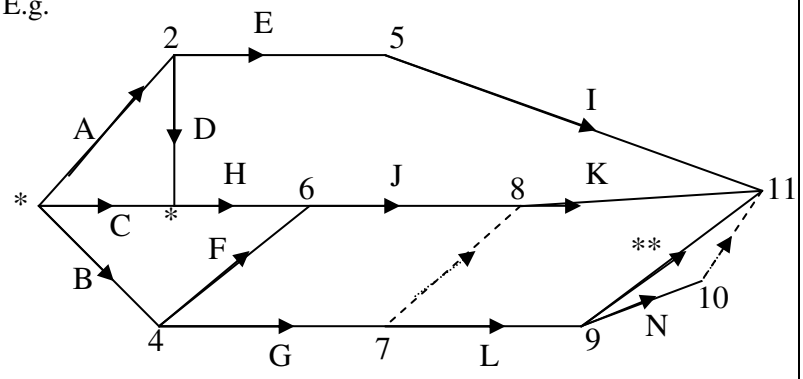
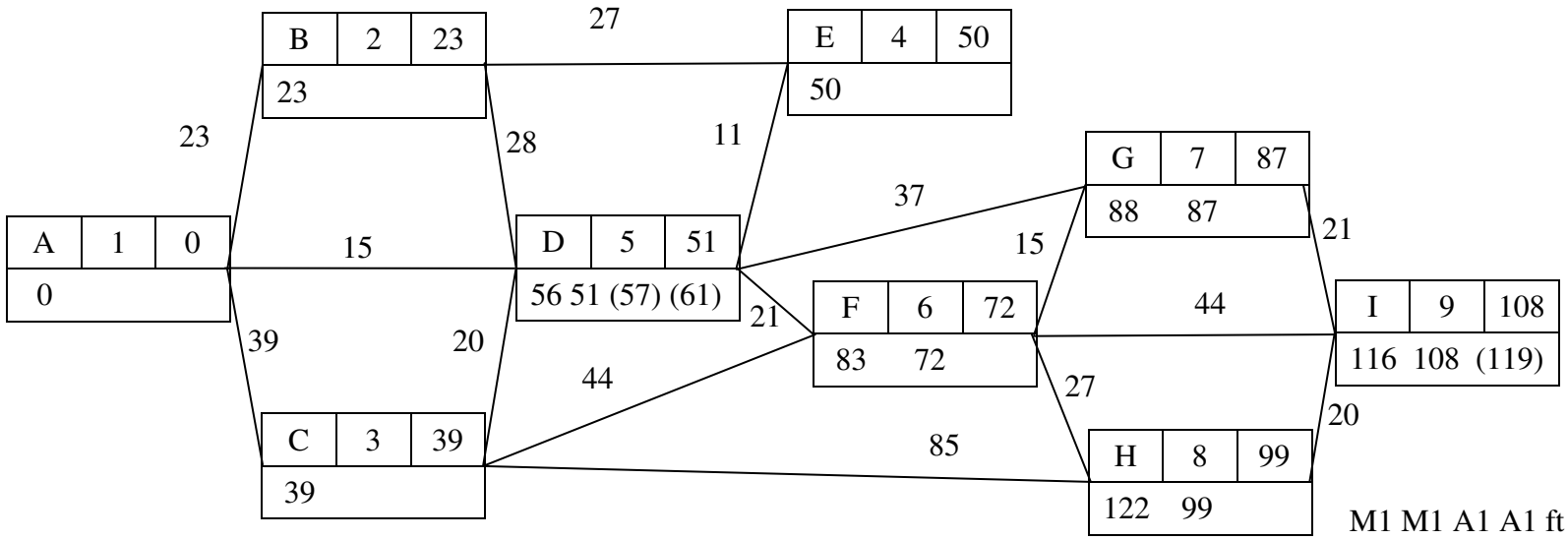
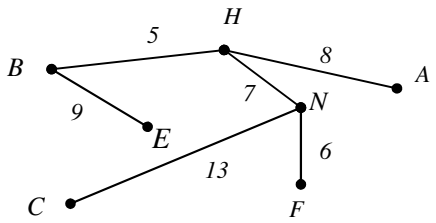
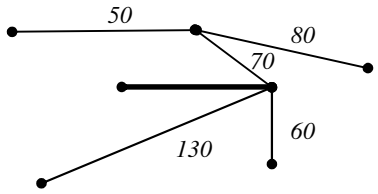
Decision Mathematics D1 (6689)

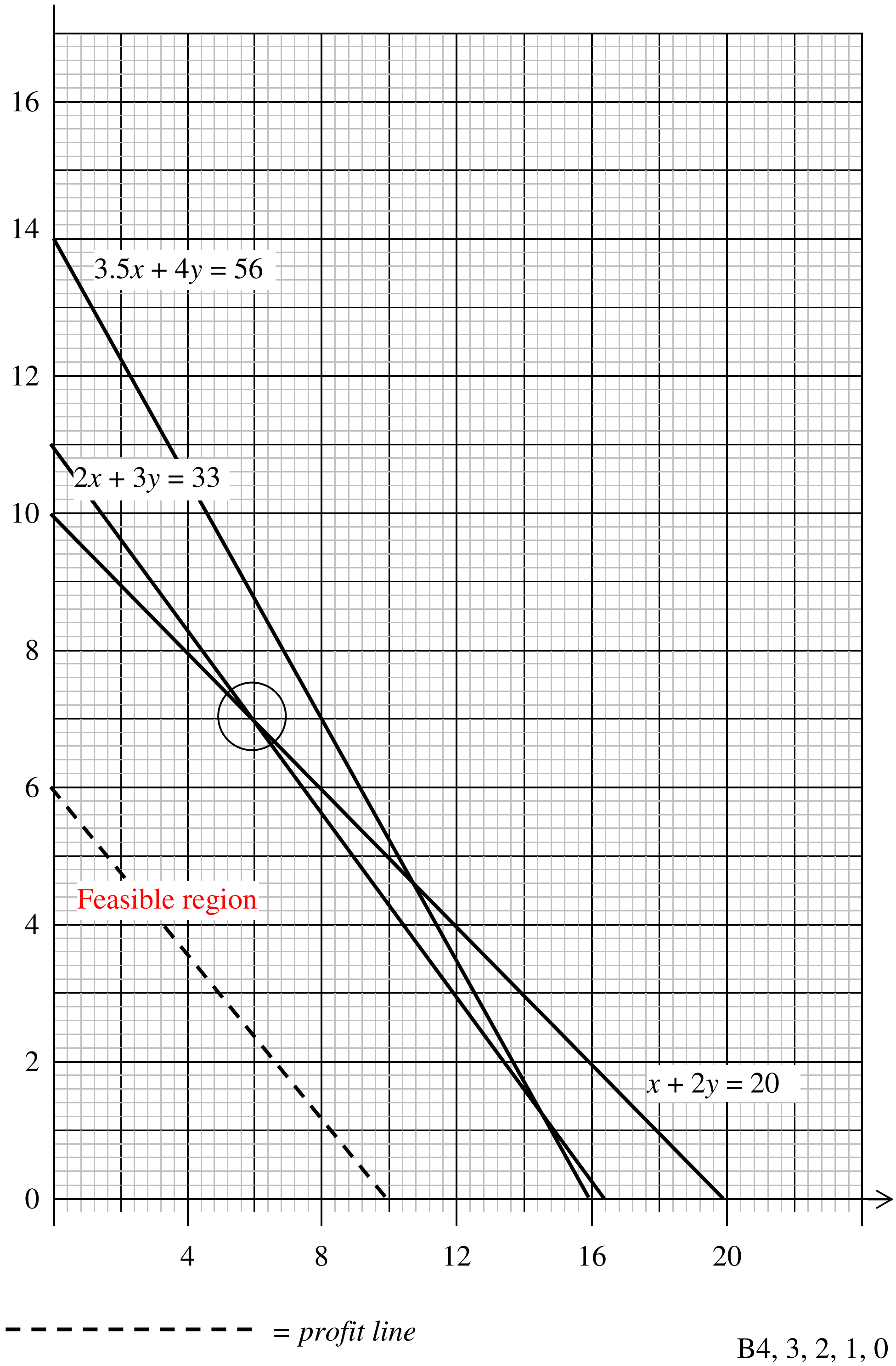
Practice paper B mark scheme

Question number		Scheme	Marks
1.	(a)	A graph consisting of <u>two distinct sets of vertices</u> X and Y	B1
		in which… <u>arcs can only join a vertex in X to a vertex in Y</u>.	B1 (2)
	(b)	A path <u>from an unmatched vertex in X to an unmatched vertex</u> in Y…	B1
		..which <u>alternately uses arcs in/not in the matching</u>.	B1 (2)
	(c)	The (1-1) matching / pairing of <u>some</u> elements of X with elements of Y.	B1 (1)
	(d)	A <u>1-1</u> matching between <u>all</u> elements of X onto Y	B1 (1)
			(6 marks)
2.	(a)	To obtain a complete matching the number of vertices on each side must be equal.	B2, 1, 0
	(b)	E.g **L** – 3 = **H** – 5 = **J** – 1a = **A** – 4	M1, A1
		c.s. **L** = 3 – **H** = 5 – **J** = 1a – **A** = 4	
		A = 4 **H** = 5 **L** = 3	
		E = 16 **J** = 1a **M** = 2	A1 (3)
	(c)	**H** and **L** can now both only do 3. So a complete matching is not possible.	B2,1,0 (2)
			(7 marks)
3.	(a)	$BD + FG = 1.3 + 0.9 = 2.2$ *	M1
		$BF + DG = 1.5 + (1.3 + 0.7) = 3.5$	A1
		$BG + DF = 0.7 + (0.9 + 0.8) = 2.4$	A1 (3)
		Repeat *BD* and *FG*	
		Route e.g. *GABCDBFEDBGFG*	B1
		Length = 8.9 + 2.2 = 11.1 km	M1 A1 (3)
	(b)	Only now need to repeat BF of length 1.5 < 2.2	M1 A1 ft
		Length = 8.9 +1.5 = 10.4 km saving 0.7 (km)	A1 (3)
			(9 marks)

Question number		Scheme	Marks
4.	(a)	E.g.  	M1 A1 A1 B1 (4)
	(b)	Reference to *K*, *J*, *G* and *L* - depends on *J* and *G*, but *L* depends on *G* only. Both *M* and *N* must be uniquely represented in terms of events.	B2, 1, 0 B1 (3) **(7 marks)**
5.	(a)	Left to right / Right to left 55 80 25 84 25 34 17 75 3 5 / 55 80 25 84 25 34 17 75 3 5 80 55 84 25 34 25 75 17 5 3 / 84 55 80 25 75 25 34 17 5 3 80 84 55 34 25 75 25 17 5 3 / 84 8 55 75 25 34 25 17 5 3 84 80 55 34 75 25 25 17 5 3 / 84 80 75 55 34 25 25 17 5 3 84 80 55 75 34 25 25 17 5 3 84 80 75 55 34 25 25 17 5 3 Sort complete, no more changes	M1 A1 A1 ft A1 ft A1 cso (5)
	(b)	403 ÷ 100 = 4.03 ∴ 5 bins	M1 A1 (2)
	(c)	Bin 1 84 5 3 Bin 2 80 17 Bin 3 75 25 Bin 4 55 34 Bin 5 25	M1 (to 34) A1 A1 (3) **(10 marks)**

Question number	Scheme	Marks
6. (*a*)	A path is a (finite) sequence of edges, such that the end vertex of one edge is the start vertex of the next and in which no vertex appears more than once/ no cycles	B2, 1, 0 (2)
(*b*)		M1 M1 A1 A1 ft
	Shortest path : ABDFGI Length: 108 miles	A1 A1 ft (6)
(*c*)	Eg 108 – 21 = 87 GI 87 – 15 = 72 FG 72 – 21 = 51 DF 51 – 28 = 23 BD 23 – 23 = 0 AB <u>OR</u> - trace back from I - includes are *xy* if *y* is and if the difference in first labels equals length of arc	
(*d*)	*ABDEFGI* Length: 118 miles	M1 A1 (2)
		(12 marks)

Question number	Scheme	Marks
7. (*a*)(i)	A connected graph with no cycles, loops or multiple edges	B1
(ii)	A tree that includes all vertices	B1
(iii)	A spanning tree of minimum total length	B1 (3)
(*b*)	E.g. • In Kruskal the shortest arc is added (unless it completes a cycle), in Prim the nearest unattached vertex is added • There is no need to check for cycles when using Prim, but there is when using Kruskal • In Prim the tree always "grows" in a connected fashion • Kruskal starts with the shortest edge, Prim with any vertex	B1 (1)
(*c*)	*BH*, *NF*, *HN*, *HA*, *BE*, *NC*	M1 A1
	length = 48	B1
		B1 (4)
(*d*)		B1
	New cable – 390 m	M1 A1 (3)
		(11 marks)

Question number	Scheme	Marks
8. (a)	($P =$) $300x + 500y$	B1
(b)	Finishing $3.5x + 4y \le 56 \Rightarrow 7x + 8y \le 112$ (or equivalent)	B1
	Packing $2x + 4y \le 40 \Rightarrow x + 2y \le 20$ (or equivalent)	B1 (3)
(c)		B4, 3, 2, 1, 0 (4)

Question number	Scheme	Marks
(d)	*Point testing:* Test corner points in feasible regions Find profit at each and select point yielding maximum *Profit line:* Draw profits lines Select point on profit line furthest from the origin	B2, 1, 0 (2)
(e)	Using a correct method	M1
	Make 6 Oxford and 7 York	A1
	Profit = £5300	A1 (3)
(f)	The line $3.5x + 4y = 49$ passes through (6, 7)	M1
	So reduce finishing by 7 hours	A1ft A1 (3)
		(15 marks)