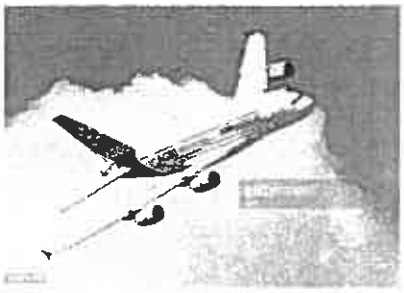
Mathematics Methods Unit 3 2019

Investigation 2: Applications of Integration:

Part C **In-class validation** **Time allowed 50 minutes**

Name: Solutions **Marks:** _____ / 28

The Airbus A380 plane was assembled in Toulouse, France from sections manufactured in France, Germany, Spain & the United Kingdom and these are transported there by specialised road and water methods, though some parts are moved by the A300-600ST *Beluga* transport aircraft.



A380 components on a barge

In order to avoid damage from direct handling, parts are secured in custom made framework.

Transportation of a large part through public streets

a typical flatbed truck

The real-life scenario being presented to you involves the arrangements for transportation of two plane parts on flatbed trucks: a hemispherical nose cone and a longer and flatter irregular shape.

Your task is to assess what size of flatbed truck will be needed to transport these parts separately. You may need to make assumptions along the way. These should be explained in Question 3.
In both cases the mass of the parts is uniformly spread.

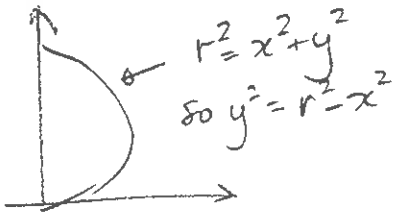
[11,3 = 14 marks]

Question 1 ~~[8,2~~ **= 10 marks]**

Assuming the nose cone of the Airbus A380 is a hemisphere with a radius of 5 metres, what length of tray on a flatbed truck would be needed to transport it to a port or factory:

a) in an upright position in an appropriate custom framework to hold it

i) in that position, with an overhang allowed?
Show your reasoning in detail.



upper limit ✓
formula for sum of moments ✓
Substitute circle formula ✓
Answer ✓

Sum of moments $= \int_0^{5\checkmark} x \pi y^2 mg\, dx$ ✓

$= \pi mg \int_0^5 x(25 - x^2)\, dx$ ✓

$= 156.25\, \pi mg$

Volume of hemisphere ✓
Formula for moment of sum ✓
Answer ✓
Balanced formula ✓
Solution ✓

Moment of sum

$= \frac{2\pi \times 5^3}{3} mg\bar{x}$ ✓✓

$= \frac{250}{3} mg\bar{x}$ ✓

so $156.25\, \pi mg = \frac{250}{3} \pi mg\bar{x}$

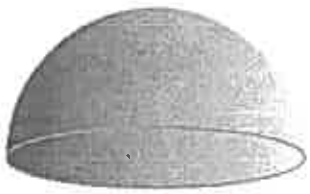
$\Rightarrow \bar{x} = 1.875$

The centre of gravity is 1.875m from the cab of the truck so 1.875m is the minimum length. ✓ In Context

ii) without an overhang ? (the radius of the hemisphere would be the furthest extent - so 5m. ✓

b) in a **flat position** ?

10m long with no overhang ✓
or 5m long with overhang ✓
because hemisphere is symmetrical ✓

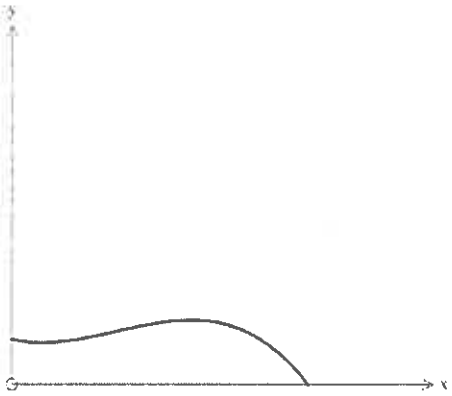


Question 2 **[1,7,2 = 9 marks]**

A section of the fuselage takes shape based on the formula

$y = -0.0006x^3 + 0.019x^2 - 0.1x + 2$

with both axes measured in metres.

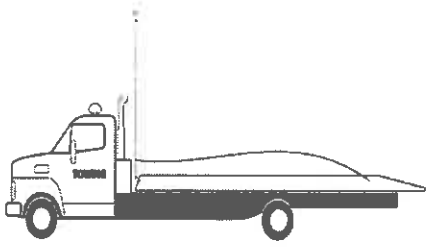


You will need to assume the width of the item is uniform and conforms to the width of the tray of the truck.

a) What is the minimum length of tray required to accommodate this piece of aircraft positioned as shown if an overhang is not allowed ?

Max x value is 29.82576

So 29.82576 metres ✓
to nearest mm.



b) What is the minimum length of tray required if an overhang is allowed?

Sum of moments $= mg\int_0^{29.82576} xy\,dx$ Formula ✓

$= mg\int_0^{29.82576} x(-0.006x^3 + 0.019x^2 - 0.1x + 2)\,dx$ ✓ function values

$= 931.7599357\,mg$ ✓ answer

Moment of sum $= mg\bar{x}\int_0^{29.82576} (-0.006x^3 + 0.019x^2 - 0.1x + 2)\,dx$ Formula ✓

$= 64.5086813\bar{x}\,mg$ Answer ✓

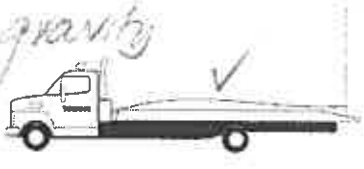
$931.7599357\,mg = 64.5086813\bar{x}\,mg$ Balance formula ✓

$\Rightarrow \bar{x} = 14.44394641$ Solution ✓

So centre of gravity is 14.444 m (3dp) from cab of truck
So minimum length of tray is this. Answer in context ✓

c) How would this be affected if the item was placed the other way round, ie the more contoured end facing the cab of the truck ?

Distance from back of truck to centre of gravity is $29.82576 - 14.44394641$



So 15.382 m (3dp) ✓

Question 3 [5 marks]

List five assumptions you have made in the process of answering these questions, stating reasons for each.

Back wheels of truck are positioned at the very back of the tray ✓. If not counter weights would be needed at cab. ✓

- Roads are wide enough to accomodate 10m wide load on nose cone ✓

The extra length for custom jigs have not been taken into account ✓

Area over cab has not been taken into account ✓

For safety the centre of gravity should not be further back than the back row of wheels.

or any relevant points

END OF PAPER