MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

ACTIVITY EXAMPLE

Commercial Training Solutions

KEY WORDS

Measurement | distance |speed | height | temperature | angles | volume | mass | lateral navigation | vertical navigation | flight planning | aviation

ALSO USEFUL FOR

Business studies | Tourism | Science | Physics

PROGRAMME OUTLINE

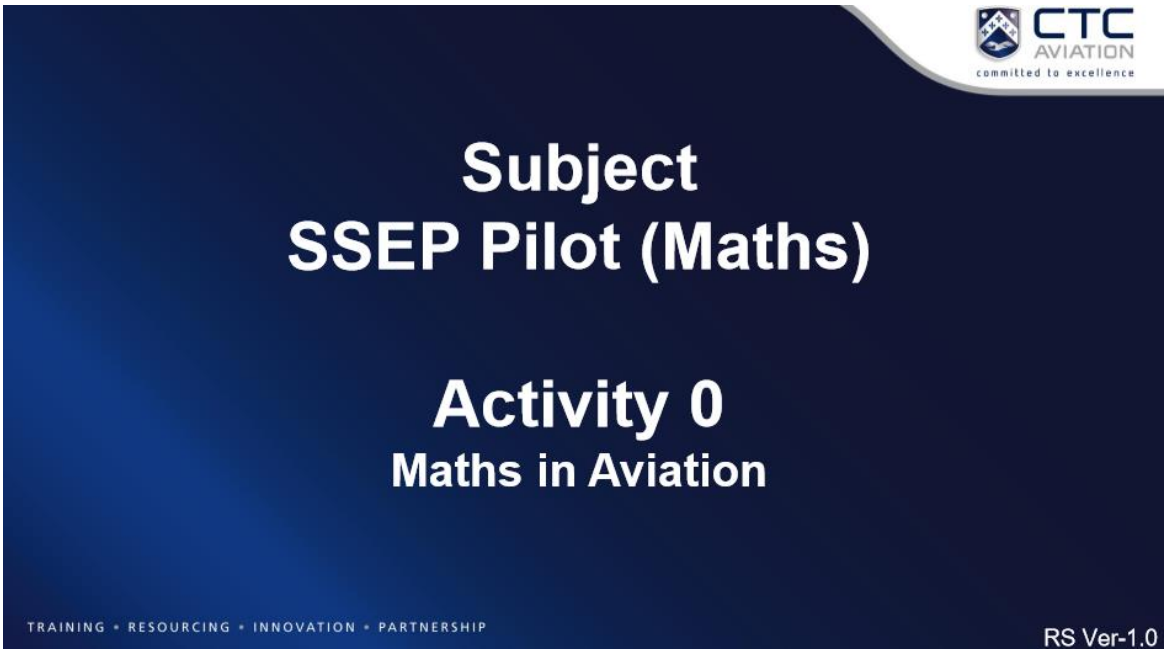
3 POINTS OF CONTACT

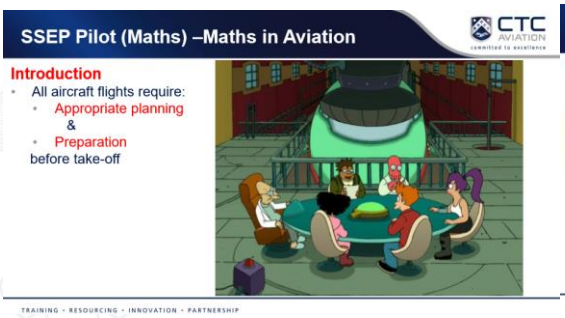
- staff come into classroom (x2)
- Workplace visit (x1)

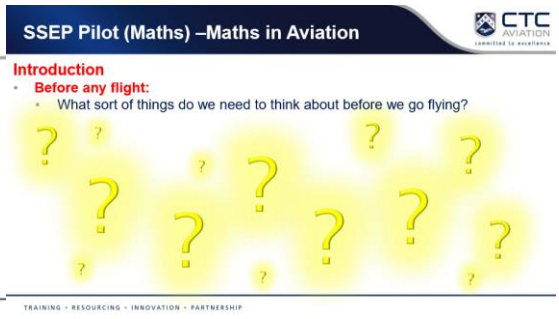
EXAMPLE

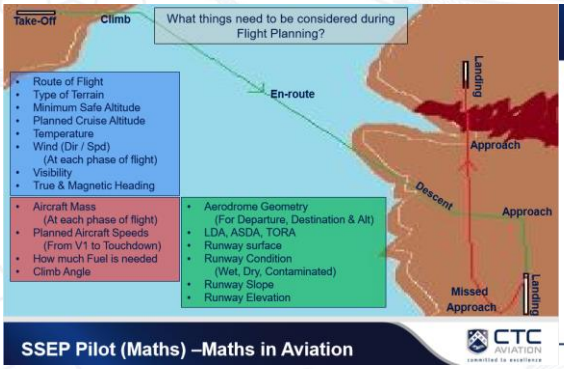
1. LT3 (formerly CTC Aviation) staff come into classroom, introduce themselves, background to the industry, their careers and how maths is used in the industry.
2. Workplace visit.
   Student activity: Calculating fuel
3. Staff come into classroom.
   Student activity: Calculating a profitable flight

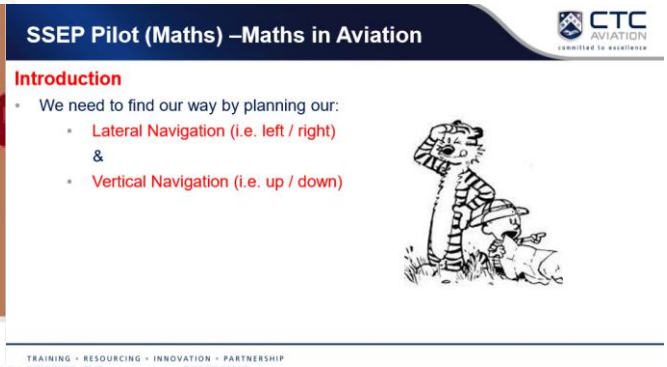
For more on SSEP see:
www.smartnz.nz











MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

ACTIVITY EXAMPLE

SSEP Pilot (Maths) –Maths in Aviation

Units in Aviation

- So to plan a flight you will need to measure:
  - Distance
  - Speed
  - Height
  - Temperature
  - Angles
  - Volume
  - Mass

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Units of measurement used in Aviation

- Sometimes we use the metric system:

Distance	**Kilometres, Metres, Centimetres, Millimetres**
Speed	**Kilometres / Hour or Metres / Second**
Temperature	**Degrees Celsius, Degrees Kelvin**
Angles	**Degrees**
Volume	**Litres, Millilitres**
Mass	**Kilograms, Grams**

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Units in Aviation

- In Aviation, additional units are also used
  - So when measuring Distance or Height

In addition to:	We also use:
i. Kilometres	v. Feet
ii. Metres	vi. Inches
iii. Centimetres	vii. Nautical Miles
iv. Millimetres	

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Units in Aviation

- In Aviation, additional units are also used
  - So when measuring Speed

In addition to:	We also use:
i. Kilometres per Hour	iii. Nautical Miles per Hour
ii. Metres per second	iv. Feet per minute

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Units in Aviation

- In Aviation, additional units are also used
  - So when measuring Mass or Volume

In addition to:	We also use:
i. Litres,	v. US Gallons
ii. Millilitres	vi. Pounds
iii. Kilograms	
iv. Grams	

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Lateral Navigation

- **Short Distances**

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Lateral Navigation

- **Longer Distances**

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Lateral Navigation

- **Tools**
  1. Map (Chart)
  2. Ruler marked in Nautical Miles
  3. Protractor
  4. Calculator

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

ACTIVITY EXAMPLE

For more on SSEP see:
www.smartnz.nz

MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

ACTIVITY EXAMPLE

SSEP Pilot (Maths) –Maths in Aviation

Lateral Navigation

- Planning Calculations
  - Example: How long to get there?
    - Speed = 110kt
    - Distance = 67nm

110kt ÷ 60min = 1.8nm/min
67nm ÷ 1.8 = 38min

Ans: 38min to travel 67nm

Note: 0.1 of an hour = 6mins

- Example: How much Fuel?
  - Journey Time = 2.3hrs
  - Fuel Flow = 37 l/hr

2.3hrs = 138min
37 l/hr ÷ 60 = 0.62 l/min
0.62 x 138 = 85.6

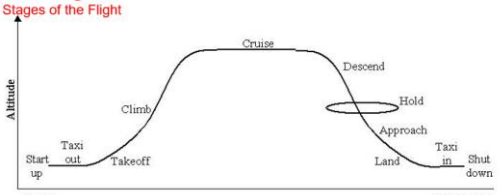
Ans: 85.6 l of fuel needed

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

- Stages of the Flight

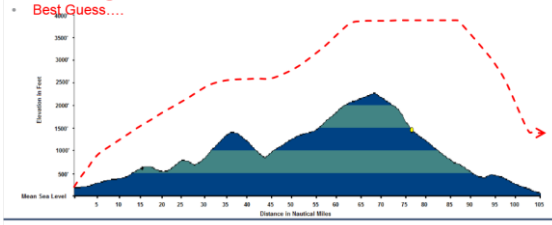


TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

- Best Guess….



TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

- Planning Calculations
  - Example: Ground Distance used to Climb
    - Ground Speed = 70kt
    - Climb Required = 6500ft
    - Climb Speed = 1000fpm

6500ft ÷ 1000fpm = 6.5min of climb
70kt ÷ 60 = 1.2nm/min
6.5min x 1.2nm = 7.8nm

Ans: 7.8nm to climb 6500ft

  - Example: Ground Distance used to Descend
    - Descent Speed = 500fpm
    - Descent Req = 7500ft
    - Ground Speed = 110kt

7500ft ÷ 500fpm = 15min descent
110kt ÷ 60 = 1.8nm/min
15min x 1.8nm = 27nm

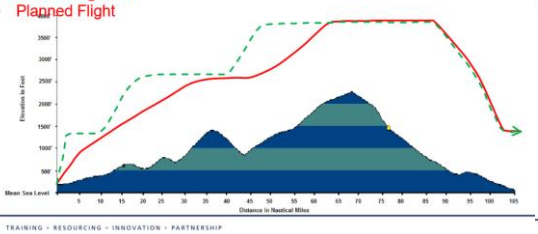
Ans: 27nm to descend 7500ft

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

- Planned Flight



TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

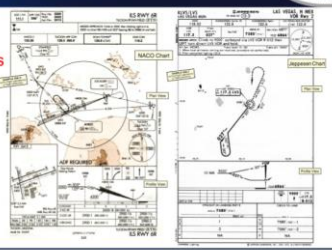
- Tools
  1. Chart
  2. Ruler marked in Nautical Miles
  3. Protractor
  4. Calculator

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Vertical Navigation

- Tools
  - Other Examples



TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Example - Gradient / Angle of Climb Calculations:

- Given:
  - The thrust of a twin-engine aircraft is 40,000 Newton's per engine
  - The minimum permissible climb gradient is 2.4% in still air
  - Gravity (g) = 10 m/s²
  - Drag = 29,000 Newton's
  - Calculate the maximum permissible aircraft mass that will enable it to achieve the minimum permissible climb gradient with one engine inoperative
- Solution:

$$\text{Gradient} = \frac{\text{total thrust (N)} - \text{total drag (N)}}{\text{total mass (N)}} \times 100$$

$$\text{Total mass (N)} = \frac{\text{total thrust (N)} - \text{total drag (N)}}{\text{gradient}} \times 100$$

$$\text{Mass} = \frac{40\,000 - 29\,000}{2.4} \times \frac{100}{10}\ (\text{kg}) = 45\,833\ \text{kg}$$

Ans: 45,833Kg

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

ACTIVITY EXAMPLE

For more on SSEP see:
www.smartnz.nz

MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

ACTIVITY EXAMPLE

SSEP Pilot (Maths) –Maths in Aviation

Flight Planning Log

- A Flight Planning Log is used to keep your pre-planned information during the flight

LEG	ALT / MSA	TRK	HDG	DIST	GS	TIME	PLAN FUEL	ETA / REV	ATA	

Fuel Planning Log	
Trip Fuel	
Contingency Fuel	
Reserve Fuel	
Total Fuel Required	

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

SSEP Pilot (Maths) –Maths in Aviation

Flight Planning Log

- A Flight Planning Log is used to keep your pre-planned information during the flight

LEG	ALT / MSA	TRK	HDG	DIST	GS	TIME	PLAN FUEL	ETA / REV	ATA	
NZHN to NZXX	6500 / 3700	090	065	125	125	60	37	13:05		
NZXX to NZHN	6500 / 3700	270	245	125	125	60	37	14:05		

Fuel Planning Log		
Trip Fuel	74	litres
Contingency Fuel	7.4	litres
Reserve Fuel	27.75	litres
Total Fuel Required	109.15	litres

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

What is fuel?

- Fuel is burnt within the engine
- It is chemical energy, that is then transformed into heat energy when ignited
- This heat energy than turns into mechanical energy
- This mechanical energy turns the propeller – which propels the aircraft forward.
- Without fuel, our aircraft would not fly!

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

How is fuel measured?

- By mass
  - The amount of matter (atoms) in an object
- By volume
  - The amount of space occupied by an object

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

How is fuel measured?

- Which object has the largest mass?
- Which has the largest volume?

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

How is fuel measured?

- By mass
  - Kilograms (KG)
  - Pounds (lbs)
  - Ounce
  - Tonne
  - Dram
  - Grain
  - And many more…
- By volume
  - Litres (L)
  - US gallons (USG)
  - Imperial gallons (IMPG)
  - Bushel
  - Pint
  - Quart
  - And many more…

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

What does this mean for us?

- Different units of mass and volume used for different things within Aviation
  - Calculating how much the aircraft weighs or how long the aircraft can fly for
- It is important you know which unit you are using, and why

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

- At L3 CTS Aviation Academy we use;
  - US Gallons
    - When calculating how much fuel is needed for flight
      - The flight manual states how many US gallons are required per hour
  - Fuel pounds
    - When calculating the total weight of the aircraft
      - It is important your aircraft is not too heavy
  - Litres
    - When we refuel after a flight, the fuel pump reads in litres (just like a car one does)

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

ACTIVITY EXAMPLE

For more on SSEP see:
www.smartnz.nz

MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

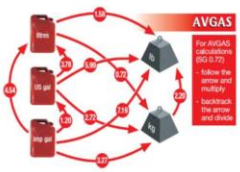
ACTIVITY EXAMPLE

- This means you must first work out how many US gallons are required for your flight
- Then you need to work out how much that fuel will weigh in pounds
- After flight, you need to work out how many litres are left on board the plane, and how many litres you need to uplift for the next flight

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Conversion Rates

- 1 USG is equal to 6lbs of fuel
- 1 USG is equal to 3.4 litres of fuel
- 1 L is equal to 1.58 pounds of fuel



TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Your Turn

Sample Aircraft

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Sample Aircraft

- You will be using this aircraft as your sample aircraft
- It burns two USG per hour
- It can carry a total of ten USG
- If this aircraft has a full fuel tank, how many hours can it fly for?
  - Five hours

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Practice

- You dip the aircrafts tanks, and see that you have 4 USG, how many hours flying time is this?
  - Two hours
- You want to fly for three hours. How many extra USG are required?
  - Two USG
- You need to fuel up at the pump; how many litres are you going to add?
  - 3.4L to 1USG
    - 3.4 x 2 = 6.8

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Practice

- You return from your flight after two and a half hours
- How many USG have your burnt?
  - Five USG
- How many litres have your burnt?
  - 5 x 3.4 = 17L

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Practice

- How many USG will be required for a three and half hour flight?
  - 7 USG
- How many fuel lbs is this?
  - 1 USG = 6 fuel lbs
    - 7 x 6 = 32lbs
- And how many litres is this?
  - 1 USG = 3.4L
    - 7 x 3.4 = 23.8L

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

Practice

- You return from your flight after two hours
- How many USG have your burnt?
  - 4 USG
- How many litres have your burnt?
  - 4 x 3.4 = 13.6L

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

ACTIVITY EXAMPLE

For more on SSEP see:
www.smartnz.nz

MATHS

SSEP EXAMPLE // AVIATION
DEVELOPED BY // FAIRFIELD COLLEGE AND L3 AIRLINE ACADEMY

ACTIVITY EXAMPLE

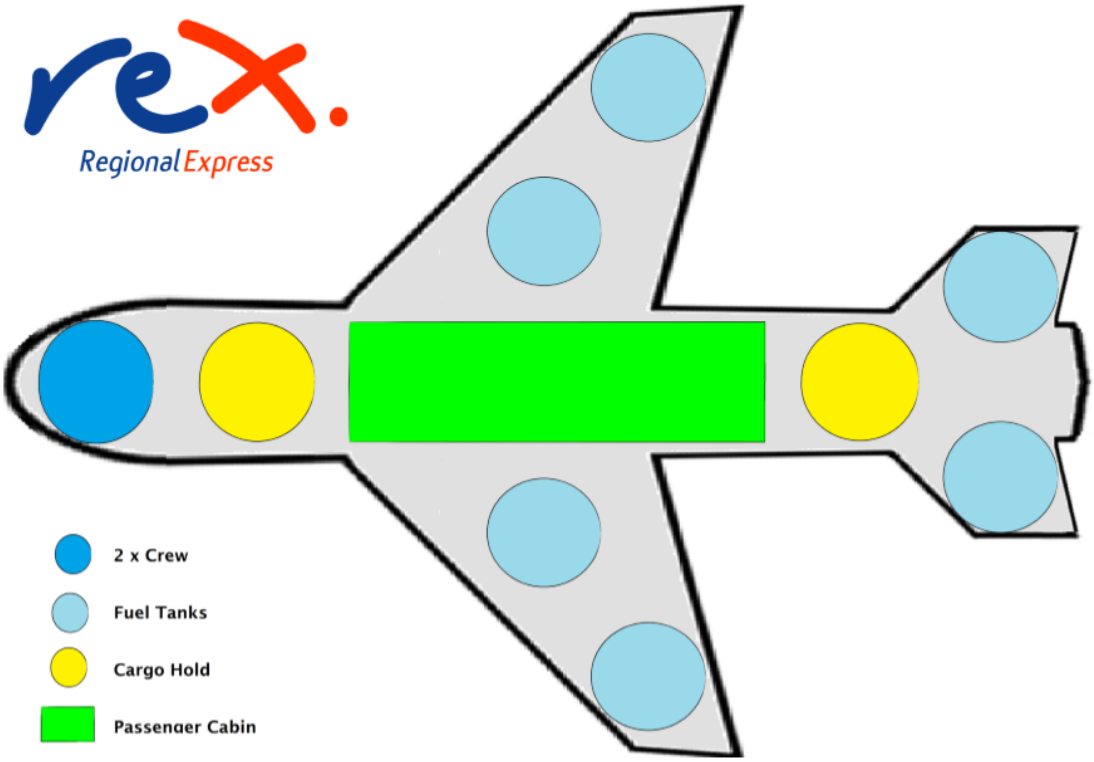
Practice

CTC AVIATION committed to excellence

- You dip the aircrafts tanks and find you only have 3 USG.
- How many hours of flying is this?
  - Three hours
- You want to go on a 5 hours flight
- How many extra USG do you need to uplift?
  - Seven USG
- What will this display in Litres on the fuel pump?
  - 7 x 3.4 = 23.8 Litres
- How many extra pounds is 23.8 Litres?
  - 23.8 x 6 = 37.6

TRAINING • RESOURCING • INNOVATION • PARTNERSHIP

rex. Regional Express



ACTIVITY EXAMPLE

ACTIVITY EXAMPLE

Basic Empty Mass	Kg
Variable Load (Minimum of 1,500kg)	Kg
(A) Aircraft Prepared for Service	Kg
Forward Cargo Hold	Kg
Rear Cargo Hold	Kg
(B) Total Cargo Load	Kg
(C) Total Cargo Load (Kg) X 8.5 =	$
(D) Passengers Total Load	Kg
(E) Passengers Total Load (kg) X 5.5 =	$
(F) Total Payload (Mass) = (B + D) =	Kg
(A+F) Zero Fuel Mass =	Kg
Minimum Fuel Volume (Litres)	L
1 Litre of Fuel = 0.8Kg	
Minimum Fuel Required (Mass)	Kg
Extra Fuel Carried	
(G) Scheduled Take-off Mass	
(H) MSTOM	59,450Kg

Questions	
1 - Where is CG Position? (mm aft of Datum	mm
2 - Is CG Within Limits	Y / N
3 - Is G < H? *Note: If Y, Adjust Loads Until G = H*	Y / N
4 - Money earned from Payload? (C + E)	$
Subtract aircraft operating & Fuel Costs	$
5 - Profit achieved for this flight	$

Notes

Mass Scale - 1 Gram (g) = 100 Kilograms (Kg)

So for each gram of Payload: Remember 1g = 100Kg

Each Kg of passenger payload	= $5.00 revenue
Each Kg of cargo payload	= $8.50 revenue
Minimum Fuel Load Required	= 15,937.5Litres
Capacity of each Fuel Tank	= 6,375.0Litres
1 Litre Fuel = 0.8Kg	

Additional fuel may be carried as ballast
Variable Load not less than 1,500kg (on Flight Deck)
Max Structural Take-off Mass must not be exceeded
CG must be in limits

A = Total Value of Payload	= $_____
B = Cost of Operating Aircraft	= $ 11,385
Profit for your flight (A – B)	= $_____

Names:

1: **3:**

2: **4:**

Basic Empty Mass	Kg
Variable Load (Minimum of 1,500kg)	Kg
(A) Aircraft Prepared for Service	Kg
Forward Cargo Hold	Kg
Rear Cargo Hold	Kg
(B) Total Cargo Load	Kg
(C) Total Cargo Load (Kg) X 8.5 =	$
(D) Passengers Total Load	Kg
(E) Passengers Total Load (kg) X 5.5 =	$
(F) Total Payload (Mass) = (B + D) =	Kg
(A+F) Zero Fuel Mass =	Kg

Minimum Fuel Volume (Litres)	L
1 Litre of Fuel = 0.8Kg	
Minimum Fuel Required (Mass)	Kg
Extra Fuel Carried	
(G) Scheduled Take-off Mass	
(H) MSTOM	52,450Kg

Questions	
1 - Where is CG Position? (mm aft of Datum	mm
2 - Is CG Within Limits	Y / N
3 - Is G < H? *Note: If Y, Adjust Loads Until G = H*	Y / N
4 - Money earned from Payload? (C + E)	$
Subtract aircraft operating & Fuel Costs	$
5 - Profit achieved for this flight	$

Notes

- Mass Scale - 1 Gram (g) = 100 Kilograms (Kg)

- So for each gram of Payload: Remember 1g = 100Kg

  - Each Kg of passenger payload = $5.00 revenue
  - Each Kg of cargo payload = $8.50 revenue
  - Minimum Fuel Load Required = 15,937.5Litres
  - Capacity of each Fuel Tank = 6,375.0Litres
  - 1 Litre Fuel = 0.8Kg
  - Additional fuel may be carried as ballast
  - Variable Load not less than 1,500kg (on Flight Deck)
  - Max Structural Take-off Mass must not be exceeded
  - CG must be in limits

A = Total Value of Payload = $_____

B = Cost of Operating Aircraft = $ 11,385

Profit for your flight (A – B) = $_____