|  |  |  |  |
| --- | --- | --- | --- |
| **Question** | **Scheme** | **Marks** | **AOs** |
| **1(a)** | |  |  |  |  |  | | --- | --- | --- | --- | --- | | *n* | A | B | C | Is B > 0? | | 6 | 1 | 4 | 4 | – | |  | 2 | 3 | 11 | Yes | |  | 3 | 2 | 19 | Yes | |  | 4 | 1 | 26 | Yes | |  | 5 | 0 | 30 | No |   **(i)**  **(ii)** Final output = 30 | M1  A1  A1  A1 | 1.1b  1.1b  1.1b  1.1b |
|  |  | **(4)** |  |
| **(b)** |  | M1 | 3.1a |
|  |  | A1ft | 2.2a |
|  |  | **(2)** |  |
| **(c)** | Prim’s algorithm is of cubic order/has cubic complexity | B1 | 2.2b |
|  |  | **(1)** |  |
| **(7 marks)** | | | |
| **Notes:** | | | |
| **(a)(i)**  **M1:** At least three rows of cells in columns A, B and C completed with a correct first row for A, B and C only  **A1:** Cao – second and third rows correct  **A1:** Cao – fourth and fifth rows correct  **(ii)**  **A1:** Cao (output = 30)  **(b)**  **M1:** Using f(*n*) with *n* = 6 and their final output  **A1ft:** Cao following through their final output  **(c)**  **B1:** Cao | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Question** | **Scheme** | **Marks** | **AOs** |
| **2(a)**  **(i)**  **(ii)** |  | M1  A1  A1 | 1.1b  1.1b  1.1b |
| Shortest path from A to J is ABCGFEJ | A1 | 1.1b |
| Length of shortest path is 20 | A1ft | 1.1b |
|  | **(5)** |  |
| **(b)** | G(FE)D + EJ = 9 + 3 = 12  G(F)E + D(E)J = 5 + 7 = 12  G(FE)J + DE = 8 + 4 = 12 | M1  A1  A1 | 3.1b  1.1b  1.1b |
|  | Repeat arcs: DE, EF, FG, EJ | A1 | 2.2a |
|  |  | **(4)** |  |
| **(c)** | Length of route = 88 + 6 + 12 = 106 | B1ft | 1.1b |
|  |  | **(1)** |  |
| **(10 marks)** | | | |
| **Notes:** | | | |
| **(a)(i)**  **M1:** For a larger number replaced by a smaller one in the working values boxes at C, E, F or J  **A1:** For all values correct (and in correct order) at A, B, C, G and D  **A1:** For all values correct (and in correct order) at F, H, E and J  **A1:** Cao of ABCGFEJ  **(ii)** A1ft: Follow through their final value at J  **(b)**  **M1:** Three pairings of the correct four odd nodes  **A1:** Two pairings correct including correct totals  **A1:** All three pairings correct including correct totals  **A1:** Correct arcs to repeat (DE, EF, FG, EJ)  **(c)**  **B1ft:** Cao following through their smallest repeat (from a choice of at least two totals) | | | |
| **Question** | **Scheme** | **Marks** | **AOs** |
| **3(a)** |  | M1  A1  M1  A1  **(4)** | 1.1b  1.1b  1.1b  1.1b |
| **(b)** | Critical activities: C, D, G, H and K | B1 | 2.2a |
|  |  | **(1)** |  |
| **(c)** | Total float for activities  A: (7 + *x*) – 3  E: (11 + *x*) – 8 – 5 | B1ft | 1.1b |
|  |  | M1 | 2.1 |
|  |  | A1 | 1.1b |
|  | Minimum completion time = 21 + *x* = 40 days | A1 | 2.2a |
|  |  | **(4)** |  |
| **(9 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **M1:** top values generally increasing from left to right (dealing with *x* correctly at least twice)  **A1:** top values correct  **M1:** bottom values generally decreasing from right to left (dealing with *x* correctly at least twice)  **A1:** bottom values correct  **(b)**  **B1:** Cao  **(c)**  **B1ft:** One correct total float following through their values  **M1:** Constructing a correct equation using their total floats and minimum completion time (all three terms must include *x*)  **A1:** Cao (for *x*)  **A1:** Cao (minimum completion time) | | | |
| **Question** | **Scheme** | **Marks** | **AOs** |
| **4(a)** | Let *x* be the number of lemon cakes the baker makes and let *y* be the number of cherry cakes the baker makes | B1 | 2.5 |
|  | Minimise  Subject to | B1  B1  B1  B1  B1 | 1.2  3.3  3.3  3.3  3.3 |
|  |  | **(6)** |  |
| **(b)** | (Note to typesetters: change *x*-axis label to *‘*number of lemon cakes’ and *y*-axis to ‘number of cherry cakes’) | B1  B1  B1  B1 | 1.1b  1.1b  1.1b  2.2a |
|  | Objective line drawn or at least two vertices tested | M1 | 3.1a |
|  | Solving correct simultaneous equations for their optimal vertex | M1 | 1.1a |
|  | The baker should make 120 lemon cakes and 240 cherry cakes | A1 | 3.2a |
|  |  | **(7)** |  |
| **(c)** |  | B1ft | 3.4 |
|  |  | **(1)** |  |
| **(14 marks)** | | | |
| **Notes:** | | | |
| **(a)**  **B1:** Defining variables  **B1:** Cao (for objective) - must contain ‘minimise’  **B1:** Any one correct (accept any equivalent form for each constraint)  **B1:** Any two correct  **B1:** Any three correct  **B1:** All four correct | | | |
| **(b)**  **B1:** Any two correct lines  **B1:** Any three correct lines  **B1:** All four correct lines  **B1:** Deduce correct feasible region distinctly labelled  **M1:** Selecting an appropriate mathematical process to solve the problem – either drawing an objective line with the correct gradient (or reciprocal gradient), or testing at least two vertices in *R*  **M1:** Solving simultaneous equations for their optimal vertex  **A1:** Cao (in context – so not in terms of e.g. *x* and *y*) | | | |
| **(c)**  **B1ft:** Using correct constraint with their optimal vertex | | | |