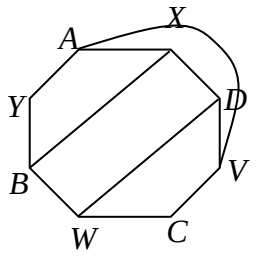
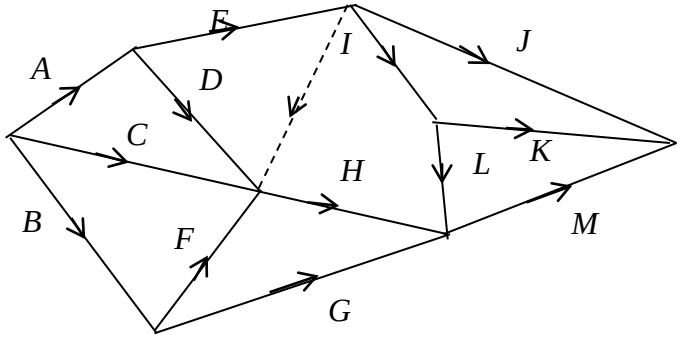
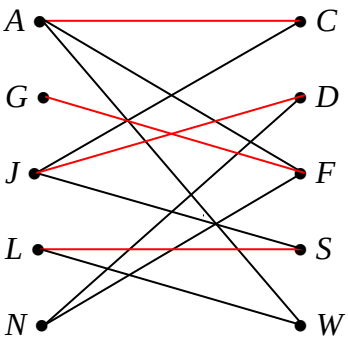
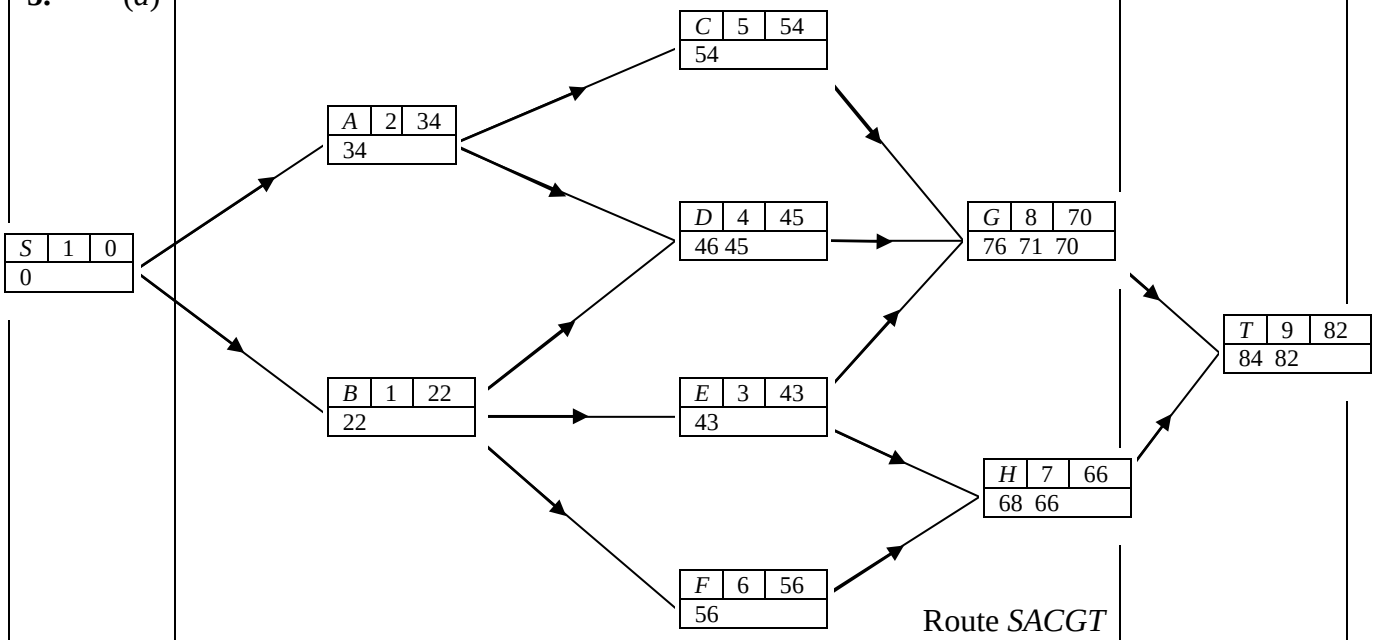
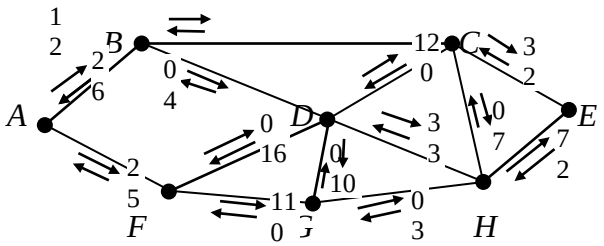
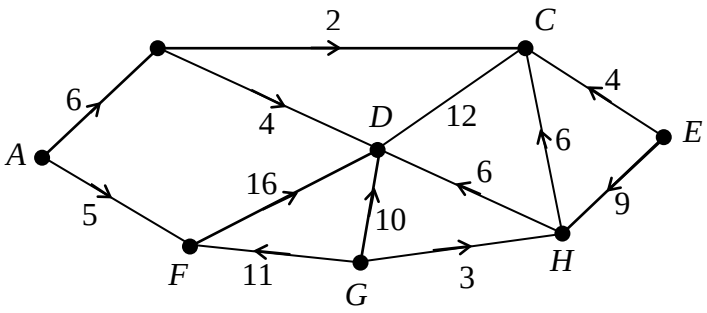
Question Number	Scheme	Marks
1. (*a*)	(*A*, *X*, *D*, *V*), *C*, *W*, *B*, *Y*, *A*	M1, A1 **(2)**
(*b*)		M1 A1 **(2)** **(4 marks)**
2. (*a*)		M1 A1 ($A \rightarrow F$) A1 (dummy) A1 ($G \rightarrow M$) A1 (1 start + 1 finish) **(5)**
(*b*)	*H*, *I* and *J* all depend on *E*, but *I* and *J* depend *only* on *E* whereas *H* depends on *E and C* and *D* and *F*	B1 **(1)** **(6 marks)**

Question Number	Scheme	Marks
3. (*a*)		B1, B1 **(2)**
(*b*)	$C = A - W$ $D = J$ $S = L - W$ N $F = G$ (stop) So either $N = D - J = C - A = W$ Or $N = D - J = S - L = W$ Matchings $A - W$, $G - F$, $J - C$, $L - S$ and $N - D$ Or $A - C$, $G - F$, $J - S$, $L - W$ and $N - D$	M1 A1 A1 **(3)**
(*c*)	If *J* does *D*, *N* must do *F*, leaving *G* without a sport to coach.	B2, 1, 0 **(2)** **(7 marks)**
4. (*a*)	Odd nodes *C*, *F*, *G*, *H* $CF + GM = 12 + 8 = 20$ $CG + FM = 9 + 7 = 16$ $CM + FG = 9 + 10 = 19$ So *CG* and *FH* should be repeated	B1 M1 A1 A1 **(4)**
(*b*)	*FH* is the shortest path so finish at *G* Length of route = 137 + 7 = 144	B2, 1, 0 B1 **(3)** **(7 marks)**

Question Number	Scheme	Marks
5. (*a*)	 Route *SACGT* length 82	A1 ft **(6)**
(*b*)	E.g. 82 – 12 = 70 *GT* 70 – 16 = 54 *CG* 54 – 20 = 34 *AC* 34 – 34 = 0 *SA* Work back from *T*. Include arc *XY* if *Y* already lies on the path and arc length *XY* = Final label of *Y* – final label of *X*	B2, 1,0 **(2)**
(*c*)	Shortest route *S* to *H* + *HT*	M1
	SBFHT length 84	A1 **(2)**
6. (*a*)	Left to right 55 80 25 84 25 34 17 75 3 5 80 55 84 25 34 25 75 17 5 3 80 84 55 34 25 75 25 17 5 3 84 80 55 34 75 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 Right to left 55 80 25 84 25 34 17 75 3 5 84 55 80 25 75 25 34 17 5 3 84 8 55 75 25 34 25 17 5 3 84 80 75 55 34 25 25 17 5 3	M1 A1 A1 A1
	Sort complete, no more changes	A1 **(5)**
(*b*)	403 ÷ 100 = 4.03 ∴ 5 bins	M1 A1 **(2)**
(*c*)	Bin 1 84 5 Bin 2 80 17 3 Bin 3 75 25 Bin 4 55 34 Bin 5 25	M1 (to 34) A1 (to 2nd 25) A1 **(3)**
		(10 marks)

Question Number	Scheme	Marks
7. (*a*)	*A*, *E* and *G*	B2, 1, 0
(*b*)	45	B1 **(3)**
(*c*)		M1 A1
	e.g *EHD* – 2	M1 A1
	ECHD – 1	M1 A1 **(6)**
(*d*)	 Maximum Flow 48	M1 A1 B1 **(3)**
(*e*)	Max flow – Min cut theorem	M1
	Cut through *DB*, *DC*, *DH*, *DG*, *DF*	A1 **(2)**
		(14 marks)

8. (*a*)

Objective: Maximise $P = 4x + 5y = 3z$ — B1

Subject to $3x + 2y + 4z \leq 35$ — B1

$x + 3y + 2z \leq 20$ — B1

$4x + 5y + 3z \leq 24$ — B1 **(4)**

(*b*)

Basic Variable	x	y	z	r	s	t	Value	
r	2	0	$\frac{5}{4}$	1	0	$-\frac{1}{2}$	23	$R_1 - 2R_2$
s	$-\frac{1}{2}$	0	$-\frac{1}{4}$	0	1	$-\frac{3}{4}$	2	$R_2 - 3R_3$
y	$\frac{1}{2}$	1	$\frac{3}{4}$	0	0	$\frac{1}{4}$	6	$R_3 \div 4$
P	$-\frac{3}{2}$	0	$\frac{3}{4}$	0	0	$\frac{5}{4}$	30	$R_4 + 5R_3$

M1 A1 M1 A1 **(4)**

Basic Variable	x	y	z	r	s	t	Value	
x	1	0	$\frac{5}{4}$	$\frac{1}{2}$	0	$-\frac{1}{4}$	$\frac{23}{2}$	$R_1 \div 2$
s	0	0	$\frac{3}{8}$	$\frac{1}{4}$	1	$-\frac{7}{8}$	$\frac{31}{4}$	$R_2 + \frac{1}{2}R_1$
y	0	1	$\frac{1}{8}$	$-\frac{1}{4}$	0	$\frac{3}{8}$	$\frac{1}{4}$	$R_3 - \frac{1}{2}R_1$
P	0	0	$\frac{21}{8}$	$\frac{21}{8}$	0	$\frac{7}{8}$	$\frac{189}{4}$	$R_4 + \frac{3}{2}R_1$

M1 A1 M1 A1 **(4)**

$P = 47\frac{1}{4}$ $x = 11\frac{1}{2}$, $y = \frac{1}{4}$, $z = 0$ — M1 A1 A1 **(3)**

(*c*) There is some slack $\left(7\frac{3}{4}\right)$ on *S*, so *do not* increase blending; therefore increase Processing and Packing which are both at their limit at present — B2, 1,0 **(2)**

(17 marks)