Assignment 3

Air Vehicle Performance (AERO 374)

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INDEX NO 9383417

SECTION A

Q1.

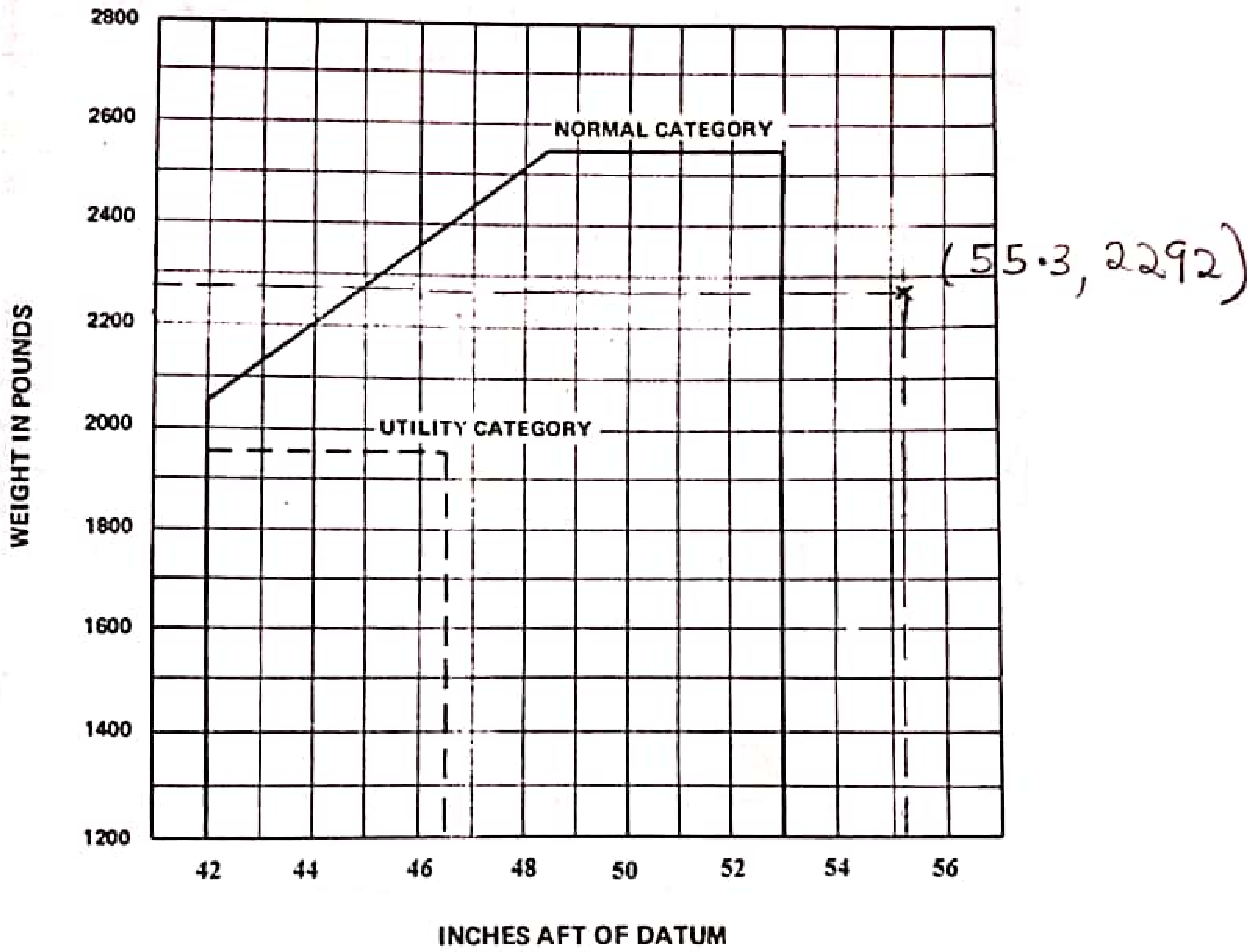
Item	Weight (lb)	Arm (in)	Moment (lb in)
Basic Empty Weight	1200	50.0	60000
Pilot and front Passenger	412	38.0	15656
Passenger Rear Seat	338	75.0	25350
Fuel	144	50.0	7200
Oil	10	-16.0	-160
Baggage Forward	188	100.0	18800
TOTAL	2292		126846

i. From table Gross weight = 2292 lb

ii Position of Centre of gravity $= \dfrac{\Sigma(\text{Moment})}{\Sigma(\text{Weight})}$

$$= \frac{126846 \text{ lbin}}{2292 \text{ lb}} = 55.34 \text{in}$$

Indicate the centre of gravity calculated in (b) on the safety envelope provided.



rom your results in (c) comment on the flight readiness of the aircraft, whether it is safe
or take-off and give reasons.

A. Agyei-Agyemang

iv. Aircraft is not safe for takeoff

This is because the centre of gravity for the aircraft when indicated falls outside the normal category on the safety envelope.

This implies that the weight of the aircraft is not well distributed which might result in instability. Hence it's not safe for take-off.

Q2. Parameters

Gross weight (W_0) = 3000lb

Thrust specific fuel consumption (C_t) = $1.917 \times 10^{-4} s^{-1}$

Flight speed (V_∞) = 300ft/s

Lift to drag ratio $\left(\frac{L}{D}\right) = 14$

Fuel weight = 100gallons × 6.9lb/gal

= 690lb

Final weight after fuel burnout (W_1) = Gross weight − fuel weight

= 3000 − 690

= 2310lb

a. Endurance (E) $= \frac{1}{C_t} \cdot \frac{L}{D} \ln \frac{W_0}{W_1}$

$$= \frac{1}{1.917 \times 10^{-4}} \cdot (14) \cdot \ln\left(\frac{3000}{2310}\right)$$

$$= 19087.67s$$

$\therefore$ Endurance in hours $= \dfrac{19087.67}{3600}$

$= 5.3$ hours

b. Range (R) $= \dfrac{V_\infty}{C_t} \cdot \dfrac{L}{D} \cdot \ln \dfrac{W_0}{W_1}$

$= \dfrac{300}{1.917 \times 10^{-4}} \cdot (14) \cdot \ln\left(\dfrac{3000}{2310}\right)$

$= 5726301.56$ ft

Given

5280ft = 1 mile

$5726301.56 = \dfrac{5726301.56}{5280} \times 1$ mile

$= 1084.53$ miles

$\therefore$ Range in miles of the airplane is 1084.53

c. The aircraft covers a distance of 1084.53 miles with 100 gallons of fuel and an endurance of ~~to~~ 5.3 hours.

This occurs when the airplane is operating with maximum efficiency

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SECTION B

Q3 Gross weight of piper PA-28-181 : 2450lb

Altimeter reading at take-off : 4000ft

Altimeter setting : 28.8 inches Hg

i. Pressure Altitude = Altimeter reading + Pressure altitude conversion factor

From the chart the pressure altitude conversion factor at an altimeter setting of 28.8 inches Hg is 1053

∴ Pressure Altitude = 4000ft + 1053ft

= 5053ft

ii With a 5053ft Pressure Altitude and airport temperature at 10°C

The Density Altitude obtained using the chart is 5500ft

iii From the above airport conditions and a headwind of 10knots.

The ground roll at takeoff obtained using the take off performance chart is 1450ft

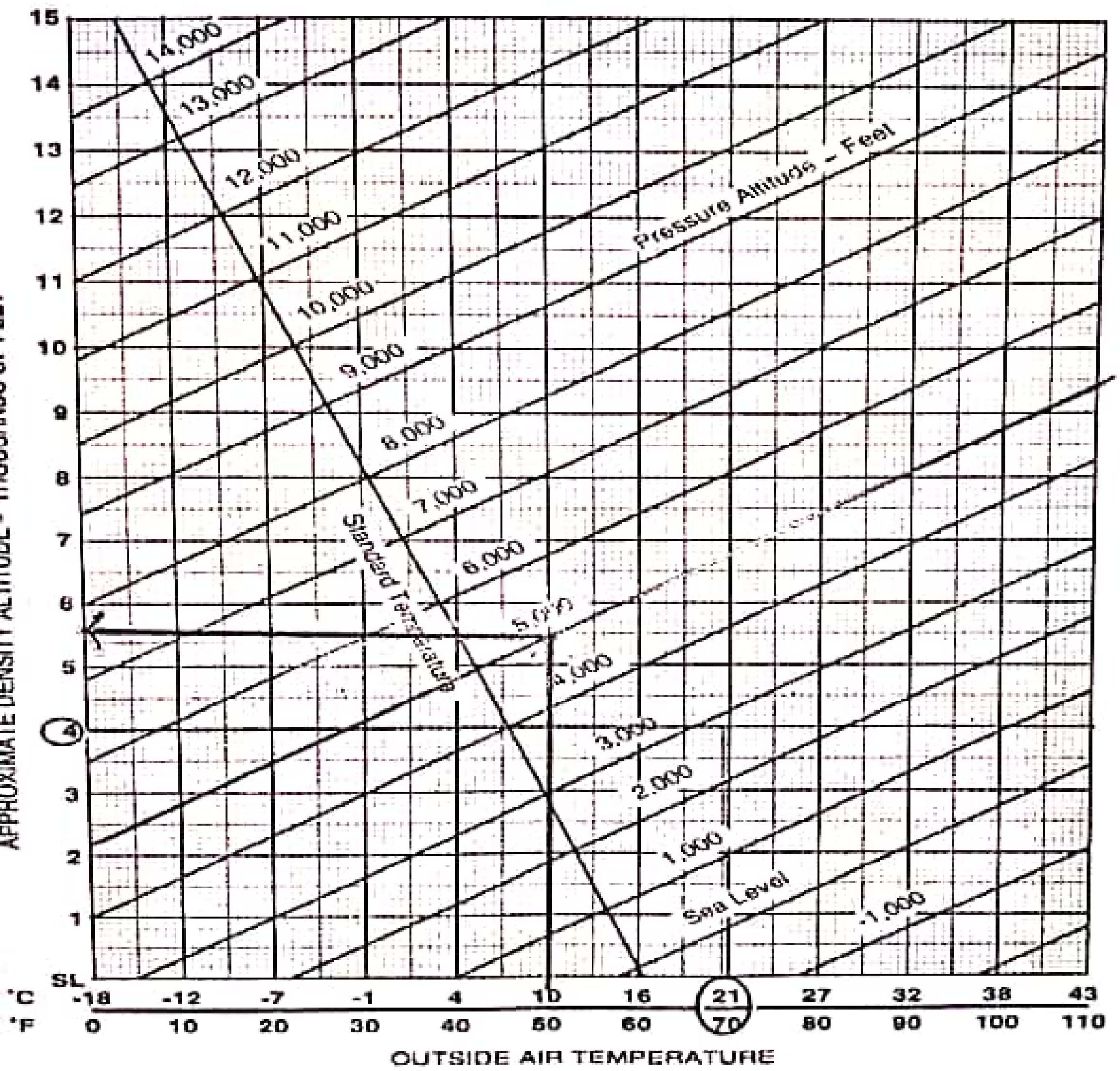
iv. Airborne distance = Total takeoff distance - Ground roll

From the takeoff performance chart, the total takeoff distance is determine to be 2600ft

∴ Airborne distance = 2600 − 1450

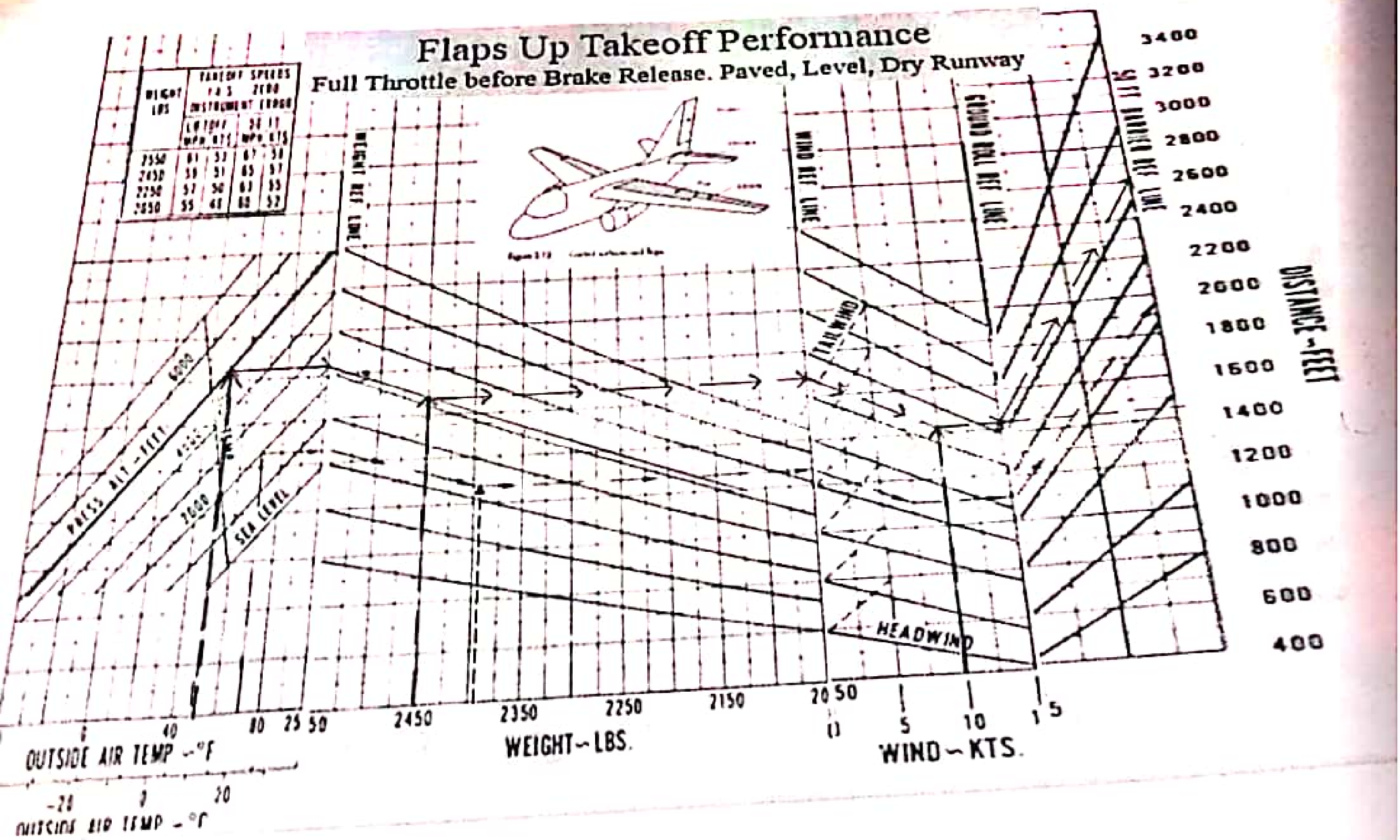
= 1150ft

DENSITY ALTITUDE CHART



Altimeter Setting ("Hg)	Pressure Altitude Conversion Factor
28.0	1,824
28.1	1,727
28.2	1,630
28.3	1,533
28.4	1,436
28.5	1,340
28.6	1,244
28.7	1,148
28.8	1,053
28.9	957
29.0	863
29.1	768
29.2	673
29.3	579
29.4	485
29.5	392
29.6	298
29.7	205
29.8	112
29.9	20
29.92	0
30.0	-73
30.1	-165
30.2	-257
30.3	-348
30.4	-440
30.5	-531
30.6	-622
30.7	-712
30.8	-803
30.9	-893
31.0	-983

FIGURE 4-8.—Pressure altitude and density altitude chart.


Flaps Up Takeoff Performance
Full Throttle before Brake Release. Paved, Level, Dry Runway
PRESS ALT - FEET
6000
4000
2000
SEA LEVEL
WEIGHT REF LINE
WIND REF LINE
TAILWIND
HEADWIND
GROUND ROLL REF LINE
50 FT BARRIER REF LINE
DISTANCE - FEET
3400
3200
3000
2800
2600
2400
2200
2000
1800
1600
1400
1200
1000
800
600
400
OUTSIDE AIR TEMP - °F
OUTSIDE AIR TEMP - °C
WEIGHT - LBS.
2450
2350
2250
2150
WIND - KTS.
0
5
10
15

v. From the PA-28-181 takeoff performance chart
The total takeoff distance of the airplane is
2600ft

Q4. Parameter

Thrust (T) = 30,000lb

Takeoff velocity (V_∞) = 250ft/s at sea level.

Jet velocity of engine (V_j) = 1,850ft/s

fuel-air-ratio by mass = $\frac{\dot{m}_{fuel}}{\dot{m}_{air}} = 0.04$

Assumption

Engine exit pressure = Ambient ($P_e = P_\infty$)

$$T = (\dot{m}_{air} + \dot{m}_{fuel})V_j - \dot{m}_{air}V_\infty$$

$$\dot{m}_{fuel} = 0.04\dot{m}_{air}$$

$$\Rightarrow T = (\dot{m}_{air} + 0.04\dot{m}_{air})V_j - \dot{m}_{air}V_\infty$$

$$30{,}000 = (1.04\dot{m}_{air})(1850) - 250\dot{m}_{air}$$

$$30000 = 1674\dot{m}_{air}$$

$$\therefore \quad \dot{m}_{air} = \frac{30000}{1674} = 17.9211 \text{ slug/s}$$

Also $\dot{m}_{air} = \rho V_\infty A_{in}$ where ρ = Air density
A_{in} = Inlet area of engine

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$$\therefore \quad A_{in} = \frac{\dot{m}_{air}}{\rho V_\infty}$$

From tables provided

$\rho = 2.3769 \times 10^{-3}$ slug/ft^3 at sea level

$$\therefore \quad A_{in} = \frac{17.9211 \text{ slug/s}}{2.3769 \times 10^{-3} \text{ slug/ft}^3 \times 250 \text{ ft/s}}$$

$$A_{in} = 30.16 \text{ ft}^2$$