Question 1

(15 marks)

Let E = **# ounces** of Egg in the diet
Let L = **# ounces** of Liver in the diet
Let S = **# ounces** of Spinach in the diet

} 3 marks

MIN 0.10E + 0.20L + 0.04S

} 2 marks

Subject to:

Calories)	40E + 60L + 10S >= 3000	*calories*
Protein)	13E + 25L + 10S >= 70	*grams*
Iron)	4E + 18L + 10S >= 12	*milligrams*
Blending)	E >= 0.20 (E + L + S)	*ounces*
Blending)	L >= 0.20 (E + L + S)	*ounces*
Blending)	S>= 0.20 (E + L + S)	*ounces*
Non-neg)	E, L, S >= 0	

} 7 marks

Note: *The Blending constraints could also be written in standard form as:*

0.80E - 0.20L - 0.20S >= 0

0.80L - 0.20E - 0.20S >= 0

0.80S - 0.20L - 0.20E >= 0

Marking Key: (15 marks in total)
* marks as indicated above **and**
* 2 marks in total for units (Calories, grams etc)
* 1 mark in total for Names in Column A (Calories, Protein, Iron etc)

Question 2

(25 marks)

Input Data

	Each				
	Fieta	Explorer	Mustang	MarkV	
MPG	30	18	16	14	
Marginal Cost	12,500	24,100	22,700	25,700	
Selling Price	13,000	25,700	23,500	30,000	
					Total profit
Profit / unit	$ 500.00	$ 1,600.00	$ 800.00	$ 4,300.00	$ 6,550,000,000.00

Average Required MPG over all vehicles 18 *miles/gallon*

Action Plan

	Fieta	Explorer	Mustang	MarkV	Total	
# units to produce	250,000	2,000,000	0	750,000	3,000,000	*cars*

Additional constraints

	Model Output		Model Requirement	units
# Fiesta	250,000	<=	250,000	*cars*
# Explorer and Mustang	2,000,000	<=	2,000,000	*cars*
# Mustang & Mark V	750,000	<=	1,500,000	*cars*
Sales capacity	3,000,000	<=	3,000,000	*cars*
MPG (Minimum)	54,000,000	>=	54,000,000	*miles*

Marking Guide:
* This sheet is worth 25 marks
* Do NOT deduct any marks if their model layout is well organized, easily understood by the marker, and they show at least one formatting activity.
* deduct 1 mark if they do not write "Each" (or equivalent) in the Input Data section
* deduct 1 mark if it is printed in Landscape
* deduct a maximum of 2 marks in total if students do not use some formatting (bold, shading ,borders etc)
* deduct 1 mark if they include text boxes identifying changing cells, target cell or constraints
*deduct 1 mark if they include Row/Column headings
*deduct 0 marks if they print with gridlines (although the model looks much better without them)
* deduct 2 marks if they do not include the 18 MPG value in a cell
* deduct a maximum of 2 marks in total if they do not include titles (Fiesta, Marginal Cost, # units to produce , MPG, etc)
* deduct a maximum of 2 marks in total if they do not include units
* deduct 4 marks for each missing or incorrect constraint

Question 3

a. ① 7000 (liftmasters)

b. ① 3132 (frames)

c. ① $156,066

Units required for c, k, l… -1 if no units (first time only)

d. ① 1300 (liftmasters)

e. ① Cutting & Milling

f. At least 1832 ① and at most 3132 ① *(must convey range for full 2 marks)*

g. ① B *or* ② G

h. ① No.

② Within allowable ↑

i. ① False.

② [Manufacturing cost / obj. coef.] of supports would have to [decrease / improve] by at least [$4.132 / the reduced cost] to [start making supports / be in the solution]

-1 for generic correct definition, e.g., "opportunity cost"

-1 for mostly correct… guideline: 3 out of 4 [bracketed phrases]

j. ① No

k. (i) Target cell will ① decrease by ① $1059 (-$3.53 × 300) ...new value = $572,025

(ii) ① Will change. ① Binding constraint.

l. Target cell will ① decrease by ① $459 ((-$3.53 + $2) × 300) ...new value = $572,625

(OK if k & l both say ↑ and correct $459, i.e., only -1 for wrong direction in k & l)

m. ① Yes.

① They are binding constraints. *(Or, opt. solution becomes infeasible; must change)*

n. ① Yes. ① 1040 * (-$1.25) ① $1300 (or more) saved is better than $1000 cost.

Need concept of "at least"

(Also OK: (-1300) - (-1000) = -300, or -1300 < -1000)

(Also OK: target cell ↓ by at least $300)

o. (i) ① Shadow price will be [a more negative value / less than -1.25 / smaller]

(must convey direction clearly!)

(ii) Yes. ② As Cutting hours [are reduced / get scarcer], they get more valuable.

(Also OK: Law of diminishing returns)

(-1 if somewhat true. No marks for "Yes", but -1 if "No")

Question 4

a. ① =SUMPRODUCT(C7:E7,$C$18:$E$18)
or =SUMPRODUCT(C7:E7,C$18:E$18)

b. ① =K7*60 *or* =$K7*60

c. ① =C22*2 *or* =E22*2 *or* =7000*2 *(OK with $ ref)*
(OK if says it should be linked to an input cell)

d. ① sunk

For a, b, c:
- "=" is optional
- either order is OK
- -1 for incorrect references, e.g.:
  - K:7
  - C7;E7
  - C7:E7;C18:E18
    (first time only)

e. ① No.
② An change/increase in [one / any] binding constraint will [improve / decrease] the cost (or will change the optimal solution). *(Be generous; -1 if somewhat true)*

f. ① FM + FB ≥ 7000
① SM + SB ≥ 14000
① STM + STB ≥ 7000

-1 for Cutting, Milling, and/or Shaping constraints.
-1 for non-neg. constraints.
-1 for wrong sign.

g. (i) ② 1.2(FM + FB) + 1.4(SM + SB) + 0.8(STM + STB) ≤ 30,000
OK if expanded: 1.2FM + 1.2FB +1.4SM + 1.4SB + 0.8STM + 0.8STB
-1 if ≤ 500 (hours, not minutes)
-1 if only "Make" variables: 1.2FM + 1.4SM + 0.8STM
-1 if new variables: 1.2F + 1.4S + 0.8ST
-1 if wrong sign
(ii) ① Yes.
② Opt. solution becomes infeasible (33,600 > 30,000) so would have to change.
-1 if math correct but no words to "explain"
-2 if the explanation is that there is a new constraint so it must change
There are two ways to get 1 out of 3 for g.ii. when answer "No":
-1 if correct math but make mistake and answer "No"
-1 if g.i. has only Make variables, so answer "No" but for the right reason