Student ID:

Instructions: This is a take-home exam that lasts for 3 hours.

Questions 1 to 3 are based on the following information.

Amy is leading a team of 3 (including herself) to carry out a gardening project that involves 6 tasks with the following details.

Task ID	Description	Duration	Predecessor	Required Staff	Normal Cost	Slope	Allowable Reduction
A	Soil	2 weeks	None	2	$500	N/A	None
B	Walkways	2 weeks	A+FS2	2	$800	$100/week	1
C	Irrigation	3 weeks	A	1	$800	$200/week	1
D	Fence	3 weeks	A	1	$600	$120/week	1
E	Lighting	3 weeks	B, C+FS2	2	$400	$150/week	1
F	Planting	1 week	D, E	2	$300	N/A	None

Note: +FS2 represents a finish-to-start lag of 2 weeks.

The indirect cost of the project is $280 per week.

Question 1 (16 marks):

a) (12 marks) Assist Amy in creating a project planning network <u>without</u> considering the constraints on staff availability. (Hint: The following empty network can be used in your answer.)

b) (1 mark) What is the project duration?

The project duration is 11 weeks.

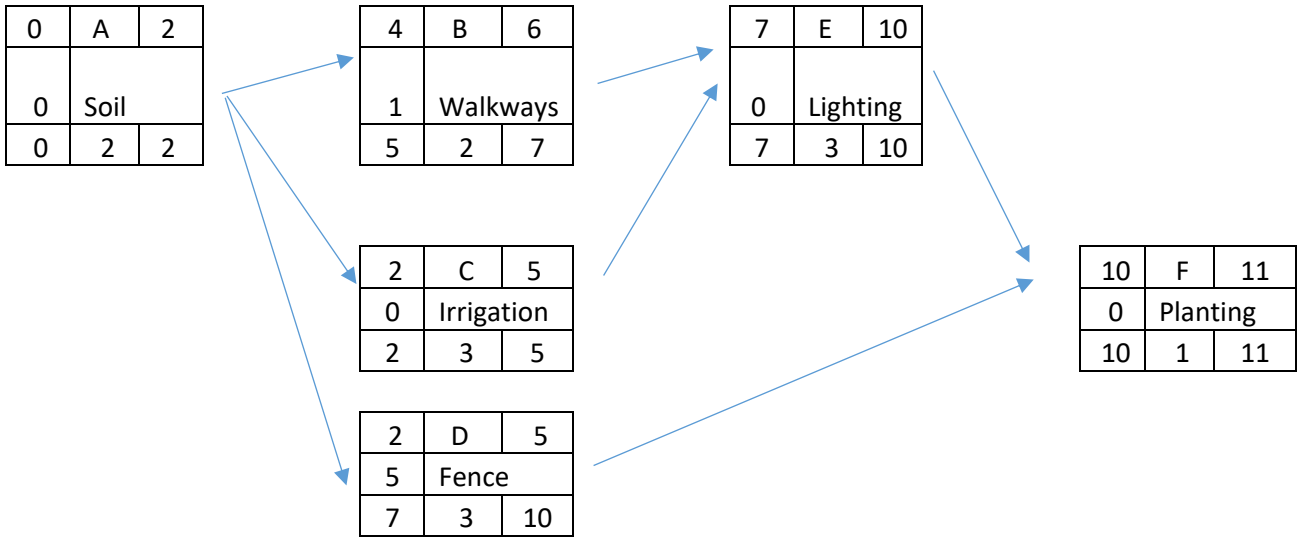
c) (1 mark) What is the critical path?

The critical path is A-C-E-F.

d) (2 marks) For each of the non-critical activity, identify the free slack.

Free slack for B: 7-6=1

Free slack for D: 10-5=5



Questions 2: (10 marks)

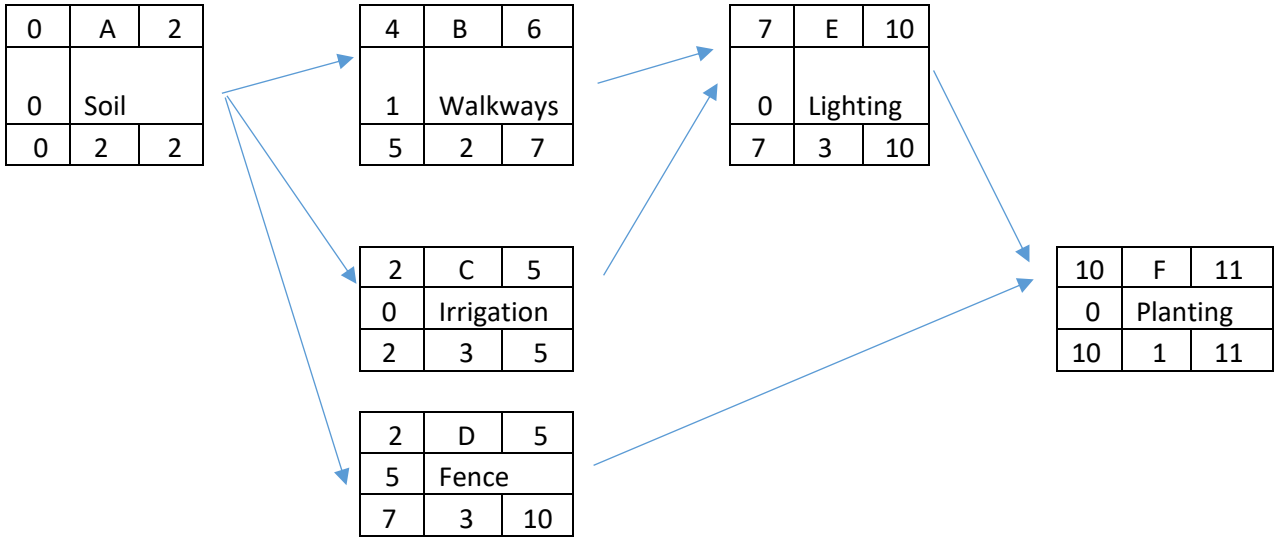
a) (6 marks) Use your answer for question 1 to create a resource consumption chart and then apply the heuristic rule that we discuss in this unit to perform the "levelling" procedure.

Task ID	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 8	Week 9	Week 10	Week 11	
A	2S	2S										
B					2S	2S						
C			S	S	S							
D						S	S	S				
E								2S	2S	2S		
F											1S	
Total	2S	2S	S	S	3S	3S	S	3S	2S	2S	1S	

b) (1 mark) Using your answer for Q1b) as the benchmark, can the project be completed without any delay?

Yes, the project can be completed without any delay.

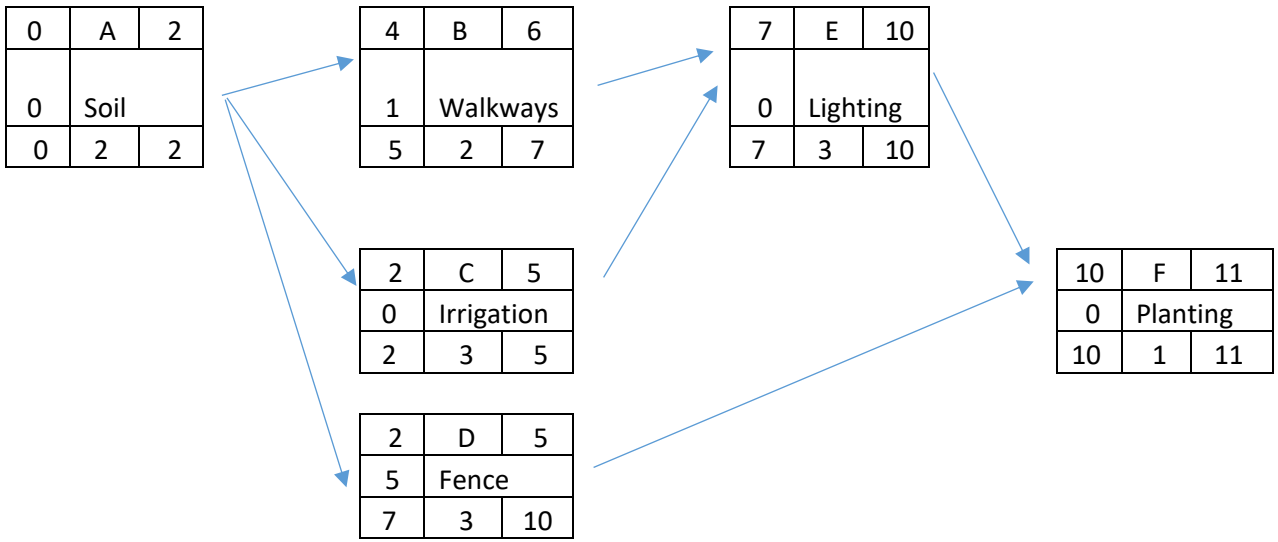
c) (3 marks) Construct the updated project network after you finish the “levelling” procedure.



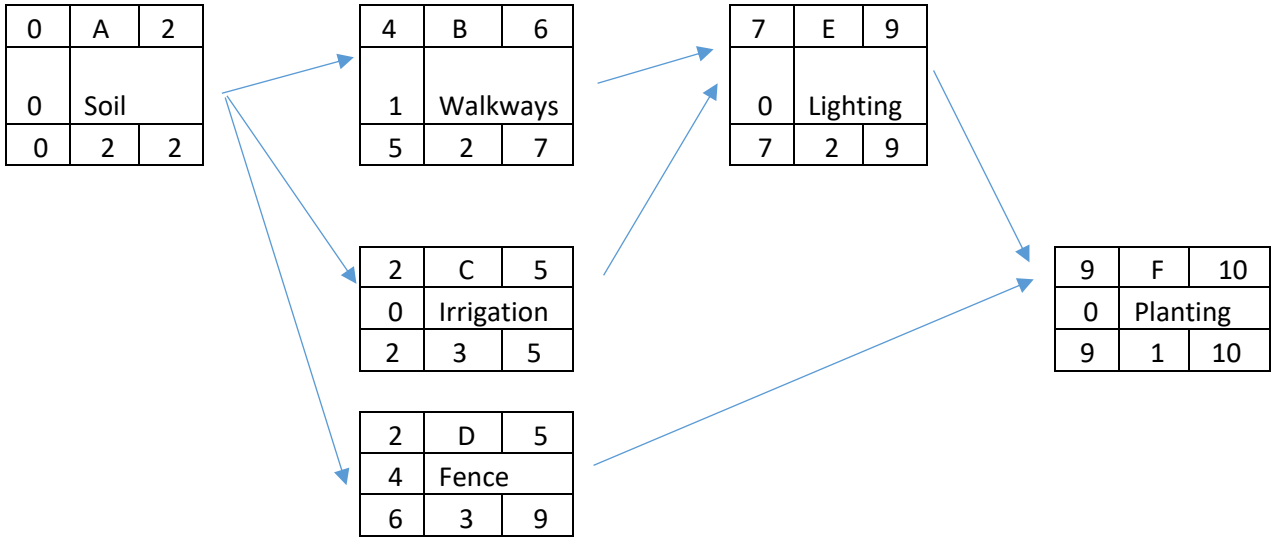
Question 3: (14 marks) Amy wishes to reduce the project duration as much as possible.

a) (9 marks) Use your answer for Question 2 as the starting point to construct the optimal crashing plan.

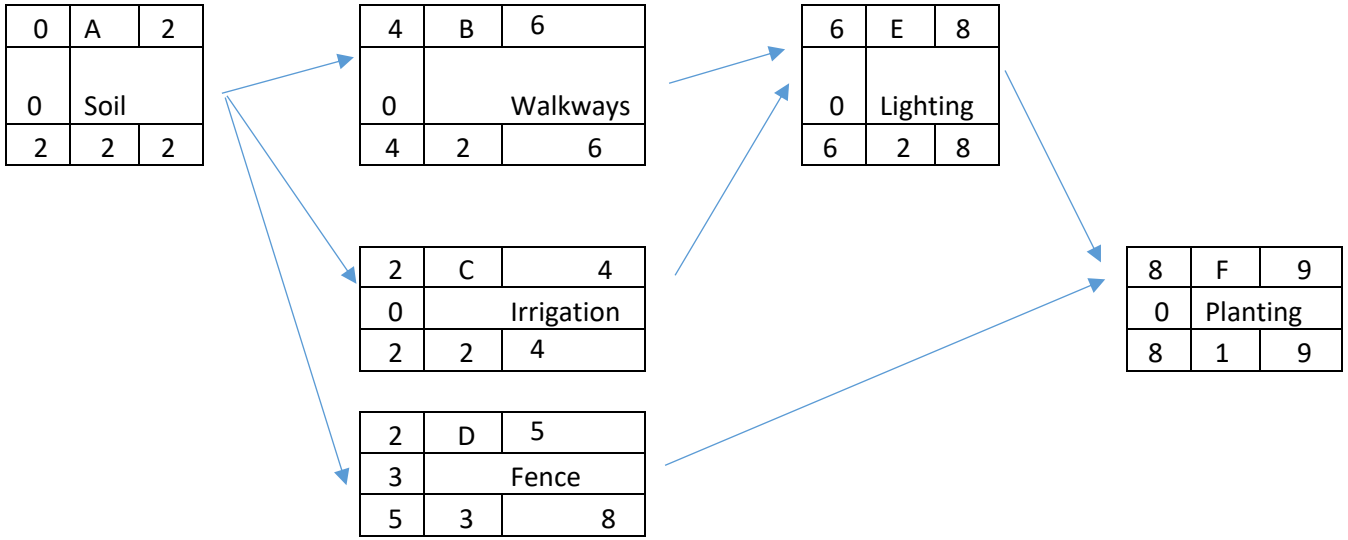
Iteration 1:



Iteration 2:


0 A 2
0 Soil
0 2 2
4 B 6
1 Walkways
5 2 7
7 E 9
0 Lighting
7 2 9
2 C 5
0 Irrigation
2 3 5
2 D 5
4 Fence
6 3 9
9 F 10
0 Planting
9 1 10

Iteration 3:


0 A 2
0 Soil
2 2 2
4 B 6
0 Walkways
4 2 6
6 E 8
0 Lighting
6 2 8
2 C 4
0 Irrigation
2 2 4
2 D 5
3 Fence
5 3 8
8 F 9
0 Planting
8 1 9

b) (4 marks) Summarise your answers in the following table.

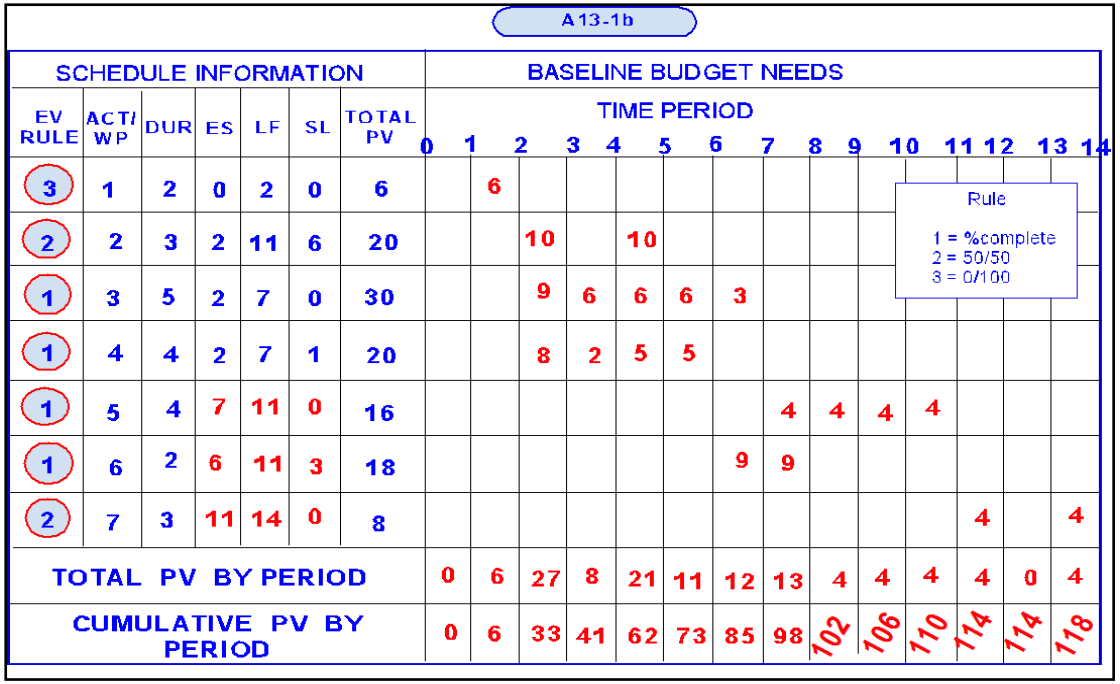
Project Duration	Indirect Cost	Direct Cost	Total	Activity to crash
11	3080	3400	6480	N/A
10	3550	2800	6350	E
9	3750	2520	6270	C

c) (1 mark) What is the optimal duration that minimizes the total cost?

The optimal duration is 10 weeks with the minimum cost of $6279.

Question 4 (15 marks) The information below relates to a project that aims to develop a product warranty. And the status information for periods 5, 6 and 7 is also given.

a) Compute the EV, PV, SV, and CV for periods 5, 6, and 7.



Status Report: Ending Period 5

Task	% Complete	EV	AC	PV	CV	SV
1	Finished	6	5	6	1	0
2	50%	20	8	20	12	0
3	60%	30	12	21	18	9
4	70%	20	10	15	10	5
Cumulative Totals		76	**35**	62	41	14

Status Report: Ending Period 6

Task	% Complete	EV	AC	PV	CV	SV
1	Finished	6	5	6	1	0
2	50%	20	10	20	10	0
3	80%	30	16	27	14	3
4	Finished	20	15	20	5	0
Cumulative Totals		76	**46**	73	30	3

Status Report: Ending Period 7

Task	% Complete	EV	AC	PV	CV	SV
1	Finished	6	5	6	1	0
2	Finished	20	14	20	6	0
3	Finished	30	20	30	10	0
4	Finished	20	15	20	5	0
5	0%	16	0	0	16	16
6	50%	18	9	9	9	9
Cumulative Totals		110	**63**	85	47	25

b) Compute Indexes (Keep 3 decimal places)

Period	SPI	CPI
5	1.226	2.17
6	1.041	1.652
7	1.294	1.746

c) Forecast EACf using the information at the end of period 7. (Keep 2 decimal places)

EACf = ETC+AC

Question 5 (15 marks) Your team is to upgrade your department's IT infrastructure. There are 50 employees in the department, each of whom uses a laptop or desktop computer, and the department also maintains a server. You are to make changes that will increase productivity and efficiency over the long term, without exceeding your budget of $4000 or causing serious disruptions to day-to-day operations. Your team has suggested objectives for this project. Accept or reject them according to whether you believe they are safely within the scope of the project.

Project Objective	Accept	Reject
Upgrade anti-virus and firewall software at a cost of $30 per licence and 50 licences are needed.	yes	
Upgrade the operating system at a cost of $229 per license and 50 licenses are needed.		yes
Replace the server for $6,000 to $10,000.		yes
Check if older files and data can be archived.	yes	
Send all employees simultaneously for a week-long computer training conference.	yes	

Use your decisions in the above table to prepare a project scope statement.

Project objective:

1) Check if older files and data can be archived.
2) Upgrade anti-virus and firewall software
3) Send all employees simultaneously for a week-long computer training conference.

Deliverables:

1) 50 licences for upgrading anti-virus and firewall software
2) Folder files and data
3) Training conference

Milestones:

Assume the project start from 1 Jan

1) Complete checking and archiving older files and data by 8 Jan
2) Purchase 50 licences for upgrading anti-virus and firewall software by 16 Jan

3) Finish scheduling the long-term weekly training by 10 Jan.
4) Finish enrolling employees into training course by 16 Jan
5) Training course starts from 20 Jan

Technical requirements:

1) Computers used need to upgrade to support the upgraded anti-virus and firewall software
2) Rooms, trainees and equipment for weekly training.
3) Version control software needed for checking and archiving older data.

Limits and exclusions:

1) The license supplier is responsible for the validity of license for upgrade anti-virus and firewall software.
2) With any outsourced training courses, contractors are responsible for allocation of trainees and places.

Question 6 (15 marks) The Road and Maritime Services (RMS) Department considers outsourcing a highway repair project to a new contractor. The project is rather routine, but the contractor is new.

a) If the objective of RMS is to control the cost of the project, should RMS offer a cost-plus (CP) or fixed price (FP) contract?
RMS should offer a fixed price contract which the contractor agrees to perform all works at a fixed price. In this case, RMS would not suffer from any surprising cost when processing project so that the risk of overbudget can be avoided.
b) If the objective of RMS is to shorten the completion time of the project, under what circumstance, should RMS offer a fixed time fixed price contract or a time-dependent bonus contract?
A time-dependent bonus contract should be offered. Some incentives can be placed so that the contractor is motivated to reduce the completion time.
c) The contractor has two options to undertake the highway repair project. The details of these two options are listed in the following table.
Hint: Part c) is unrelated to part a) or b).

Option ID	Contractor's Cost	Completion Time
1	3	F-distribution with mean 30
2	6	Log-normal distribution with mean 20

RMS wishes to induce the contractor to choose option 2 (which is the socially optimal choice). Due to moral hazard, RMS can neither observe nor verify what option the contractor uses. Instead, RMS offers to pay the contractor $P(t)=f-bt$, where f is a fixed payment, b is a linear penalty rate, and t is the project completion time. The contractor is risk-neutral and has a reservation value of 2. Derive the incentive compatibility (IC) constraints and individual rationality (IR) constraint to induce the contractor to take option 2.

Object: Z=min{f-b*20} where f>=0 and b>=0

Subject to:

Reservation value of 2: f-b*20-6>=2

Choosing 2 over 1: f-b*20-6>=f-b*30-3

-b*20-6>=-b*30-3

10*b>=3
b>=0.3
b = 0.3 (minimum)
f – 0.3*20 – 6 >=2
f – 12 >= 2 -> f >=14
therefore the optimal values are b=0.3 and f=0. The incentive compatibility is 14 while the individual rationality is 0.3

Question 7 (10 marks) Assume that you have the following decision-making options: (1) make the decision on your own with available information, (2) consult others before making a decision, and (3) call a meeting and reach a consensus, seeking to arrive at a final decision that everyone can agree on. Which one of these three options would you use in each of the following circumstance and why?

a) You are the project leader for Social Dance on campus, a charitable event organized by your group to raise money for homeless people. The event was a success, garnering a net profit of $2,530. Before the event your team researched nearby organizations that support homeless people and to which organization the money could be given. You narrowed choices to the "Chunk of Coal House" and "Big Soup Kitchen." Eventually, your team decided that the funds be given to Chunk of Coal House. When you are about to write a cheque to its director, you read from the newspaper that Chunk of Coal House ceased its operations. You need to determine what to do with the money.

   I call a meeting and reach a consensus, seeking to arrive at a final decision that everyone can agree on. On the meeting I would share the newspaper and any up-to-date information with my teammates. Because I may not be 100% sure about whether the new about Chunk of Coal House is true and by exchanging information, we may be able to validation the new and reach a consensus. If the new is true, we are motivated to further estimate the status of the other option "Big Soup Kitchen" and encounter the risk of it being closed. Moreover, by reaching a consensus among the team, we are sharing the responsibility of any potential risks. In addition, a contingency plan may be used in this case. If the new is fake, then we would reach the consensus of continuing the original plan.

b) You are a golf course designer hired by Triple Tree Golf Club to renovate their golf course. You have worked closely with the board of directors of the club to develop a new layout that is both challenging and aesthetically pleasing. Everyone is excited about the changes. The project is nearly 75 percent complete when you encounter problems on the 13th hole, which is a 125-yard par three in which golfers have to hit their tee shots over a lake to a modulated green. During the construction of the new tee box, workers discovered that an underground spring runs beneath the box to the lake. You inspected the site and agreed with the construction supervisor that this could

create serious problems, especially during the rainy winter months. After surveying the area, you believe that the only viable option would be to extend the hole to 170 yards and create elevated tees on the adjacent hillside.

I will consult the board of directors before making a decision. It is important to explain the unreliable design and the corresponding risks to stakeholders. I'll explain the unrealistic design of the 13th hole and report the new design. Also, the causes and consequences of the underground spring will also be explained to the board of directors. In this way, I will make sure my stakeholders understand the risks and consequences of them as well as the estimates of new changes so that they would not be surprised by the extending completion time and any additional costs.

Question 8 (5 marks) Assume that the learning curve effect is valid and takes the following form: $F_t = ar^{\frac{lnt}{ln2}}$, where F_t represents the time for finishing the t-th item (measured in hours), *a* represents the time for finishing the first item, and *r* presents the learning rate. Amy obtains empirical data and performs a linear regression using $Y=ln(F_t)$ as the dependent variable and $X=ln(t)$ as the independent variable, where *ln* is the natural logarithm. Amy obtains the following regression result: Y=4.382 – 0.415X. Determine the time for finishing the first two items. (Keep 1 decimal place).

$$\ln(F_1) = 4.392 - 0.415\ln(1)$$
$$\ln(F_1) = 4.392$$
$$F_1 = e^{4.392} = 80.8$$
$$\ln(F_2) = 4.392 - 0.415\ln(2)$$
$$\ln(F_2) = 4.104$$
$$F_2 = e^{4.104} = 60.6$$