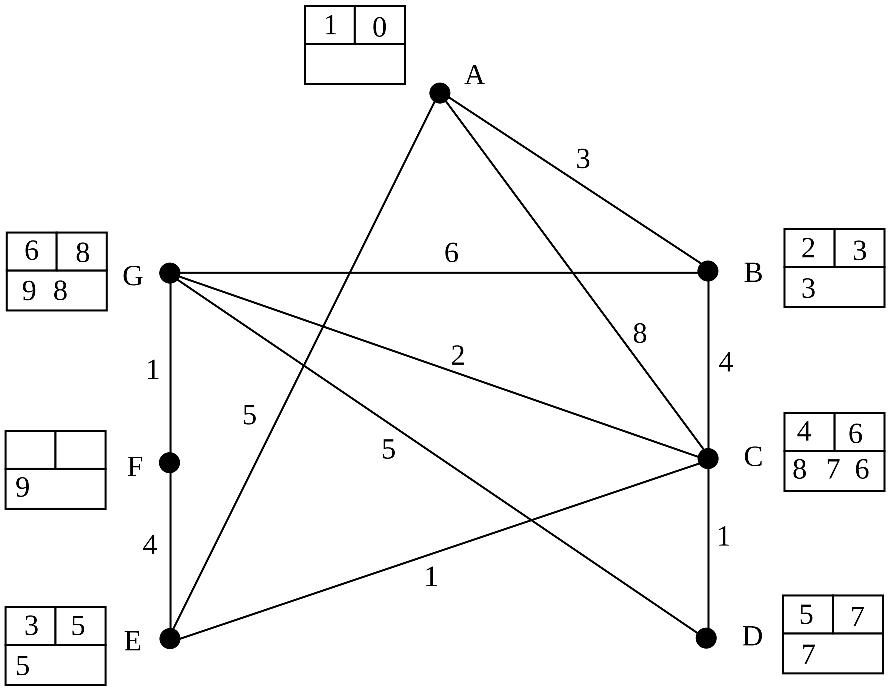
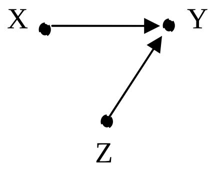
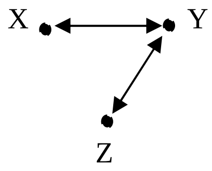
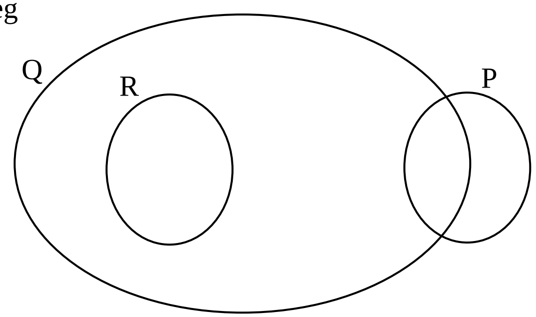
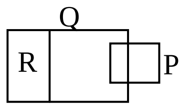
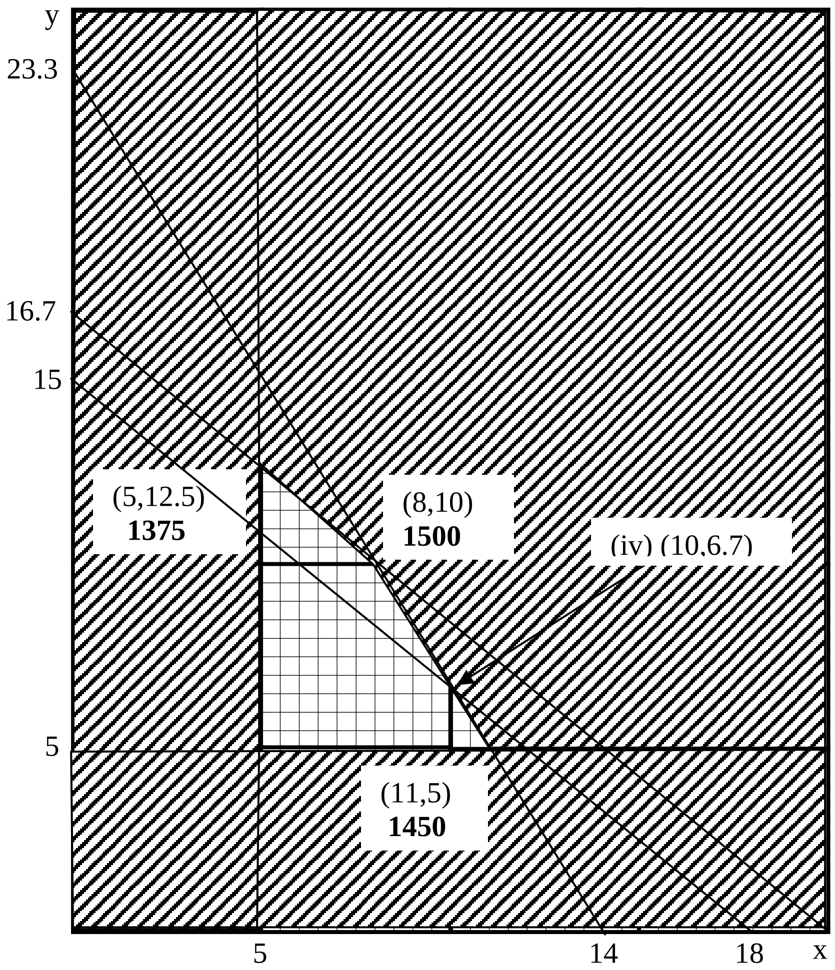
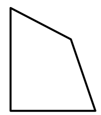
Question		Answer	Marks	Guidance	
1	(i) & (ii)	 Route: AECG Distance: 8	B1 B1 B1 B1 B1 B1 B1 B1 **[8]**	connectivity lengths Dijkstra working values other than at C order of labelling labels	 Award if wv's OK at C. allow legitimate later and larger wv's which are listed, but not used. Disregard F. SC ... If possible follow for these two marks. following errors in network

Question			Answer	Marks	Guidance	
2	(i)		A L R B f(L) f(R)			
			3 3.382 3.618 4 2.146 1.910	B1 B1	R and L f(R) and f(L)	-1 once only for incorrect accuracy, but condone 1.91. Surds OK, but lose the accuracy mark. (Q says 3dp.)
			3.382 3.618 3.764 4 1.910 1.875	B1 B1 B1	A L and R f(L) and F(R)	
			3.618	B1	A	
				[6]		
2	(ii)		Saves a function evaluation	B1 **[1]**		Has to be a comment about function values.
2	(iii)		eg Setting the control on a gas fire to achieve a room temperature of 20C. Function could be $(\text{temp}–20)^2$. (This example shows that optimising can be used to "achieve".) Note that the domain cannot be time based ... i.e finding when something occurred. One cannot go back in time to take a reading!	B1 **[1]**	Optimisation with need to sample at discrete intervals.	"Deepest point in seabed" example seen. This is acceptable, assuming that depth soundings are taken at points, and ignoring the fact that the domain is two dimensional rather than one dimensional.

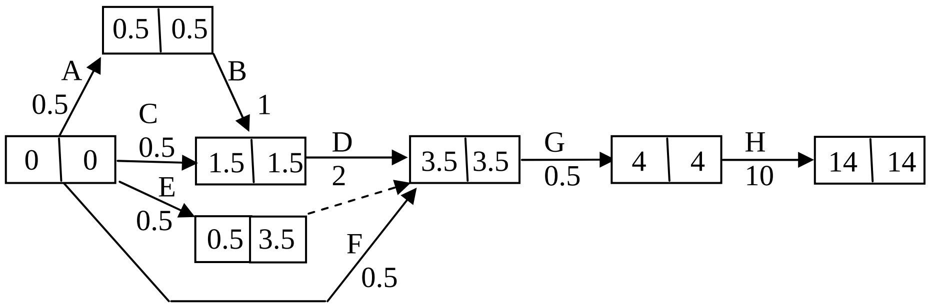
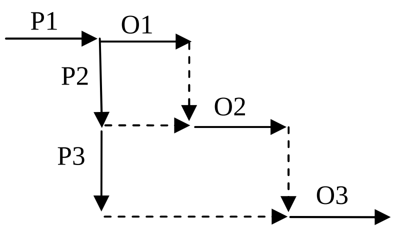
3	**(i)**		“is a subset of”  “shares at least one element with”  	M1 A1 M1 A1 **[4]**	directed graph on 3 vertices all correct undirected on 3 vertices all correct	 Arcs must either have an arrow at each end. or no arrows.
3	**(ii)**		eg  	M1 A1 B1 B1 **[4]**	R subset of Q no other subsets $P \cap Q$ $P \cap Q'$	Allow area split in two, with third area. eg  If P and R shown intersecting then can score M1 A1 B0 B0.

Question			Answer	Marks	Guidance	
4	(i)		Let x be the number of type X motors produced. Let y be the number of type Y motors produced. $10x + 12y \leq 200$ $x \geq 5$ and $y \geq 5$ $0.5x + 0.3y \leq 7$	M1 A1 B1 B1 B1 **[5]**	adequate definition “number of”	Strict inequalities are equally OK
4	(ii)			B1 B1 B1 B1 **[4]**	inclined line inclined line x=5 and y=5 shading follow line errors if shape is 	The guidance level of accuracy throughout this question is ±0.25 on the x coordinate and ±0.25 on the y coordinate. (Look at (8,10) first.) Inaccurate sketch with axis intercepts given is OK.

Question			Answer	Marks	Guidance	
4	(iii)		Profit = 100X + 70Y	B1		
			(5,12.5) or (5,12) 1375 or 1340 (8,10) 1500 (11,5) 1450	M1	optimisation	either profit line or evaluating and comparing at their 3 appropriate points (OK if on graph)
			£1500 profit.	A1	1500 seen cao SC B1 for 1500 without the preceding M mark	
				[3]		
4	(iv)		Solution in range $\left(10 \pm \frac{1}{4},\ 6\frac{2}{3} \pm \frac{1}{4}\right) = \left(9.75 - 10.25,\ 6.41\dot{6} - 6.91\dot{6}\right)$	B1	cao	looking for $\left(10,\ 6\frac{2}{3}\right)$
			Identification of one of (9,7), (10,6) and (11,5).	B1	cao	
			Evaluation at all three of (9,7) (10,6) (11,5) **1390** **1420** **1450**	M1		
			So 11 of X and 5 of Y	A1	cao	
				[4]		

Question		Answer	Marks	Guidance	
5	(i)	eg 0–7 $\rightarrow$ double 8 $\rightarrow$ single 9 reject and re-draw	M1 A1 **[2]**	reject correct proportions	Rejection can be implied.
5	(ii)	eg 0–5 $\rightarrow$ double 6,7 $\rightarrow$ single 8,9 reject and re-draw	M1 A1 **[2]**	reject correct proportions	Rejection can be implied. Ignore rule for (4,0).
5	(iii)	e.g. day / doubles selection / singles / random number 1 5 0 2 4 1 5 double	M1 A1	allow 5 shown as used on RN list. selection	For the simulation M1's you need to see a random number being used with their rules
		3 3 2 9, 4 double	M1 A1	must show RN(s) explicitly new scenario seen explicitly, not implied by day 4 rule	Follow a candidate who manages correctly to go from (4,1) to (4,0). It will then gain M1 if it correctly goes to (3,1) on day 4, with A1 if shows no simulation needed.
		4 2 3 0 double	M1 A1	a correct day 4 rule selection and new scenario	rule must be seen needs RN explicit. Allow new scenario if seen in subsequent probability calculation.
		5 1 4			
		Probability of drawing a single bag on day 5 is now 4/6.	M1 A1 **[8]**	denominator = 6 numerator	Can be implied by 2/3 or 1/3 if correct for their simulation.

Question			Answer	Marks	Guidance
5	(iv)		4 simulations, each ending with 6 bags all scenarios correct	M1 A1 **[2]**	Condone one slip. Condone simulating at (4,0) if correctly done. 6 bags can be implied by probs of thirds or sixths.
5	(v)		Either averaging correct probabilities or sum of singles/30	M1 A1 **[2]**	Correct computation, but allow 1 slip or omission. Correct answer for their simulations.

Question			Answer	Marks	Guidance
6	(i) & (ii)		 Minimum completion time = 14 mins Critical activities ... A, B, D, G, H	M1 A1 A1 A1 A1 M1 A1 M1 A1 B1 B1 **[11]**	activity on arc at least 1 dummy for E and F precedences for D precedences for G rest eg. penalise multiple starts forward pass backward pass If OK at start of dummy. If there is no dummy then these two marks are not available.
6	(iii)		2 people	B1 **[1]**	
6	(iv)		1 person ... 15.5 mins	B1 **[1]**	
6	(v)		 time = 35.5 minutes	B1 B1 **[2]**	network time with small oven
6	(vi)		revised time = 26.5 minutes	B1 **[1]**	time with large oven