot ance aircraft during Korean War. On Nov. 8, 1950, an F-80C flown by 1st Lt. Russell J. Brown sho down a Russian-built MiG-15 in world's first all-jet fighter air battle.

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE
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?

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

## 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?

Solution:
$\mathrm{d}=\mathrm{r}$ times
$\frac{d}{r}=\frac{c t}{r} \quad \frac{1.090}{437}=\frac{437}{437} x$
$d=t \quad 1.090=$ time
437
2.49 hours $=$ time

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

## Distance, Rate and 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

NATIONAL 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/

## Distance, Rate and Time

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?

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

Distance, Rate and Time
Exercise 3
The A-10 has a range of 800 miles and a maximum speed of 450 knots. If if 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 $t$
$d=L t \quad \underline{800}=450 \times$ time
rr $\quad 450$
$d=t \quad \frac{800}{450}=$ time
1.7 hours $=$ time (To convert hours to minutes, multiply by 60 ) 1.7 hours $\times 60$ minutes/hour $=106.6$ minutes

NATIONAL MUSEUM
of the united states air force

## Distance, Rate and Time

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
OF THE UNITED STATES AIR FORCE'
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?

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

## Distance, Rate and Time

Exercise 4
The F-117A has a maximum cruising speed of 684 knots. Its range is unlimited due to air-toair refueling. If it flew for three hours, how far did it fly?

Solution:
$d=r$ times $t$
$d=684$ knots $\times 3$ hours
$d=2,052$ nautical miles

NATIONAL MUSEUM
of the united states air force

## More Resources

Additional resources are available
online at:
www.nationalmuseum.af.mil/education/ teacher/index.asp

NATIONAL MUSEUM
OF THE UNITED STATES AIR FORCE

