P1 (a)	
Mark	Description
2	An original statement with the logical structure of an implication is supplied---it really is a statement, not a predicate---the contrapositive, converse, inverse are correctly given and ALL are clearly labelled so that the student's mastery of the concept has been clearly demonstrated. Accept predicates (even though they are not statements).
1.5	A minor error
1.0	Several minor errors, or some understanding demonstrated
0.5	Something to give credit for, but not much
0	

P1 (b)	
Mark	Description
2	The details of the two properties are provided correctly; notation is used accurately.
1	A minor error or one of the definitions is given correctly. E.g. If reference was made to f without any explanation.
0.5	Several minor errors, or some understanding demonstrated
0	

P1 (c)	
Mark	Description
2	A statement that is logically equivalent to NOT s, and in which the negation operator does not appear, is written. OK is the student writes an English sentence, but then the word NOT should not appear.
1.0	A minor error
0	

P1 (d)(i)	
Mark	Description
1.5	Correct answer, demonstrating that the student understands the toggle plus one method
1	Minor error (e.g. forgot to add 1 or that it was negative)
0.5	Several minor errors
0	If completely wrong, or calculated eta of the number instead

P1 (d)(ii)	
Mark	Description
1.5	Correct answers
1	A minor error, but the solution demonstrates that the student understands the method
0	

P1 (d)(iii)	
Mark	Description
1	Two correct reasons; Generally looking for (1) Greater range because zero is not represented twice, and (2) Better for implementing arithmetic in circuits.
0.5	One correct reason
0	

P2(a)	
Mark	Description
5	A complete induction proof is provided including: a basis step; The inductive hypothesis (string induction or otherwise is fine) is made explicitly; there is an explicit indication of when the inductive hypothesis is used; the inductive step is complete
4	As for 5, but does not explicitly make the inductive hypothesis or does not give explicit indication of when the inductive hypothesis is used
3.5	Structure is good (inductive hypothesis etc) but cannot finish the algebra
2.5	Structure is missing one small piece (use of inductive hypothesis not indicated etc) but otherwise good, and cannot finish the algebra
2	Some indication that the student understands the idea of induction
1	Some relevant knowledge is demonstrated, but not enough to demonstrate that the student understands the method
0	

P2(b)(i)	
Mark	Description
3	An effective proof is given; notation is used accurately; labels each equivalence with a justification (NOTE: does not have to introduce U, A, B, C, or x)
2	Notation is used accurately, but does not label each equivalence with a justification
1	Some relevant knowledge is demonstrated, but not enough to demonstrate that the student understands the method. Notation possibly abused ($\Leftrightarrow$ between sets or = between statements)
0	

P2(b)(ii)	
Mark	Description
2	An explicit counterexample is described and it is effectively shown that it is a counterexample
1	An explicit counterexample is described but it is not effectively shown that it is a counterexample Or The statement is declared false and a general “reason” is given as justification
0.5	The statement is declared false, or some relevant knowledge is demonstrated.
0	

P3(a)	
Mark	Description
3	Student explains effectively that the totals are not equally likely, and that total 18 should be expected about every 216th turn. The have explained to their friend in such a way that their friend will probably see that a total is more likely if there are more “ways” the total can happen.
2.5	Effective explanation but neglects to mention either that the total 18 should be expected about every 216^{th} turn or that outcomes which can be achieved in more “ways” are more likely
2	Solid explanation, but fails to rise to higher marks for reasons such as- failing to agree/disagree with the statement, lack of supporting evidence
1	Some relevant ideas are demonstrated but justification is missing key ideas or has some errors.
0	

P3(b)	
Mark	Description
4	Student arrives at the correct answer, describing what an outcome looks like, explicitly states that outcomes are equally likely and so the P(E) may be computed by counting; correctly evaluates $\|E\|$, $\|S\|$ and P(E).
3.5	Correct answer is reached but is missing some working, (for example fails to state that outcomes are equally likely), but the structure of the answer is still clear, and notation is used correctly
3	Correct answer but notation may not be used correctly, or only minimal working shown
2	Some relevant knowledge is demonstrated but counts one of the sets incorrectly; gives some indication that they know that $P(E) = \|E\|/\|S\|$.
1	Some relevant knowledge is demonstrated, for example they are able to evaluate $\|E\|$ or $\|S\|$.
0	

P3(c)	
Mark	Description
3	Student arrives at the correct answer, describing what outcomes look like, correctly evaluates $\|E\|$, $\|S\|$ and P(E) (student does not lose another half mark here if they fail to state that outcomes are equally likely if the same error was made in part b)
2.5	Correct answer and good reasoning but part of explanation is missing
2	The right counting approach is taken, and they demonstrate that they know that $P(E) = \|E\|/\|S\|$, but a small error in calculating the size of one of the sets
1	Some relevant knowledge is demonstrated
0	

P4(a)	
Mark	Description
3	All three items correctly specified
2	Two items correctly specified
1	One item correctly specified
0	

P4(b)	
Mark	Description
3	A very good explanation that rises to the level of a proof
2	A correct solution that is missing some steps (the most common example being not explaining why we must delete g)
1	A good idea or recalling correct knowledge for instance saying we need to delete g, drawing K_3,4, describing K_3,4 or giving the definition of an isomorphism of graphs
0	

P4(c)	
Mark	Description
4	All four answers correct
3	Three answers correct
2	Two answers correct
1	One answer correct
0	

P5(a)	
Mark	Description
2	Input and Output described (may omit the mention of the labelling function in the output)
1.5	Minor problem eg sub graph
1	Input and Output described well enough (mentions that G is weighted and the shortest path from A to Z is found)
0	

P5(b)	
Mark	Description
2	An explicit counterexample is described and it is shown that it is a counterexample
1.5	minor problem (usually if counter example not properly constructed or missing weights)
1	An explicit counterexample is described but it is shown that it is a counterexample Or The statement is declared false and a general “reason” is given as justification
0.5	The statement is declared false or proper argument about existence of spanning tree
0	Statement is declared false but with incorrect justification (usually false statements/ unrelated to question)

P5(c)	
Mark	Description
2	Describes idea to find a cut of weight 20; invokes the min-cut/max-flow theorem; allows for possibility that such a cut may not exist
1.5	Minor error like missing one case (more or less than min-cut) or didnt relate to q
1	Some understanding of the min cut-max flow theorem demonstrated
0.5	If used vertex label instead of min cut-max flow (misunderstood the question)
0	

P5(d)	
Mark	Description
4	Correctly completes the table (incremental flows and weights of flows)
3	What looks like a minor error (incremental flows, but does not record weights). Must be evidence that the student understand virtual flows
2.5	Would be correct but virtual flow not used or used incorrectly. Need clear evidence that the VF is the only problem.
2	Did not demonstrate understanding of virtual flow, and some other minor error such as applying the algorithm as if it is greedy
1	Some understanding demonstrated.
0	

P6(a)	
Mark	Description
2	Mentions digraph, and what vertices and edges represent
1	Some understanding demonstrated
0	

P6(b)	
Mark	Description
2	Mentions starting at randomly selected page, sometimes (at a rate determined by a parameter) just typing in a URL; otherwise, randomly selecting a hyperlink on the current page if one is available or just typing in a URL if there are no hyperlinks on the current page.
1	Some understanding demonstrated but missing a piece.
0	

P6(c)	
Mark	Description
2	The steady state equation as shown in the solutions. Would also accept one of the other equations involving T, U, alpha etc if all the details are correct.
1	Missing the ‘ (transpose); given the correct equation involving T and U and n etc
0	

P6(d)	
Mark	Description
4	Correct graph and correct transition matric (row five can be 1/5 1/5 1/5 1/5 0 1/5 OR 1/6 1/6 1/6 1/6 1/6 1/6, either is fine).
3	Graph missing some details but matrix is correct; Graph is correct but matrix has a minor error in it
2	Errors in both, but demonstrates general understanding or one part correct and the other missing entirely or incorrect correct.
1	Some relevant understanding demonstrated
0	