Question Number	Scheme	Marks
4.(a)	$y \leqslant 2x$ and $3x+y \leqslant 30$	B1
	Correct method for finding the third boundary of the feasible region	M1
	$5y \geqslant 6x+10$	A1 **(3)**
(b)	(6, 12)	B1
	Solving simultaneous equations to find the other two vertices	M1
	$\left(\frac{5}{2},5\right)$ and $\left(\frac{20}{3},10\right)$	A1 **(3)**
(c)	$\left(\frac{5}{2},5\right) \rightarrow P = 20$ $\left(\frac{20}{3},10\right) \rightarrow P = \frac{130}{3}$ $(6,12) \rightarrow P = 48$	M1 A1
	Optimal vertex is (6,12) with $P = 48$	A1 **(3)**
(d)	$12+12k \square 2\left(\frac{20}{3}\right)+10k$ where $\square$ is any inequality or equals	M1
	$k \geqslant \frac{2}{3}$	A1 **(2)**
		11 marks

Notes for Question 4

a1B1: Both correct inequalities: $y \leqslant 2x$ and $3x+y \leqslant 30$ (or equivalent if they have been rearranged)

a1M1: Correct equation for the third boundary of the feasible region, e.g. $\frac{y-20}{14-20} = \frac{x-15}{10-15}$ would score **M1** (so does not need to be simplified). Condone any inequality sign used (provided that if the inequality sign was replaced with an 'equals' then the equation ($5y = 6x + 10$) would be correct). ISW once the correct equation has been seen (so condone the correct unsimplified equation if not simplified correctly)

a1A1: CAO for third inequality – must be three terms only but need not be further simplified (e.g. $12x-10y+20 \leqslant 0$, $y \geqslant 1.2x+2$ etc. scores **A1**)

b1B1: (6, 12) **or** $x = 6$, $y = 12$

b1M1: Correct method for solving their simultaneous equations (so $y = 2x$ with their $5y = 6x + 10$ **or** $3x + y = 30$ with their $5y = 6x + 10$) to find both the x and y-coordinates of at least one of the other two vertices (can be implied by either vertex stated correctly – condone non-exact values (to at least 3 sf) for this mark if no working seen)

b1A1: CAO (2.5, 5) **and** $\left(\frac{20}{3},10\right)$ (must be exact, so accept $(6\frac{2}{3},10)$, $(6.\dot{6},10)$, etc. but not (6.6666…, 10))

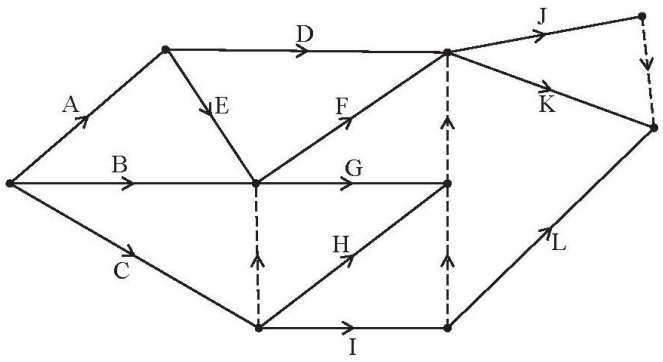
c1M1: Testing their three **vertices** (not just points in the FR) in the correct objective function ($P = 2x + 3y$). Condone one slip only when applying the objective function to one of their three vertices (so they must apply the correct objective to at least two of their three points but condone a single slip in the third)

c1A1: At least two correct (therefore exact) points tested correctly (so at least two correct values of P explicitly stated – allow awrt 43.3 when testing (20/3, 10))

c2A1: CSO all three correct (therefore exact) points tested correctly (so all three correct values of P explicitly seen – allow awrt 43.3 when testing (20/3, 10)) with a clear indication of which is the optimal vertex (this can be achieved by either making it clear that (6, 12) is the optimal point **or** that $P = 48$ is the maximum (as one implies the other))

d1M1: (6, 12) **and** their $\left(\frac{20}{3},10\right)$ (does not need to be exact) correctly substituted into $P = 2x + ky$ and compared (by comparing we mean forming an equation or any inequality). **Or** comparing $-\frac{2}{k}$ with -3 (so using the gradient of the objective line) **or** comparing $\frac{2}{k}$ with 3 **or** their reciprocals (e.g. $\frac{k}{2}$ compared with $\frac{1}{3}$ etc.) but comparing $-\frac{2}{k}$ with 3 is **M0** (by comparing we mean forming an equation or any inequality with the **correct** pairs of values)

d1A1: CAO either $k \geqslant \frac{2}{3}$ or $k > \frac{2}{3}$ **only** (or exact equivalents) – if any other answers given with $k \geqslant \frac{2}{3}$ e.g. $k \geqslant -1$ then **A0** (unless clearly rejected). Correct answer with no working can score both marks in this part. Please ensure that if working is shown that the correct answer of $k \geqslant \frac{2}{3}$ comes from correct working e.g. $-\frac{2}{k} \geqslant -3$

Question Number	Scheme	Marks
5. (a)	e.g.  	M1 A1 A1 A1 A1 **(5)**
(b)	Duration of activity K is 33 – 10 – 7 – 8 = 8 **or** the path AEFJ has a duration of < 33	M1
	Therefore the duration of J is less than 8 hours or 0 < dur(J) < 8	A1 **(2)**
		7 marks

Notes for Question 5

Condone lack of, or incorrect, numbered events throughout. 'Dealt with correctly' means that the activity starts from the correct event but need not necessarily finish at the correct event and **appears only once in the network**, e.g. 'G dealt with correctly' requires the correct precedences for this activity, i.e. B, C and E labelled correctly and leading into the same node and G starting from that node but do not consider the end event for G **so use the table below for checking as there a number of acceptable answers. Activity on node is M0**

If an arc is not labelled, for example, if the arc for activity E is not labelled (but the arc is present) then this will lose the first A mark and the final (CSO) A mark – they can still earn the second A mark on the bod. If two or more arcs are not labelled then mark according to the scheme. Assume that a solid line is an activity which has not been labelled rather than a dummy (even if in the correct place for where a dummy should be)

Ignore incorrect or lack of arrows on the activities for the first four marks only (but assume that they are in the 'correct' direction for checking purposes)

a1M1: At least seven activities (labelled on arc), one start and at least two dummies placed
a1A1: Activities A, B, C, D and E dealt with correctly
a2A1: Activities F, G, H and I dealt with correctly (so a dummy is required at the end of C + correct arrow)
a3A1: Activities J, K and L dealt with correctly (so **at least** two further dummies required + correct arrows)
a4A1: CSO – all arrows correctly placed for each activity with one finish and at most four dummies.
Please check all arcs carefully for arrows – if there are no arrows on any dummies then M1 only.
Note that additional (but unnecessary) 'correct' dummies that still maintain precedence for the network should only be penalised with the final A mark if earned

Extremely useful for checking (a)

Activity	A	B	C	D	E	F	G	H	I	J	K	L
IPA	-	-	-	A	A	B, C, E	B, C, E	C	C	D, F, G, H, I	D, F, G, H, I	I

b1M1: Either the correct method for calculating the duration of activity K seen (e.g. 33 – 10 – 7 – 8 or an answer of 8 can imply this mark) **or** stating the path AEFJ will have a duration < 33 or $\leqslant 33$

b1A1: Correct indication that the duration of K being 8 implies that J's duration is < 8 (allow $\leqslant 8$ but **A0** for $\leqslant 7$). As a minimum for both marks candidates must either say that the duration of K is 8 (e.g. K = 8) **or** that the path AEFJ has a duration < 33 or $\leqslant 33$, **together** with the duration of J being either < 8 or $\leqslant 8$. A lower limit is not required but if stated then it must be either > 0 or $\geqslant 0$ **only**