CEE 3804: Computer Applications in Civil Engineering
Spring 2026

Assignment 2: Excel Pivot Tables and Excel Functions

Date Due: February 9, 2026 (Midnight).
Instructor: Trani

Show all your work including screen captures of Excel pivot tables, VBA code, etc. Create a single PDF file for the complete homework and submit a single file.

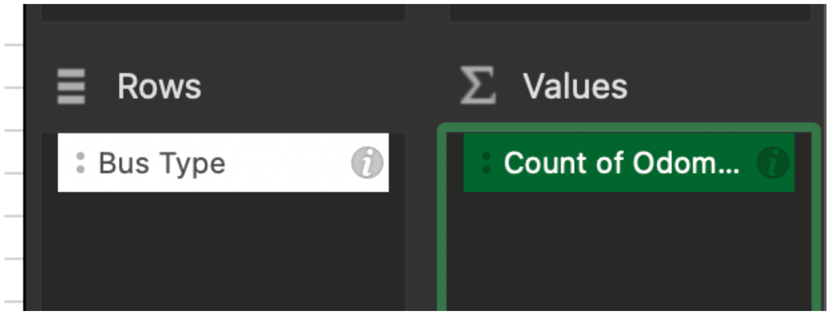
Problem 1

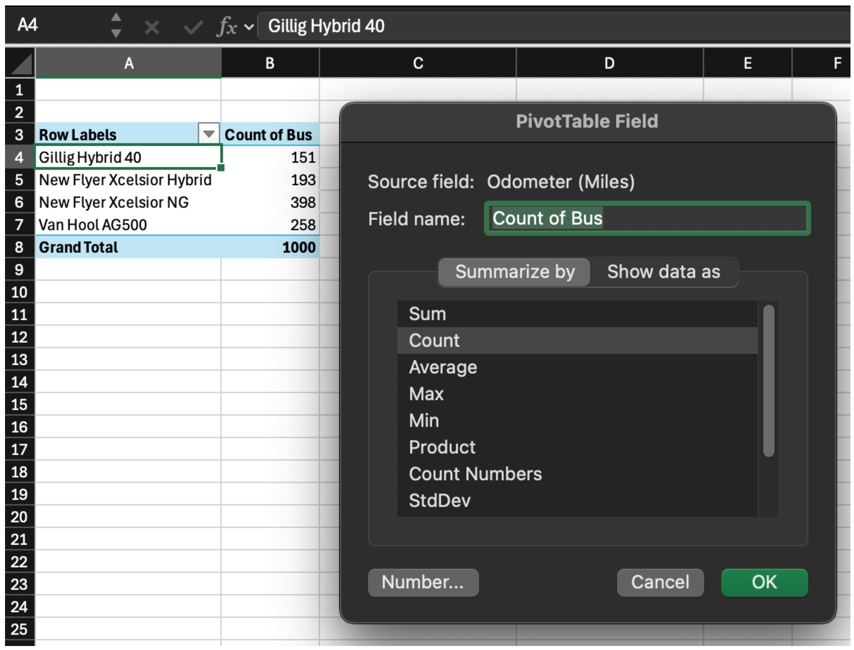
Use the California Transit Company file provided to answer the following questions. Figure 1 shows a sample view of the file.

	A	B	C	D
1	**City**	**Bus Type**	**Odometer (Miles)**	**Route length (miles)**
2	Los Angeles	Gillig Hybrid 40	110,498	35.6
3	San Diego	Van Hool AG500	260,756	10.9
4	Los Angeles	Van Hool AG500	71,010	17.0
5	San Diego	New Flyer Xcelsior	132,532	22.2
6	San Luis Obispo	Van Hool AG500	200,620	17.4
7	San Jose	New Flyer Xcelsior	208,128	15.0
8	San Diego	New Flyer Xcelsior	49,451	35.8
9	Los Angeles	Gillig Hybrid 40	148,989	27.2
10	San Jose	New Flyer Xcelsior	91,645	13.0

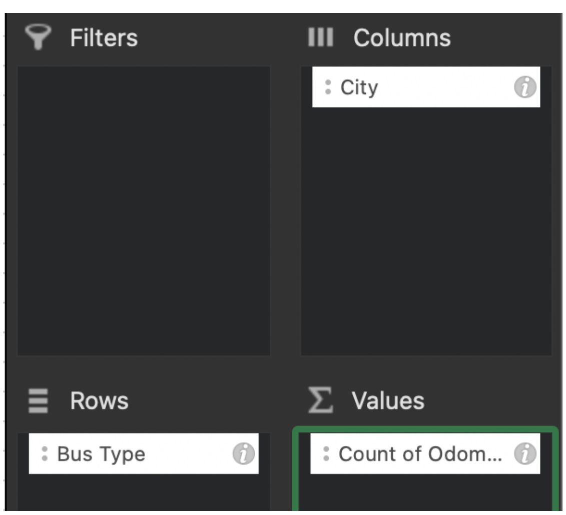
Figure 1. Sample View of Transit Company Buses.

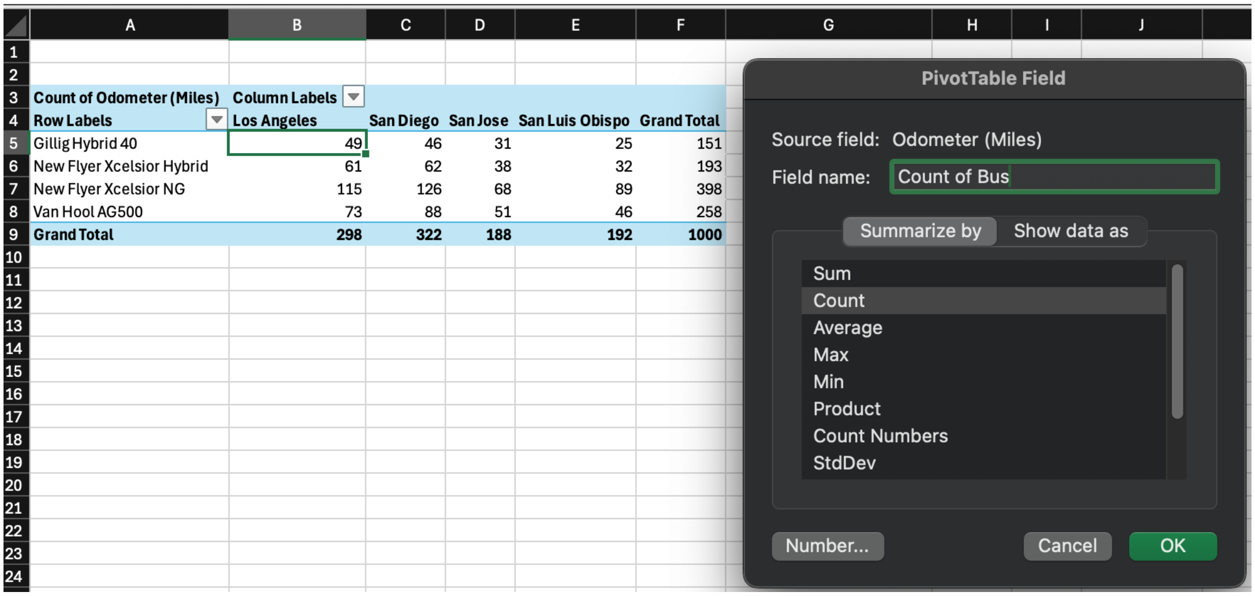
a) Create a Pivot Table to summarize the number of buses of each type owned by the company. Show a screen capture of the Pivot Table. Create the Pivot Tables in the assignment in separate tables to help you organize your answers.
See the figures below to illustrate the Pivot Table to count four types of buses in the data set.





b) Create another Pivot Table to summarize the number of buses owned by the company by type and by city (show a matrix). Show a screen capture of the Pivot Table.
Improve the Pivot Table by adding the average route length by bus type and city (see the example below).

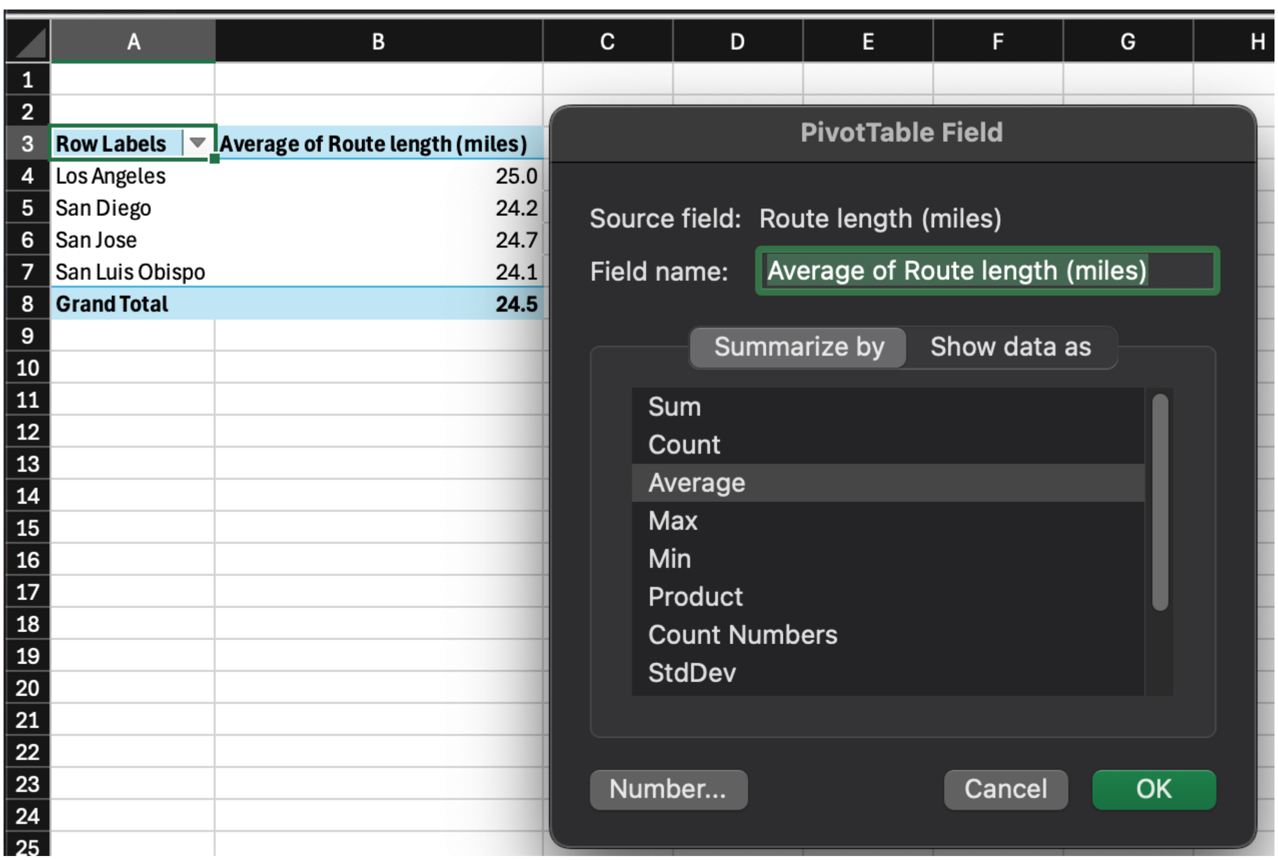




Count of Odometer (Miles)	Column Labels				
Row Labels	Los Angeles	San Diego	San Jose	San Luis Obispo	Grand Total
Gillig Hybrid 40	49	46	31	25	151
New Flyer Xcelsior Hybrid	61	62	38	32	193
New Flyer Xcelsior NG	115	126	68	89	398
Van Hool AG500	73	88	51	46	258
Grand Total	298	322	188	192	1000

c) Create another Pivot Table to calculate the average route lengths at each city. Show a screen capture of the Pivot Table. Name the cities with the shortest and longest average route length.

Shortest Average Rote Length: San Luis Obispo
Longest Average Rote Length: Los Angeles

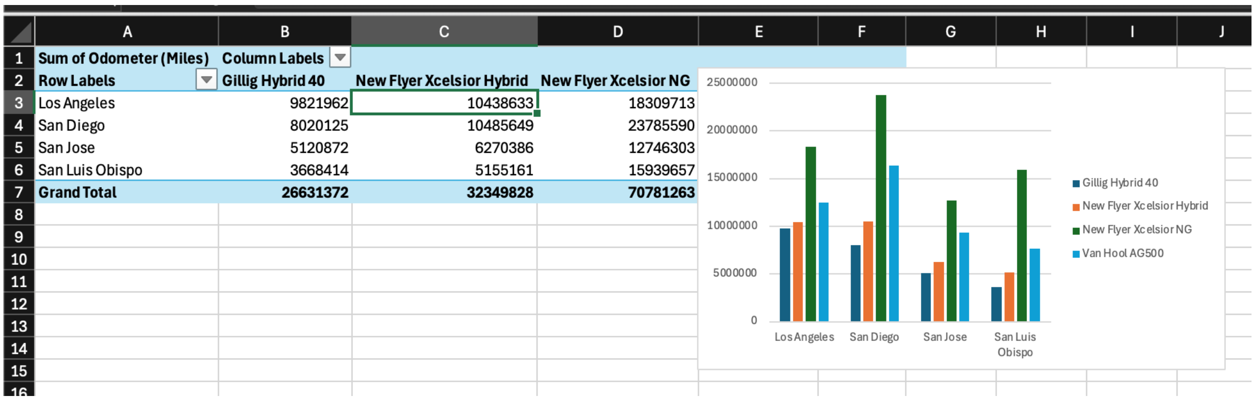


Row Labels	Average of Route length (miles)
Los Angeles	25.0
San Diego	24.2
San Jose	24.7
San Luis Obispo	24.1
Grand Total	24.5

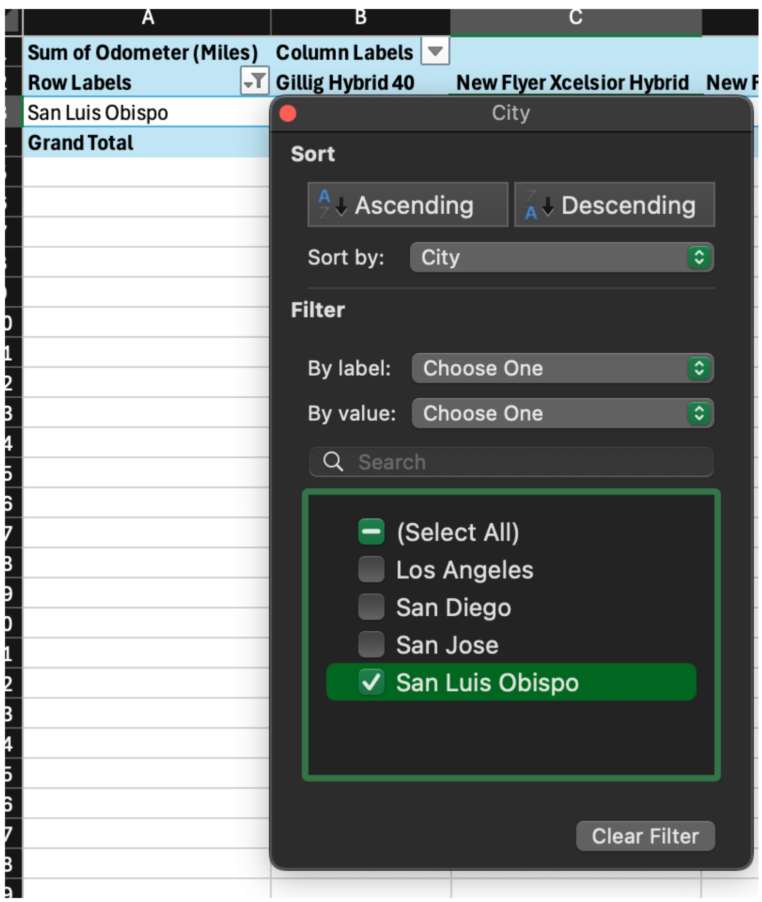
d) Use Excel to create a histogram of the odometer readings for all buses operating in San Luis Obispo. Label your axes accordingly.

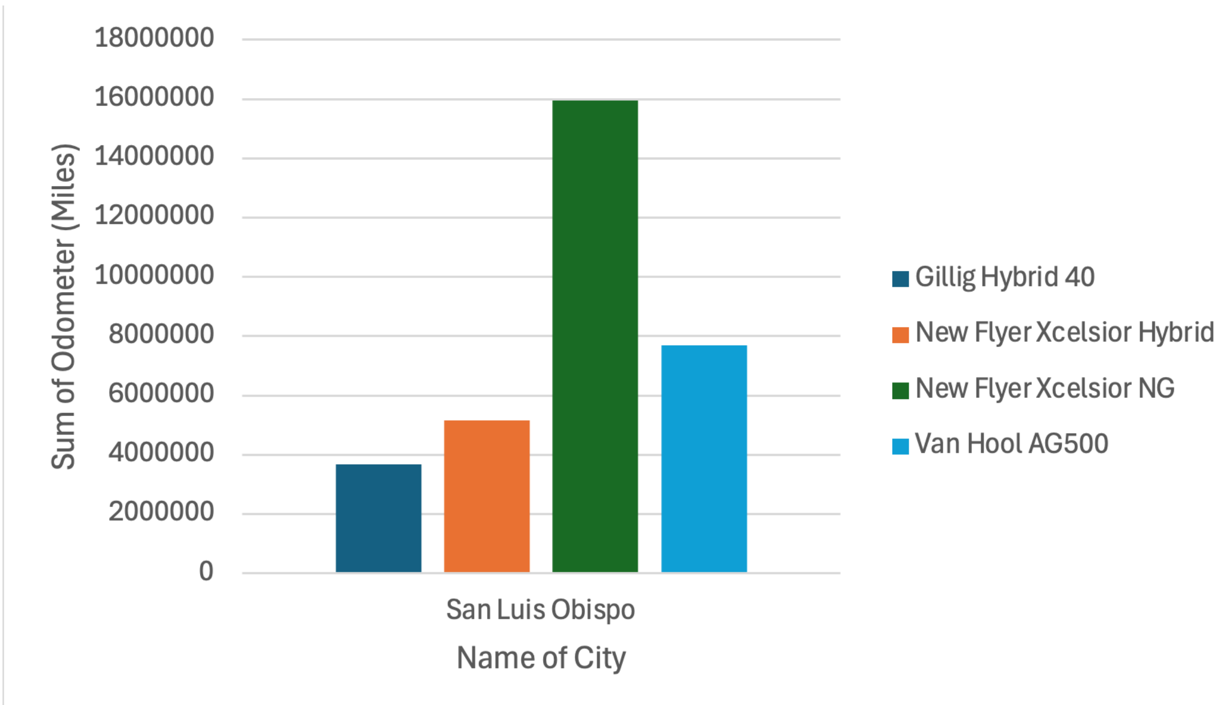
Create a PivotChart -> Filter by City -> Select San Luis Obispo

Or we can manually create the histogram.



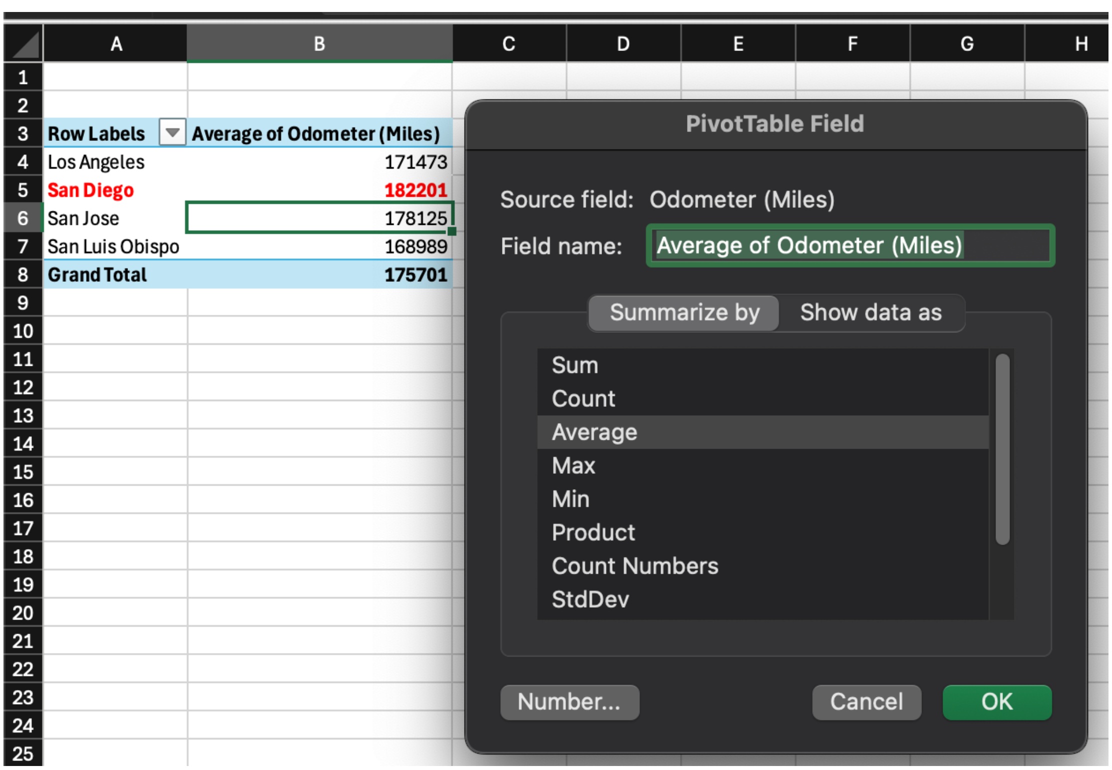
Sum of Odometer (Miles)	Column Labels		
Row Labels	Gillig Hybrid 40	New Flyer Xcelsior Hybrid	New Flyer Xcelsior NG
Los Angeles	9821962	10438633	18309713
San Diego	8020125	10485649	23785590
San Jose	5120872	6270386	12746303
San Luis Obispo	3668414	5155161	15939657
Grand Total	26631372	32349828	70781263





e) Find the mean odometer reading for buses operated in San Diego.

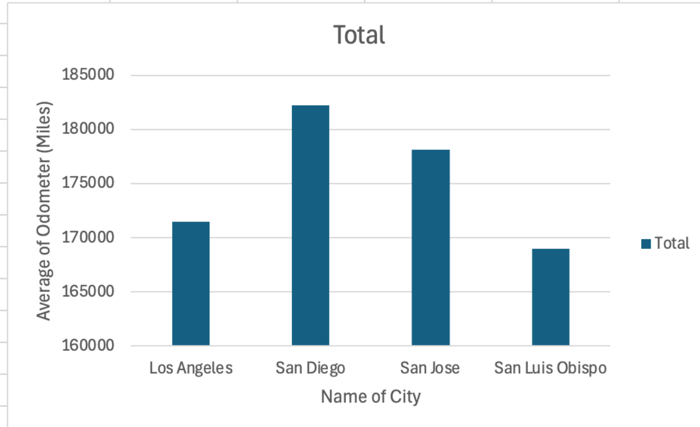
182,201 miles



f) Create a Pivot Chart showing the average odometer readings by city. Label accordingly.

The pivot chart is shown below.

Row Labels	Average of Odometer (Miles)
Los Angeles	171473
San Diego	182201
San Jose	178125
San Luis Obispo	168989
Grand Total	**175701**



Problem 2

Civil engineers design and maintain the US airport infrastructure. According to Federal Aviation Administration (FAA) records, there are 19,520 landing facilities (airports, heliports, seaplane bases, etc.) in the United States. A file containing US landing facilities is provided. Figure 2 partially illustrates the landing facility data as of January 20, 2026. With the file provided, answer the following questions:

	A	B	C	D	E	F
1	**Facility Type**	**Identifier**	**State Id**	**State Name**	**County**	**County State**
2	AIRPORT	18AA	AK	ALASKA	HAINES	AK
3	HELIPORT	AA35	AK	ALASKA	HAINES	AK
4	AIRPORT	AK46	AK	ALASKA	MATANUSKA-SUSITNA	AK
5	AIRPORT	ADK	AK	ALASKA	ALEUTIANS WEST	AK
6	AIRPORT	9AA9	AK	ALASKA	HAINES	AK
7	AIRPORT	5AK3	AK	ALASKA	FAIRBANKS NORTH STAR	AK
8	AIRPORT	AK10	AK	ALASKA	MATANUSKA-SUSITNA	AK
9	AIRPORT	AKK	AK	ALASKA	KODIAK ISLAND	AK
10	SEAPLANE BASE	KKI	AK	ALASKA	BETHEL	AK
11	AIRPORT	Z13	AK	ALASKA	BETHEL	AK
12	AIRPORT	AKI	AK	ALASKA	BETHEL	AK

Figure 2. Sample View of United States Airport Database.

a) Use a Pivot Table to find the number of landing facilities **by state**. Landing facilities can be airports, heliports, sea plane bases, etc. Show me the first few rows of the Pivot Table.

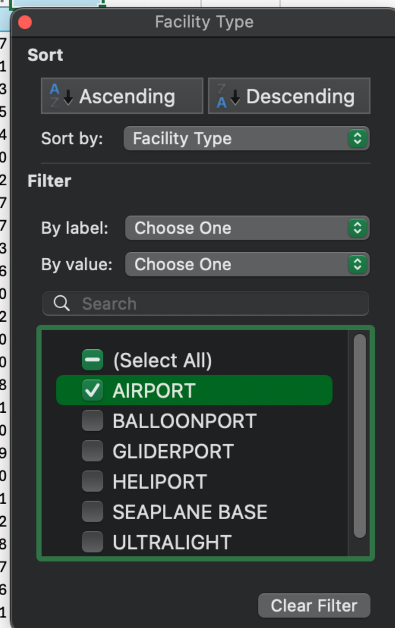
The pivot table is shown below.

Count of Identifier	Column Labels						
Row Labels	AIRPORT	BALLOONPORT	GLIDERPORT	HELIPORT	SEAPLANE BASE	ULTRALIGHT	Grand Total
ALABAMA	187			148	7		342
ALASKA	591			55	131		777
AMERICAN SAMOA	3						3
ARIZONA	185		3	111		5	304
ARKANSAS	244		1	79		2	326
CALIFORNIA	480		4	389	3	1	877
COLORADO	262		1	169	2	1	435
CONNECTICUT	47	1		43	4	1	96
DELAWARE	27			10			37
DIST. OF COLUMBIA	3			11			14
FLORIDA	486		2	383	61	2	934
GEORGIA	340		1	127	3		471
GUAM	2			1			3
HAWAII	30			13			43
IDAHO	270		1	51	4	1	327
ILLINOIS	398		2	230	4	5	639
INDIANA	351			112	32	8	503
IOWA	200			94		1	295
KANSAS	349	1	2	32		3	387
KENTUCKY	150			120		2	272
LOUISIANA	241			177	8	16	442
MAINE	122			55	54	2	233
MARYLAND	138			66	4		208
MASSACHUSETTS	67	1		103	18		189
MICHIGAN	326	1		145	15	2	489
MIDWAY ISLANDS	1						1
MINNESOTA	298			107	69	2	476
MISSISSIPPI	202			42			244
MISSOURI	368			134	3	5	510
MONTANA	275			42	3	2	322
N MARIANA ISLANDS	4			1			5
NEBRASKA	204			37	1	1	243
NEVADA	104		1	54		1	160
NEW HAMPSHIRE	52			95	18		165
NEW JERSEY	88	4		174	7		273
NEW MEXICO	132			35	1	1	169
NEW YORK	337	1	2	153	14	2	509
NORTH CAROLINA	361	1	1	147	1	4	515
NORTH DAKOTA	247			18	1	1	267
OHIO	389	1	2	191	3	1	587
OKLAHOMA	374			89		5	468
OREGON	334		1	88	3	1	427
PALMYRA ATOLL	1						1
PENNSYLVANIA	356	1	3	309	11	13	693
PUERTO RICO	14			32	2		48
RHODE ISLAND	9			12	1		22
SOUTH CAROLINA	158		1	51	2	3	215
SOUTH DAKOTA	143			43	1		187
TENNESSEE	240		2	112	3	2	359
TEXAS	1535		5	467	3	8	2018
UTAH	109			78			187
VERMONT	62			26	5		93
VIRGIN ISLANDS	2			1	2		5
VIRGINIA	259	1	1	127	9	1	398
WAKE ISLAND	1						1
WASHINGTON	356			145	23	3	527
WEST VIRGINIA	72			38	10	2	122
WISCONSIN	403			105	18	5	531
WYOMING	101			25			126
Grand Total	**13090**	**13**	**36**	**5702**	**564**	**115**	**19520**

b) Use another Pivot Table to find the number of airports (label in column A is airport) by state. Show me the first few rows of the Pivot Table.

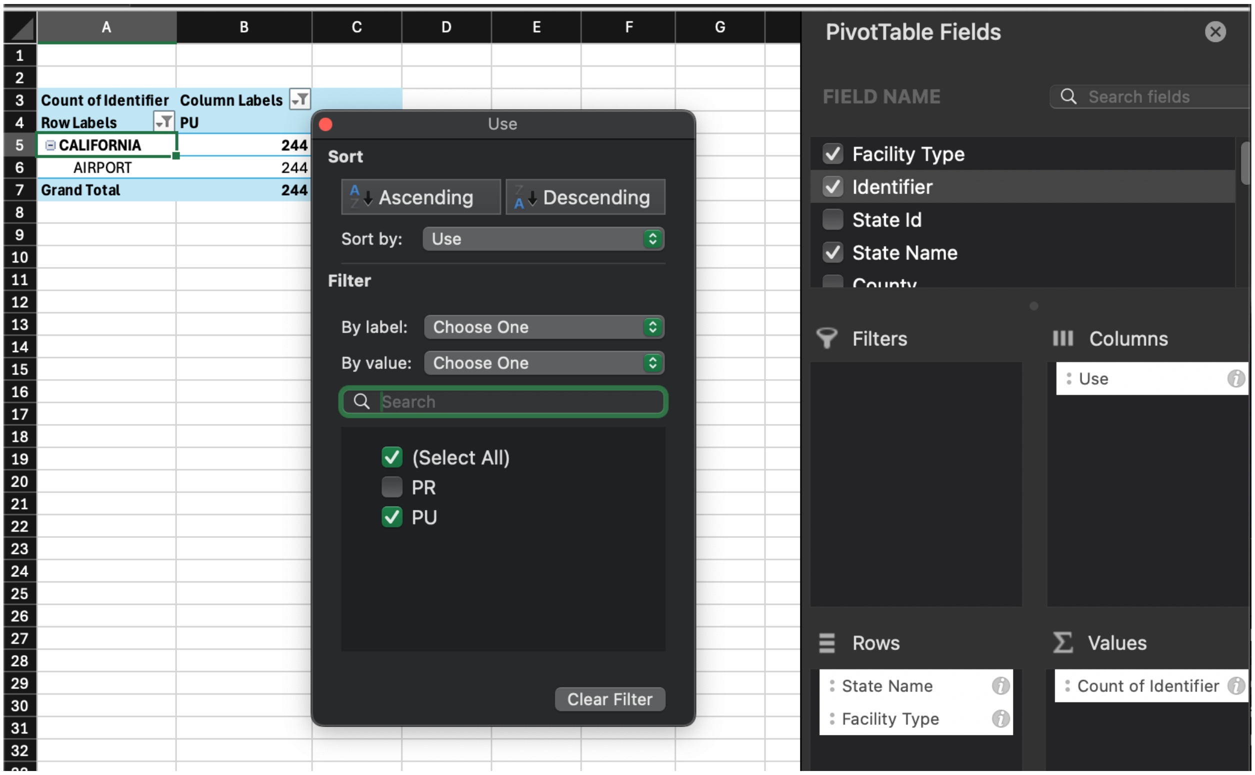
The pivot table is shown below. Filter by Facility Type -> Select Airport

Count of Identifier	Column Labels	
Row Labels	AIRPORT	
ALABAMA	187	
ALASKA	591	
AMERICAN SAMOA	3	
ARIZONA	185	
ARKANSAS	244	
CALIFORNIA	480	
COLORADO	262	
CONNECTICUT	47	
DELAWARE	27	
DIST. OF COLUMBIA	3	
FLORIDA	486	
GEORGIA	340	
GUAM	2	
HAWAII	30	
IDAHO	270	
ILLINOIS	398	
INDIANA	351	
IOWA	200	
KANSAS	349	
KENTUCKY	150	
LOUISIANA	241	
MAINE	122	
MARYLAND	138	
MASSACHUSETTS	67	
MICHIGAN	326	
MIDWAY ISLANDS	1	
MINNESOTA	298	298
MISSISSIPPI	202	202
MISSOURI	368	368
MONTANA	275	275
N MARIANA ISLANDS	4	4
NEBRASKA	204	204
NEVADA	104	104
NEW HAMPSHIRE	52	52
NEW JERSEY	88	88
NEW MEXICO	132	132
NEW YORK	337	337
NORTH CAROLINA	361	361
NORTH DAKOTA	247	247
OHIO	389	389
OKLAHOMA	374	374
OREGON	334	334
PALMYRA ATOLL	1	1
PENNSYLVANIA	356	356
PUERTO RICO	14	14
RHODE ISLAND	9	9
SOUTH CAROLINA	158	158
SOUTH DAKOTA	143	143
TENNESSEE	240	240
TEXAS	1535	1535
UTAH	109	109
VERMONT	62	62
VIRGIN ISLANDS	2	2
VIRGINIA	259	259
WAKE ISLAND	1	1
WASHINGTON	356	356
WEST VIRGINIA	72	72
WISCONSIN	403	403
WYOMING	101	101
Grand Total	**13090**	**13090**



c) Using a Pivot Table, find the number of **public use airports** in California. Public airports are identified by the letters PU in column (J). Highlight in yellow the answer to help grading.

There are 244 public use airports in California.



d) Create a new Pivot Table to fid the number of airports that have paved runways in Texas and Virginia. Highlight in yellow the answers in yellow to help with grading.

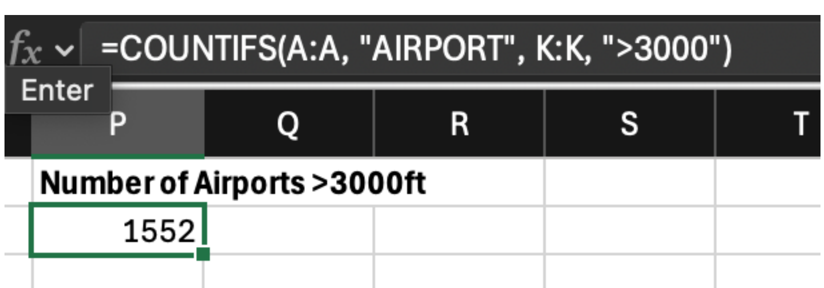
NO NEED TO SOLVE

e) Use a **CountIF** statement to find the number of airports located at elevations greater than 3,000 feet.

1552 airports.

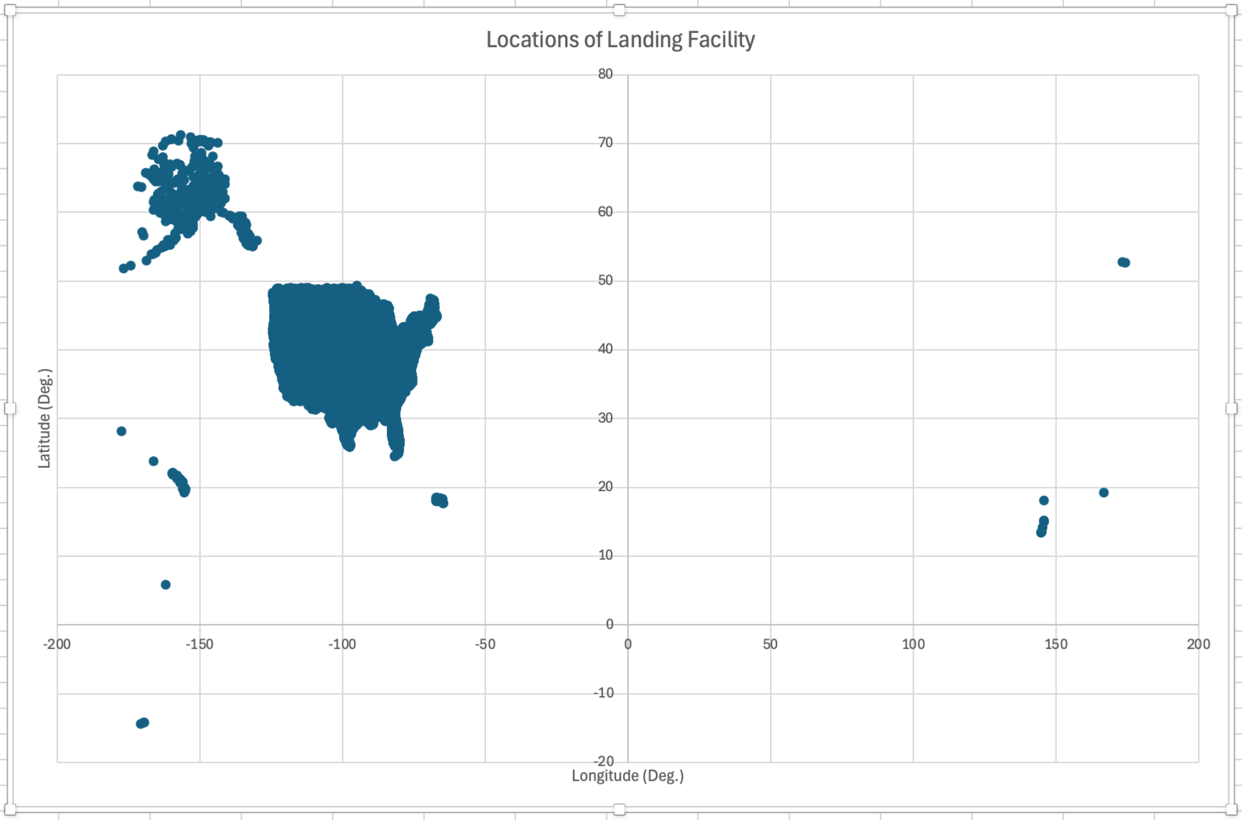
COUNTIFS can take multiple ranges.

=COUNTIFS(A:A, "AIRPORT", K:K, ">3000")



f) Make a scatter plot of the landing facility Longitude (column N) and landing facility Latitude (column M). Label your axes. Comment on the location of the landing facilities contained in the file.

The airport facilities file contains information about the landing facilities in the U.S. and its territories (i.e., Puerto Rico, Guam, etc.).



Problem 3

Use the car data file provided in class (week 1) to answer the following.

Model	Country	Type	Weight_lbs	Turning Circle_ft	Displacement_cInch	Horsepower_hp	Gas Tank Size_gallons
Acura Integra	Japan	Small	2700	37	112	130	13.2
Acura Legend V6	Japan	Medium	3265	42	163	160	18
Audi 100	Other	Medium	2935	39	141	130	21.1
Audi 80	Other	Compact	2670	35	121	108	15.9
Audi 90	Other	Compact	2790	35	141	130	15.9
BMW 325i	Other	Compact	2895	35	152	168	16.4
BMW 535i	Other	Medium	3640	39	209	208	21.1
Buick Century	USA	Medium	2880	41	151	110	15.7

a) Perform a polynomial regression using Excel to estimate the best regression model that relates vehicle the engine horsepower plotted in the x-axis, and the gas tank size (plotted in the y-axis). Use the **trend analysis function** in Excel to estimate the polynomial coefficients A, B, C of the curve that fits the data best. The second-order polynomial equation is of the type:

$$GT = A(HP^2) + B(HP) + C$$

Where:

GT is the gas tank size (gallons)

HP is the engine horsepower (horsepower)

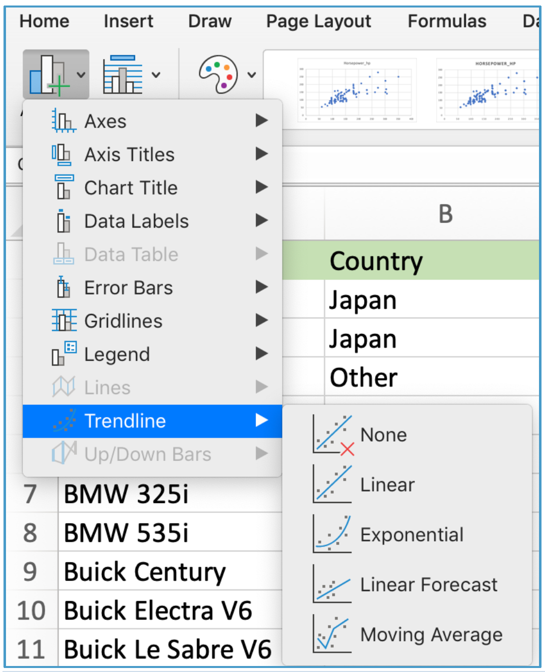
A, B, C are the polynomial coefficients of the trend line found by Excel.

The steps to make a trend line from a chart are:

i) Select the chart.

ii) Click the + button on the right side of the chart or select the Add Chart Element in the Chart Design Tab.

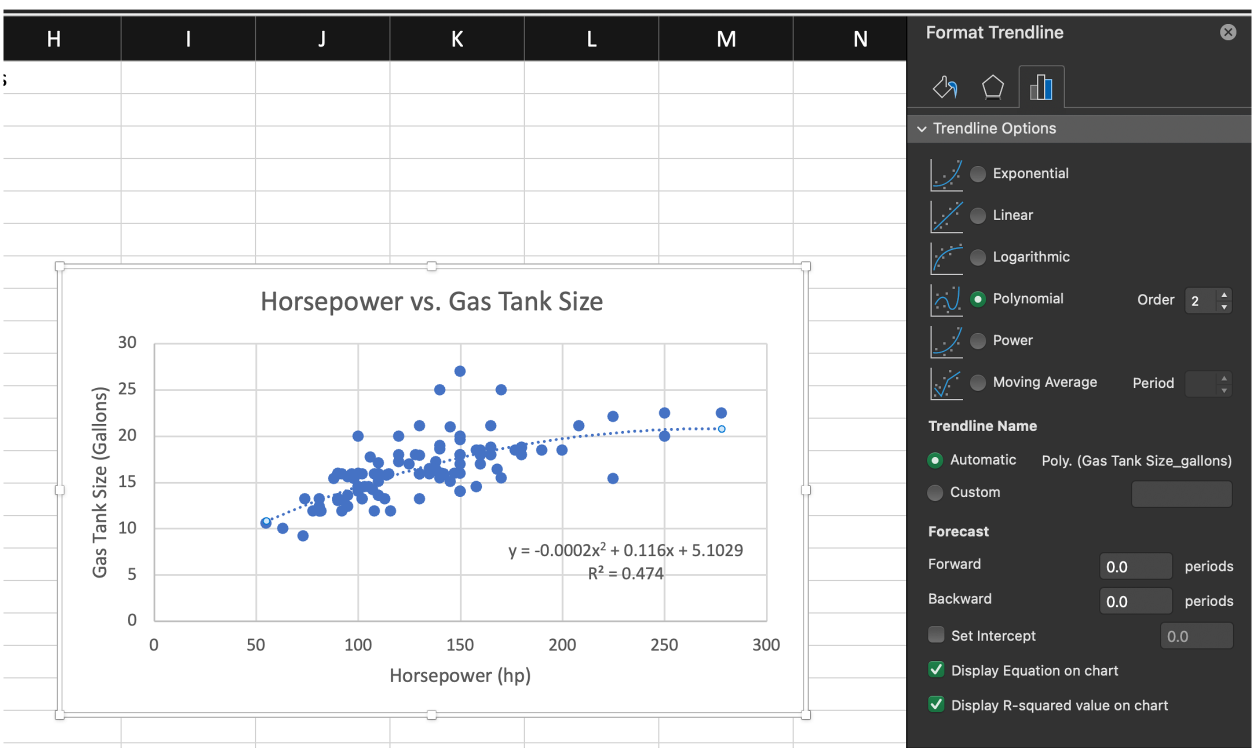
iii) Select the Trendline and make your selection of Options (see figure below).



Making a Trend Line in Excel.

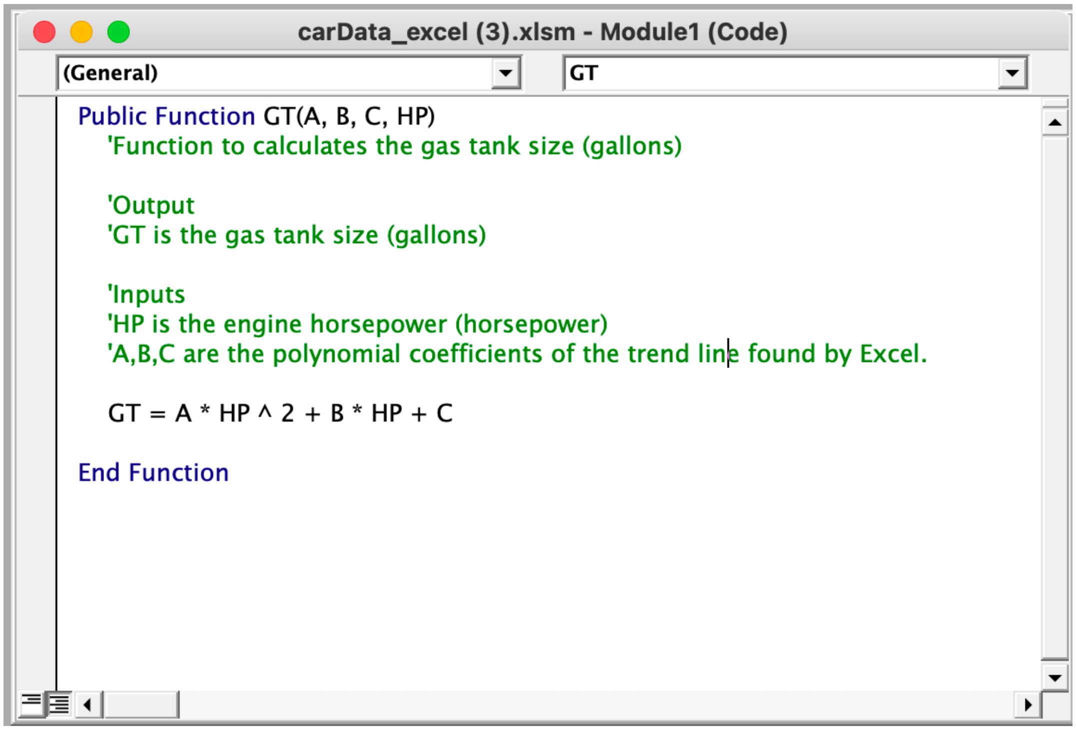
According to the second-order polynomial regression, the equation and the value of R^2 are:

$$y = -0.0002x^2 + 0.116x + 5.1029$$
$$R^2 = 0.474$$



b) Create a function using Visual Basic for Applications (VBA) to calculate the gas tank size (dependent variable) given the engine horsepower.

Although polynomial coefficients are fixed, we recommend treating them as inputs so we can change them as needed.



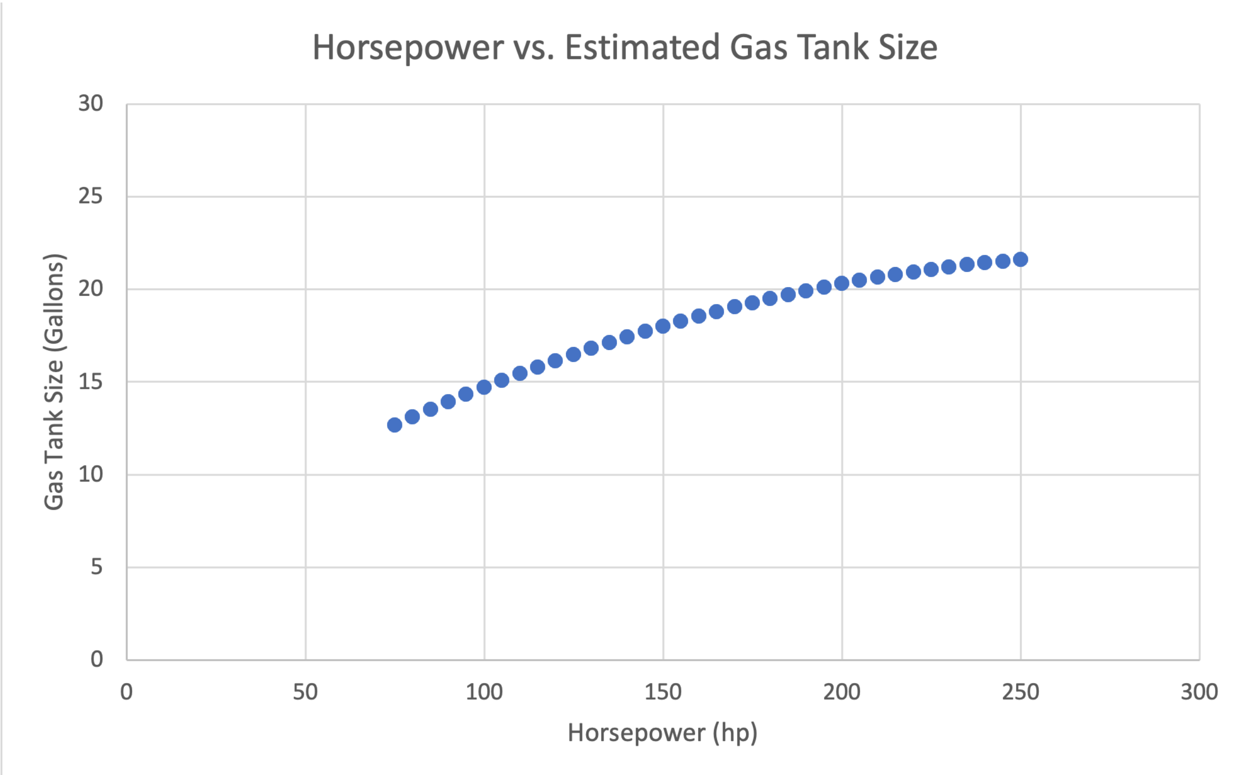

```
Public Function GT(A, B, C, HP)
    'Function to calculates the gas tank size (gallons)

    'Output
    'GT is the gas tank size (gallons)

    'Inputs
    'HP is the engine horsepower (horsepower)
    'A,B,C are the polynomial coefficients of the trend line found by Excel.

    GT = A * HP ^ 2 + B * HP + C

End Function
```

c) Test the function created in part (b) to estimate the engine horsepower expected for engine horsepower ranging from 75 to 250 at steps of 5 HP. Make a plot to check your solution.

The function and the plot of engine horsepower versus gas tank size are shown below:

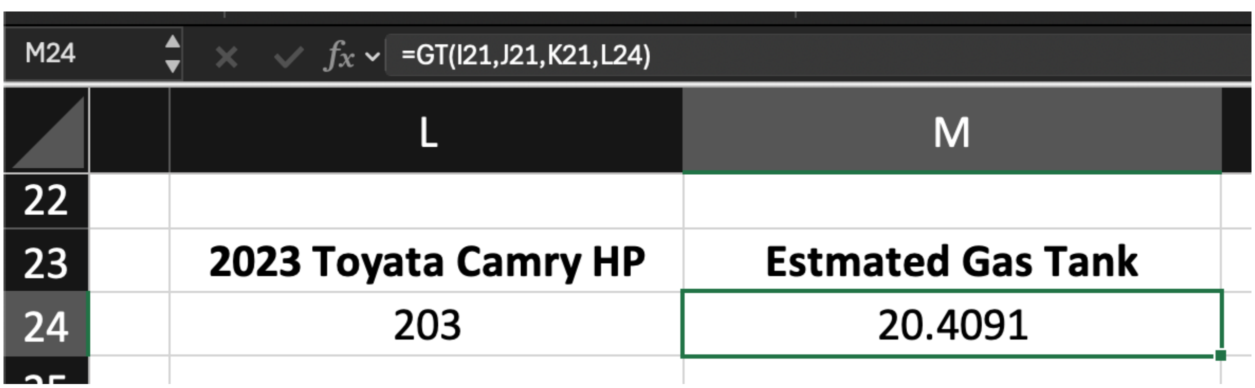
SUM =GT(I21,J21,K21,I24)

	I	J	K
19		Polynomial Coefficients	
20	A	B	C
21	-0.0002	0.116	5.1029
22			
23	**HP**	**Estimated Gas Tank**	
24	75	K21,I24)	
25	80	13.1029	
26	85	13.5179	
27	90	13.9229	
28	95	14.3179	
29	100	14.7029	
30	105	15.0779	
31	110	15.4429	
32	115	15.7979	
33	120	16.1429	
34	125	16.4779	
35	130	16.8029	
36	135	17.1179	
37	140	17.4229	
38	145	17.7179	
39	150	18.0029	
40	155	18.2779	
41	160	18.5429	
42	165	18.7979	
43	170	19.0429	
44	175	19.2779	
45	180	19.5029	
46	185	19.7179	
47	190	19.9229	
48	195	20.1179	
49	200	20.3029	
50	205	20.4779	
51	210	20.6429	
52	215	20.7979	
53	220	20.9429	
54	225	21.0779	
55	230	21.2029	
56	235	21.3179	
57	240	21.4229	
58	245	21.5179	
59	250	21.6029	



d) A 2023 Toyota Camry has a four-cylinder, 203 horsepower engine. Use the function created in part (c) to estimate the gas tank size.

The estimated gas tank size for the 2023 Toyota Camry is 20.4091 gallons.



	L	M
22		
23	2023 Toyata Camry HP	Estmated Gas Tank
24	203	20.4091

Problem 4

A simple formula used by Civil Engineers to predict **Storm Water Runoff** is shown below.

$Q = C_f CIA$

Where:

Q is the peak storm water runoff rate (ft^3/second)

C_f is the runoff coefficient adjustment factor (dimensionless)

C is the runoff coefficient (dimensionless and depends on the surface)

I is the rainfall intensity (inches/hour)

A is the drainage area (acres)

Table 1 shows typical values of the runoff coefficient (*C*) for various surfaces.

Table 1. Typical Values of Runoff Coefficient for Various Surfaces.

Surface	Runoff Coefficient (dimensionless)
Forested	0.13
Asphalt	0.85
Concrete	0.88
Brick	0.75

a) Create an Excel function to calculate the runoff (Q) given four inputs: C_f, C, I, A. The function takes four inputs and produces one output.

The VBA function to calculate the runoff (Q) is shown below.

Problem4.xlsm - Module1 (Code)

(General) | runoff

```
Public Function runoff(Cf, C, I, A)

'Function to predict storm water runoff

'Output
'Q(runoff) is the peak storm water runoff rate (ft3/second)

'Input
'C_f is the runoff coefficient adjustment factor (dimensionless)
'C is the runoff coefficient (dimensionless and depends on the surface)
'I is the rainfall intensity (inches/hour)'
'A is the drainage area (acres)

    runoff = Cf * C * I * A

End Function
```

b) Test the function created in part (b) to estimate the runoff generated by a large asphalt parking lot with a drainage area of 7.5 acres. Assume a 100-year storm rainfall rate of 8.2 inches/hr. For typical applications, the value of C_f is 1.0.

The runoff generated by a large asphalt parking lot is 52.275 ft^3/second.

=runoff(C9, C10, C11, C12)

B	C
Surface	**Runoff Coefficient**
Forested	0.13
Asphalt	0.85
Concrete	0.88
Brick	0.75
	Values
Cf	1
C	0.85
I	8.2
A	7.5
Q	52.275

c) Perform a sensitivity analysis to estimate the runoff (Q) as a function of drainage area (A). Create a table in Excel with drainage areas ranging from 1 to 20 acres at steps of one acre. For this part assume the drainage surface is asphalt. Assume a 100-year storm rainfall rate of 8.2 inches/hr.

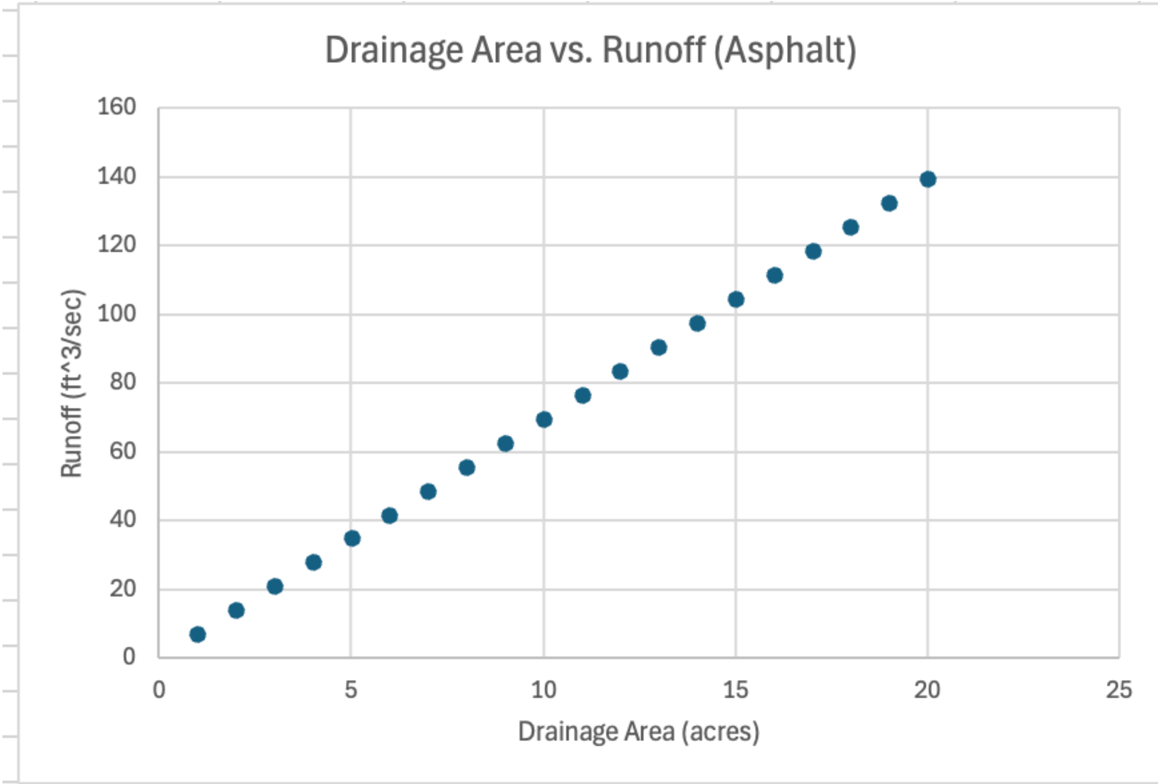
The result of the sensitivity analysis is shown below.

fx =runoff(G9,G10,G11,G12)

F	G	H	I	J
	Values			
Cf	1			
C	0.85			
I	8.2			**Values**
	1			6.97
	2			13.94
	3			20.91
	4			27.88
	5			34.85
	6			41.82
	7			48.79
	8			55.76
	9			62.73
A	10		**Q**	69.7
	11			76.67
	12			83.64
	13			90.61
	14			97.58
	15			104.55
	16			111.52
	17			118.49
	18			125.46
	19			132.43
	20			139.4

d) Plot the drainage area (independent variable) versus the runoff (dependent variable). Label accordingly.

The plot of the drainage area vs. the runoff is shown below.

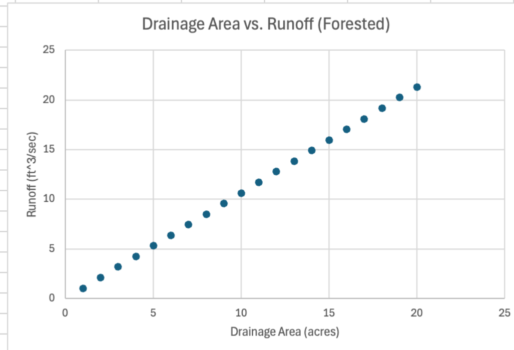


e) Repeat the analysis of part (c) but assume the drainage area is forested.

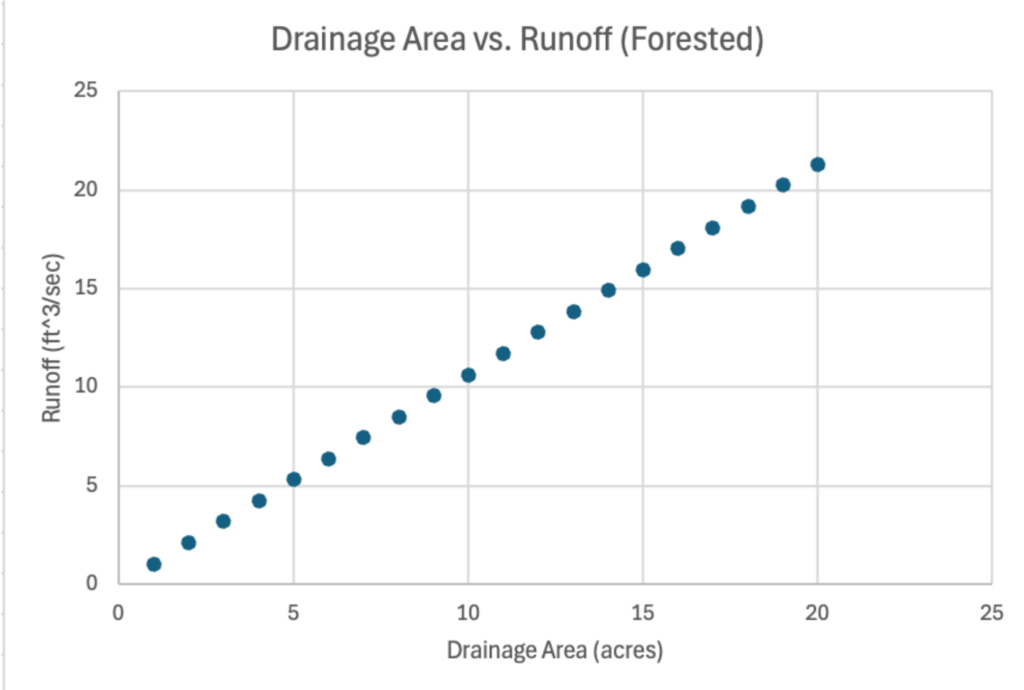
The results of the analysis for the forested area are shown below.

`=runoff($G$45,$G$46,$G$47,G48)`

	Values		
Cf	1		
C	0.13		
I	8.2		Values
	1		1.066
	2		2.132
	3		3.198
	4		4.264
	5		5.33
	6		6.396
	7		7.462
	8		8.528
	9		9.594
A	10	Q	10.66
	11		11.726
	12		12.792
	13		13.858
	14		14.924
	15		15.99
	16		17.056
	17		18.122
	18		19.188
	19		20.254
	20		21.32

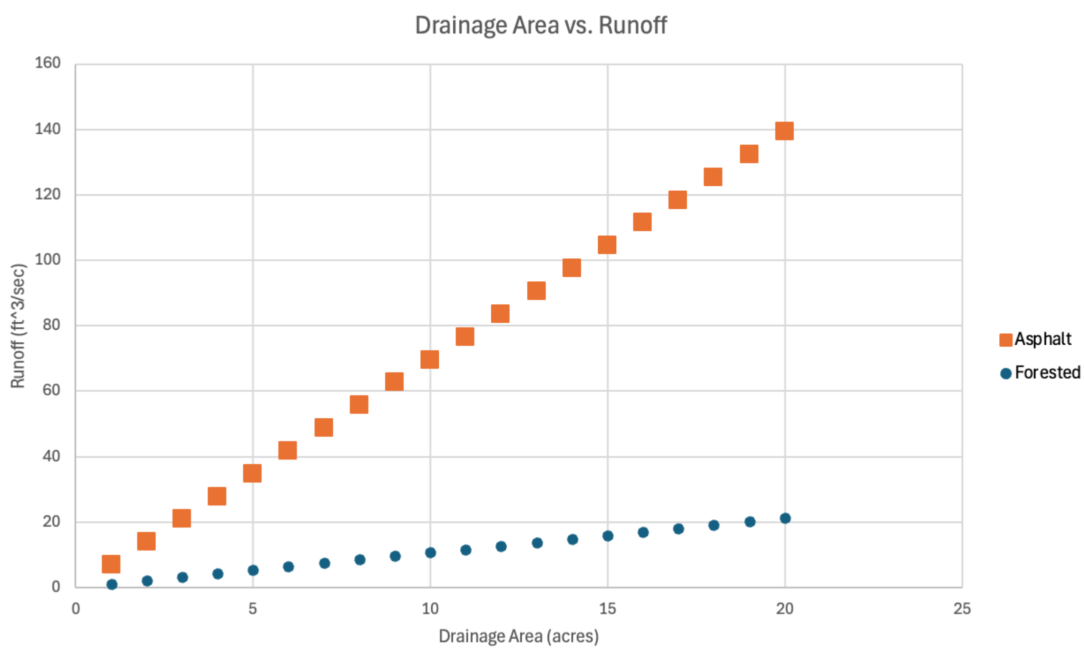


	Values		
Cf	1		
C	0.13		
I	8.2		Values
	1		1.066
	2		2.132
	3		3.198
	4		4.264
	5		5.33
	6		6.396
	7		7.462
	8		8.528
	9		9.594
A	10	Q	10.66
	11		11.726
	12		12.792
	13		13.858
	14		14.924
	15		15.99
	16		17.056
	17		18.122
	18		19.188
	19		20.254
	20		21.32



f) Improve the plot created in part (d) by adding the new runoff values for a forested drainage area. Comment on the trends observed.

As the drainage area increases, asphalt runoff tends to increase more rapidly than forested runoff.



Problem 5

A simple formula used by Civil Engineers to Stopping Sight Distance (SSD) on level grade is shown below. The SSD is an important parameter in the design of highways.

$$SSD = 1.47Vt + 1.075V^2/a$$

Where:

SSD is the stopping sight distance (feet)

V is the highway design speed (miles per hour)

t is breaking reaction time (seconds)

a is the vehicle design deceleration rate (ft/s^2)

Table 1 shows typical values used in highway design for level grades (no slope).

Table 1. Typical Values of Runoff Coefficient for Various Surfaces.

Design Parameter	Value
Braking Reaction Time	2.5 seconds
Design deceleration rate	11.2 ft/s^2

a) Create an Excel function to calculate the value of SSD given three inputs: V, a, t. The function takes three inputs and produces one output.

The VBA function for SSD calculation is shown below.

Problem5.xlsm - Module1 (Code)

(General) | ssd

```
Public Function ssd(V, t, a)
    'This function calculates the Stopping Sight Distance (SSD) on a level grade.

    'Output
    'SSD is the stopping sight distance (feet)

    'Input
    'V is the highway design speed (miles per hour)
    't is breaking reaction time (seconds)
    'a is the vehicle design deceleration rate (ft/s2)

    ssd = 1.47 * V * t + 1.075 * V ^ 2 / a

End Function
```

b) Test the function created in part (a) to estimate the stopping sight distance (SSD in feet) for design speeds ranging from 0 to 80 miles per hour at 5 mph intervals. Make a table with the results for SSD.

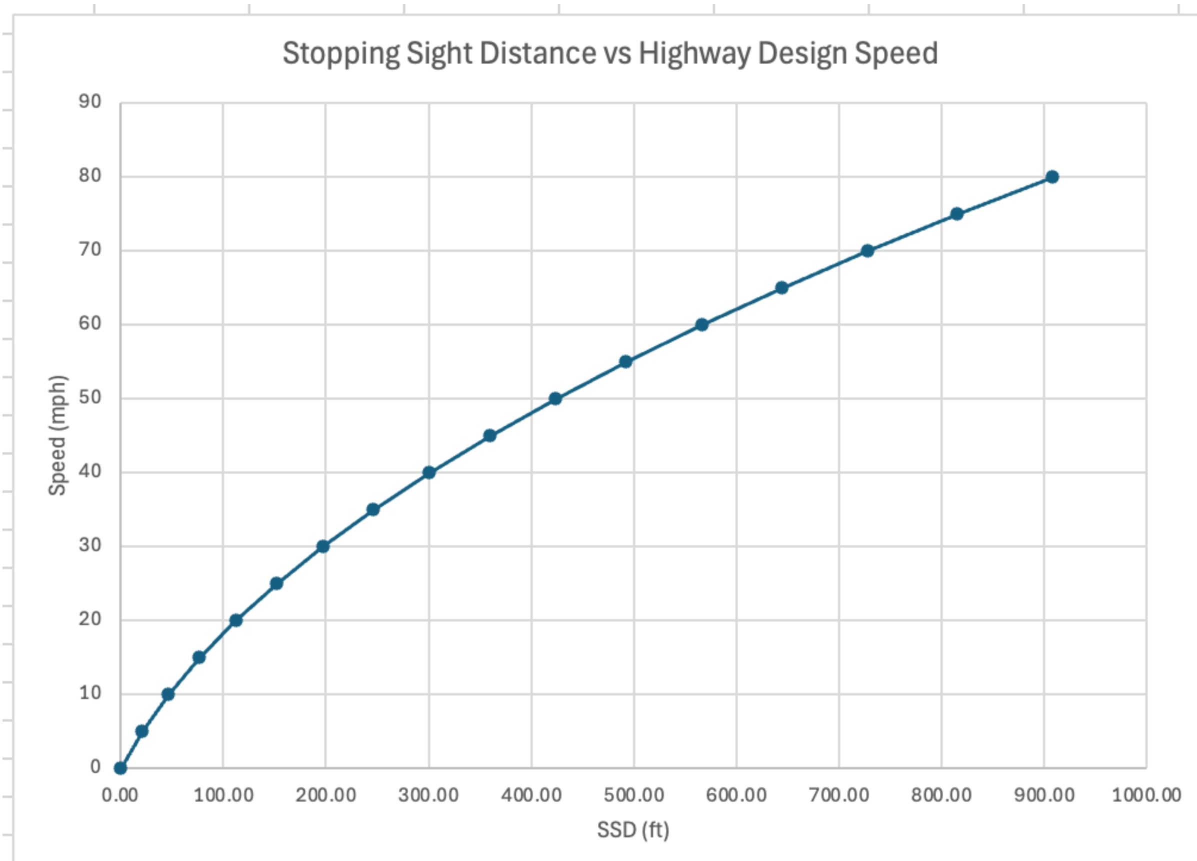
The results of SSD function are shown below.

SUM | =ssd(C7,C4,C5)

	A	B	C	D	E	F
1						
2			SSD Calculation			
3						
4		t	2.5	seconds		
5		a	11.2	ft/s^2		
6					SSD	
7		V	0		C4,C5)	
8			5		20.77	
9			10		46.35	
10			15		76.72	
11			20		111.89	
12			25		151.86	
13			30		196.63	
14			35		246.20	
15			40		300.57	
16			45		359.74	
17			50		423.71	
18			55		492.47	
19			60		566.04	
20			65		644.40	
21			70		727.56	
22			75		815.52	
23			80		908.29	

c) Plot the value of SSD (independent variable) versus the highway design speed (dependent variable). Label accordingly.

The plot of SSD and speed is shown below.



d) Compare the values obtained with your function and those published in the Texas DOT Roadway Design Manual (see https://www.txdot.gov/manuals/des/rdw/chapter-4--basic-design-criteria/4-11-sight-distance.html#:~:text=SSD = 1.47Vt + 1.075 V,Table 4-24).

Our calculated SSD matched those in the Texas DOT's Roadway Design Manual.

Table 4-23: Stopping Sight Distance on Level Grade

Design Speed (mph)	Brake Reaction Distance[1] (ft)	Braking Distance (ft)	Stopping Sight Distance	
			Calculated (ft)	Design (ft)
15	55.1	21.6	76.7	80
20	73.5	38.4	111.9	115
25	91.9	60.0	151.9	155
30	110.3	86.4	196.7	200
35	128.6	117.6	246.2	250
40	147.0	153.6	300.6	305
45	165.4	194.4	359.8	360
50	183.8	240.0	423.8	425
55	202.1	290.3	492.4	495
60	220.5	345.5	566.0	570
65	238.9	405.5	644.4	645
70	257.3	470.3	727.6	730
75	275.6	539.9	815.5	820
80	294.0	614.3	908.3	910

Notes:

1. Brake reaction distance predicated on a time of 2.5-s; deceleration rate 11.2-ft/s²