



## **Carlingford High School**

### **YEAR 12 MATHEMATICS STANDARD 2 TERM 2 Assessment Task 3 2020**

Student number:

- Time allowed: 50 minutes
- Answer all questions in this question booklet. Circle the correct responses to the Multiple Choice Questions on the question sheet.
- Approved calculators may be used.
- All necessary working should be shown in every question. Marks may be deducted for careless or badly arranged work.
- A reference sheet is provided

<b>Question/outcomes</b>	<b>Section A</b>	<b>Section B</b>	<b>Total</b>
<b>Annuities</b>	<b>/21</b>		<b>/21</b>
<b>Network</b>		<b>/17</b>	<b>/17</b>
	<b>/21</b>	<b>/17</b>	<b>/38</b>

**Annuities (21 marks)**

1. A table of future value interest factors is shown below.

**Future value of \$1 invested**

Period	Interest Rate per Period				
	1%	2%	3%	4%	5%
1	1.0000	1.0000	1.0000	1.0000	1.0000
2	2.0100	2.0200	2.0300	2.0400	2.0500
3	3.0301	3.0604	3.0909	3.1216	3.1525
4	4.0604	4.1216	4.1836	4.2465	4.3101
5	5.1010	5.2040	5.3091	5.4163	5.5256
6	6.1520	6.3081	6.4684	6.6330	6.8019
7	7.2135	7.4343	7.6625	7.8983	8.1420
8	8.2857	8.5830	8.8923	9.2142	9.5491

Harry invests \$3000 at the end of each year for 5 years at 4% per annum. Using the table above, find the value of his annuity at the end of 5 years.

- (A) \$12 739.50      (B) \$12 930.30      (C) \$16 248.90      (D) \$16 576.80

2. Hermione calculates the present value (N) of an annuity. The interest rate is 4% p.a. compounded monthly. In five years the future value will be \$100 000. Which calculation will result in the correct answer?

(A)  $PV = \frac{100\,000}{(1+4\%)^5}$

(B)  $PV = \frac{100\,000}{(1+\frac{4}{12}\%)^5}$

(C)  $PV = \frac{100\,000}{(1+4\%)^{60}}$

(D)  $PV = \frac{100\,000}{(1+\frac{4}{12}\%)^{60}}$

3. In the following diagram, Graph 1 shows the balance owing on a normal reducing-balance home loan with regular equal repayments over a period of time. Match the graph with one of the descriptions below.

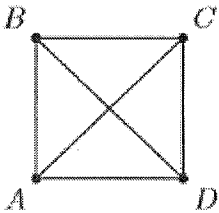
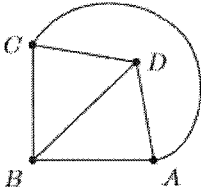

	<p style="text-align: center;">Balance owing on a loan</p> <p>(A) There is an interest-only period then regular payments are made.</p> <p>(B) A lump sum payment is made during the period of the loan.</p> <p>(C) For the first 3 years the monthly repayments are less than the interest on the loan and then regular repayments are made to pay off the loan.</p>																
4.	<p>Ron's funds in a superannuation scheme have a future value of \$740 000 in 20 years time. The interest rate is 4% per annum and earnings are calculated six-monthly. What single amount could be invested now to produce the same result over the same period of time at the same interest rate?</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	2															
5.	<p>Luna borrowed \$300 000 to buy an apartment. The interest rate is 6% per annum, compounded monthly. The repayments were set by the bank at \$2200 per month for 20 years.</p> <p>The loan balance sheet below shows the interest charged and the balance owing for the first month.</p> <table><tr><td>Month</td><td>Principal at the start of the month</td><td>Monthly interest</td><td>Monthly repayment</td><td>Balance at end of month</td></tr><tr><td>1</td><td>\$300 000</td><td>\$1500</td><td>\$2200</td><td>\$299 300</td></tr><tr><td>2</td><td>\$299 300</td><td>A</td><td>\$2200</td><td>B</td></tr></table>	Month	Principal at the start of the month	Monthly interest	Monthly repayment	Balance at end of month	1	\$300 000	\$1500	\$2200	\$299 300	2	\$299 300	A	\$2200	B	
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1	\$300 000	\$1500	\$2200	\$299 300													
2	\$299 300	A	\$2200	B													
	<p>a) What is the total amount that is to be paid for this loan over the 20 years?</p>	1															

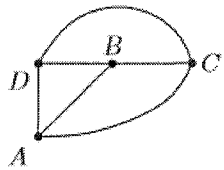
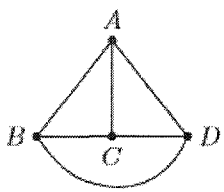
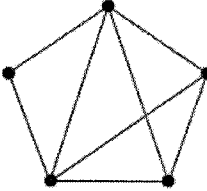
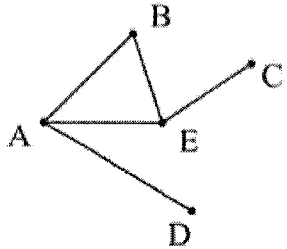
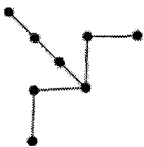
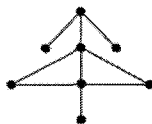
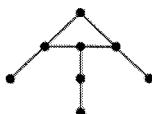
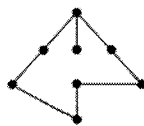
	<p>.....</p>	
	<p>b) Find the values of A and B.</p> <p>.....</p>	2
	<p>c) Luna knows she can check the bank's calculations by using the present value of an annuity formula to calculate the minimum monthly repayment. Use the formula <math>PV = a \left[ \frac{(1+r)^n - 1}{r(1+r)^n} \right]</math> to find the calculated minimum monthly repayment.</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	3
6.	<p>On the day Draco was born, and on every birthday after that, his grandparents deposited \$100 into an investment account. The interest rate on the account is fixed at 6% per annum, compounded annually.</p> <p>a) Using the formula <math>FV = a \left[ \frac{(1+r)^n - 1}{r} \right]</math>, calculate the value of the investment immediately after his grandparents deposit \$100 on his 21st birthday.</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	2
	<p>b) Calculate the total amount deposited by Draco's grandparents.</p> <p>.....</p>	1
	<p>c) Calculate the total interest earned on this investment.</p>	1



	<p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p> <p>.....</p>	
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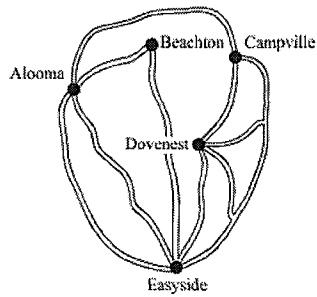
**Network (17 marks)**

1.	<p>A network of four points <math>A, B, C</math> and <math>D</math> is drawn below.</p> <div style="text-align: center;">  </div> <p>Which of the following network diagrams is <b>NOT</b> an equivalent graph of the network above?</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>(A)</p>  </div> <div style="text-align: center;"> <p>(B)</p>  </div> </div>	
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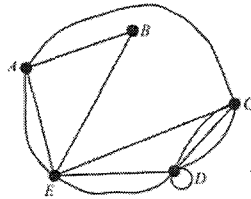
	<p>(C)</p> 	<p>(D)</p> 	
2.	<p>Find the number of edges in the graph below.</p>  <p>(A) 5                      (B) 7                      (C) 8                      (D) 10</p>		
3.	<p>What is the degree of vertex A in this network diagram?</p>  <p>(A) 4                      (B) 3                      (C) 2                      (D) 1</p>		
4.	<p>Which one of the following graphs is a tree?</p> <div style="display: flex; flex-wrap: wrap;"> <div style="width: 50%;"> <p>(A)</p>  </div> <div style="width: 50%;"> <p>(B)</p>  </div> <div style="width: 50%;"> <p>(C)</p>  </div> <div style="width: 50%;"> <p>(D)</p>  </div> </div>		







A graph that represents the map of the roads is shown below.

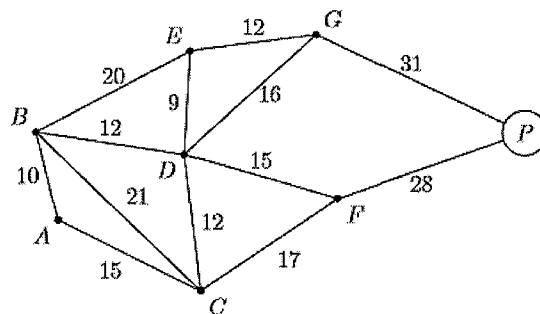


Explain what the loop at *D* represents in terms of a driver who is departing from Dovenest.

1

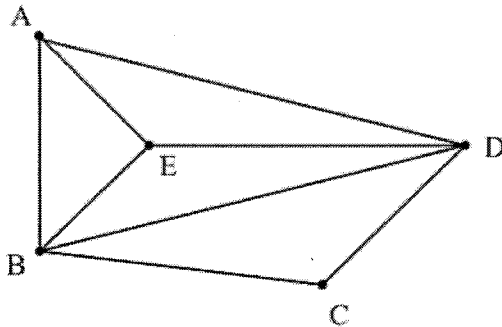
.....  
 .....

9. Cabins in a national park are to be connected to the power source at *P*. The weighted graph below shows the distances in metres between certain cabins and the power source.



Use **Kruskal's** algorithm to draw a minimum spanning tree for this network.

3

10.	<p>A university IT department has done a study to analyse the cost of installing a new high-speed fibre optic network on the campus, taking into account the distances and current infrastructure.</p> <p>The cost, in thousands of dollars, to connect cables between the main buildings is provided in the table below.</p> <table><tr><td></td><td>A</td><td>B</td><td>C</td><td>D</td><td>E</td></tr><tr><td>A</td><td></td><td>10</td><td></td><td>12</td><td>7</td></tr><tr><td>B</td><td>10</td><td></td><td>4</td><td>11</td><td>12</td></tr><tr><td>C</td><td></td><td>4</td><td></td><td>6</td><td></td></tr><tr><td>D</td><td>12</td><td>11</td><td>6</td><td></td><td>9</td></tr><tr><td>E</td><td>7</td><td>12</td><td></td><td>9</td><td></td></tr></table>		A	B	C	D	E	A		10		12	7	B	10		4	11	12	C		4		6		D	12	11	6		9	E	7	12		9		
	A	B	C	D	E																																	
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E	7	12		9																																		
	<p>a) Using the table complete the weighted network diagram below, representing the cost to connect the buildings in thousands of dollars.</p> 	2																																				
	<p>b) Use your network diagram in part (a) to draw a minimum spanning tree for the campus in the space provided below.</p>	2																																				
	<p>c) What is the minimum cost (in dollars) to connect all the buildings on the campus with fibre optic cabling?</p> <p>.....</p> <p>.....</p>	2																																				

**The End**



## Carlingford High School

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- Approved calculators may be used.
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Question/outcomes	Section A	Section B	Total
Annuities	/21		/21
Network		/17	/17
	/21	/17	/38

## Annuities (21 marks)

1. A table of future value interest factors is shown below.

Period	Interest Rate per Period				
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Harry invests \$3000 at the end of each year for 5 years at 4% per annum. Using the table above, find the value of his annuity at the end of 5 years.

- (A) \$12 739.50      (B) \$12 930.30      (C) \$16 248.90      (D) \$16 576.80

2. Hermione calculates the present value (N) of an annuity. The interest rate is 4% p.a. compounded monthly. In five years the future value will be \$100 000. Which calculation will result in the correct answer?

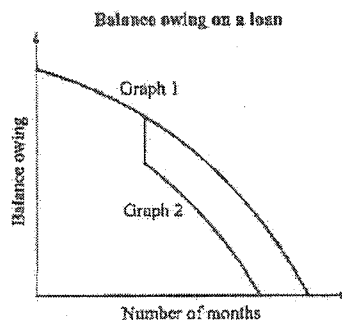
(A)  $PV = \frac{100\,000}{(1 + 4\%)^5}$

(B)  $PV = \frac{100\,000}{(1 + \frac{4}{12}\%)^5}$

(C)  $PV = \frac{100\,000}{(1 + 4\%)^{60}}$

(D)  $PV = \frac{100\,000}{(1 + \frac{4}{12}\%)^{60}}$

3. In the following diagram, Graph 1 shows the balance owing on a normal reducing-balance home loan with regular equal repayments over a period of time. Match the graph with one of the descriptions below.



- (A) There is an interest-only period then regular payments are made.
- (B) A lump sum payment is made during the period of the loan.
- (C) For the first 3 years the monthly repayments are less than the interest on the loan and then regular repayments are made to pay off the loan.

4.	<p>Ron's funds in a superannuation scheme have a future value of \$740 000 in 20 years time. The interest rate is 4% per annum and earnings are calculated six-monthly. What single amount could be invested now to produce the same result over the same period of time at the same interest rate?</p> <p><math>r = 2\% \quad n = 40</math> ①</p> <p><math>740\,000 = PV(1 + 2\%)^{40}</math> ①</p> <p><math>335138.91 = PV</math></p> <p><math>\therefore PV = \\$335138.91</math> ①</p>	2															
5.	<p>Luna borrowed \$300 000 to buy an apartment. The interest rate is 6% per annum, compounded monthly. The repayments were set by the bank at \$2200 per month for 20 years.</p> <p>The loan balance sheet below shows the interest charged and the balance owing for the first month.</p> <table><tr><th>Month</th><th>Principal at the start of the month</th><th>Monthly interest</th><th>Monthly repayment</th><th>Balance at end of month</th></tr><tr><td>1</td><td>\$300 000</td><td>\$1500</td><td>\$2200</td><td>\$299 300</td></tr><tr><td>2</td><td>\$299 300</td><td>A</td><td>\$2200</td><td>B</td></tr></table>	Month	Principal at the start of the month	Monthly interest	Monthly repayment	Balance at end of month	1	\$300 000	\$1500	\$2200	\$299 300	2	\$299 300	A	\$2200	B	
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1	\$300 000	\$1500	\$2200	\$299 300													
2	\$299 300	A	\$2200	B													
	<p>a) What is the total amount that is to be paid for this loan over the 20 years?</p> <p><math>2200 \times 20 \times 12 = \\$528\,000</math></p>	1															
	<p>b) Find the values of A and B.</p> <p><math>A = \\$1496.50</math> ①</p> <p><math>B = \\$298596.50</math> ①</p>	2															
	<p>c) Luna knows she can check the bank's calculations by using the present value of an annuity formula to calculate the minimum monthly repayment. Use the formula <math>PV = a \left[ \frac{(1+r)^n - 1}{r(1+r)^n} \right]</math> to find the calculated minimum monthly repayment.</p> <p>① <math>300\,000 = a \left[ \frac{(1 + \frac{6\%}{12})^{240} - 1}{\frac{6\%}{12}(1 + \frac{6\%}{12})^{240}} \right]</math></p> <p>① <math>2149.293 = a</math></p> <p><math>\therefore a = \\$2149.30</math> ①</p>	3															

6.	<p>On the day Draco was born, and on every birthday after that, his grandparents deposited \$100 into an investment account. The interest rate on the account is fixed at 6% per annum, compounded annually.</p> <p>a) Using the formula <math>FV = a \left[ \frac{(1+r)^n - 1}{r} \right]</math>, calculate the value of the investment immediately after his grandparents deposit \$100 on his 21st birthday.</p> <p><math display="block">FV = 100 \left( \frac{(1+6\%)^{22} - 1}{6\%} \right) \textcircled{1}</math></p> <p><math display="block">= \\$4339.23 \textcircled{1}</math></p> <p><i>1 mistake only</i> <math>\textcircled{1}</math> <math>\textcircled{1} n=22</math></p>	2																																															
	<p>b) Calculate the total amount deposited by Draco's grandparents.</p> <p><math>100 \times 22 = \\$2200</math></p>	1																																															
a-b=c	<p>c) Calculate the total interest earned on this investment.</p> <p><math>4339.23 - 2200 = \\$2139.23</math> <i>cfm b</i></p>	1																																															
7.	<p>The table below gives the present value interest factors for an annuity of \$10 per period, for various interest rates (r) and numbers of periods (N).</p> <table><tr><th colspan="6">Table of present value interest factors</th></tr><tr><th rowspan="2">N \ r</th><th colspan="5">Interest rate per period (as a decimal)</th></tr><tr><th>0.0075</th><th>0.0080</th><th>0.0085</th><th>0.0090</th><th>0.0095</th></tr><tr><td>70</td><td>54.30462</td><td>53.43960</td><td>52.59397</td><td>51.76724</td><td>50.95891</td></tr><tr><td>71</td><td>54.89293</td><td>54.00754</td><td>53.14226</td><td>52.29657</td><td>51.46995</td></tr><tr><td>72</td><td>55.47685</td><td>54.57097</td><td>53.68593</td><td>52.82118</td><td>51.97618</td></tr><tr><td>73</td><td>56.05643</td><td>55.12993</td><td>54.22502</td><td>53.34111</td><td>52.47764</td></tr><tr><td>74</td><td>56.63169</td><td>55.68446</td><td>54.75957</td><td>53.85641</td><td>52.97438</td></tr></table>	Table of present value interest factors						N \ r	Interest rate per period (as a decimal)					0.0075	0.0080	0.0085	0.0090	0.0095	70	54.30462	53.43960	52.59397	51.76724	50.95891	71	54.89293	54.00754	53.14226	52.29657	51.46995	72	55.47685	54.57097	53.68593	52.82118	51.97618	73	56.05643	55.12993	54.22502	53.34111	52.47764	74	56.63169	55.68446	54.75957	53.85641	52.97438	
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	<p>Hagrid plans to invest \$2000 each month for 6 years. His investment will earn interest per month at the rate of 9.6% per annum. Based on the information in the table, what is the present value of this annuity?</p> <p><math>PV = 54.57097 \times 200</math></p> <p><math>= \\$10914.194</math></p> <p><math>= \\$10914.19</math> } accept either...</p> <p><i>P. Ans. either</i></p>	2																																															

8.

Minerva takes out a \$290 000 home loan. The terms of the loan are 8.25% per annum over 30 years with monthly repayments. The minimum monthly repayment is \$2178.67.

4

Each month, Minerva decides to pay \$250 more than the minimum monthly repayment. Using the formula  $PV = a \left[ \frac{(1+r)^n - 1}{r(1+r)^n} \right]$  determine if Minerva would be able to pay off the loan in 20 years? Justify your answer by showing all calculations.

$$2178.67 + 250 = 2428.67 \quad (1)$$

$$PV = 2428.67 \left[ \frac{(1 + \frac{8.25\%}{12})^{240} - 1}{\frac{8.25\%}{12} (1 + \frac{8.25\%}{12})^{240}} \right] \quad (1)$$

$$= \$285033.20 \quad (1)$$

0.6875%

$$290000 - 285033.20 = 4966.80$$

$\therefore$  No as she is \$4966.80 short. (1)

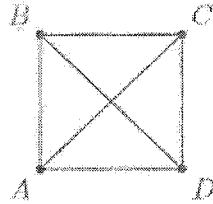
must have a reason/justification

efm



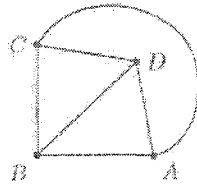
**Network (17 marks)**

1. A network of four points  $A, B, C$  and  $D$  is drawn below.

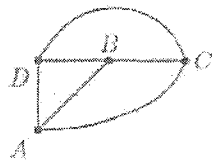


Which of the following network diagrams is **NOT** an equivalent graph of the network above?

(A)



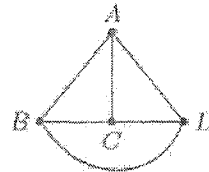
(C)



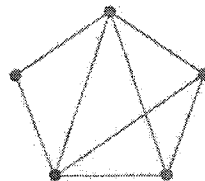
(B)



(D)



2. Find the number of edges in the graph below.



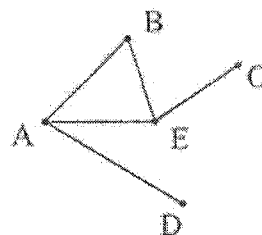
(A) 5

(B) 7

(C) 8

(D) 10

3. What is the degree of vertex  $A$  in this network diagram?


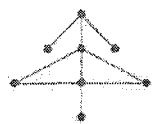
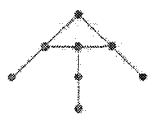
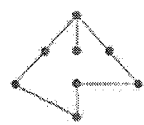
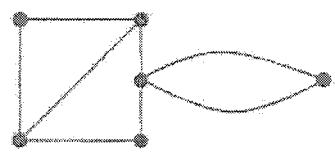
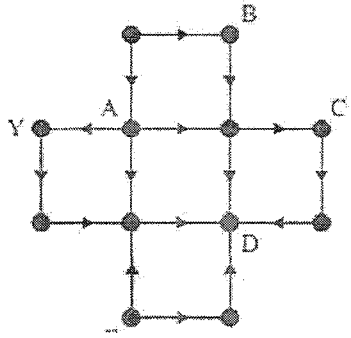
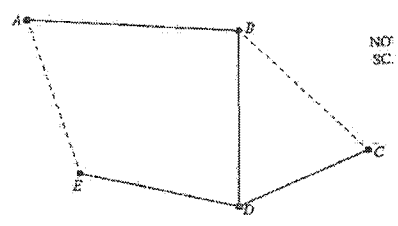


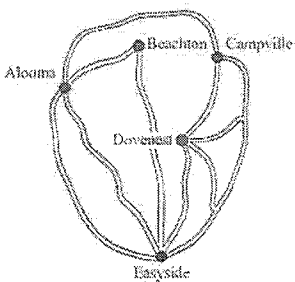
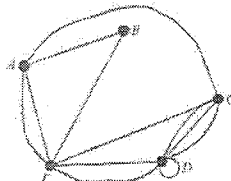
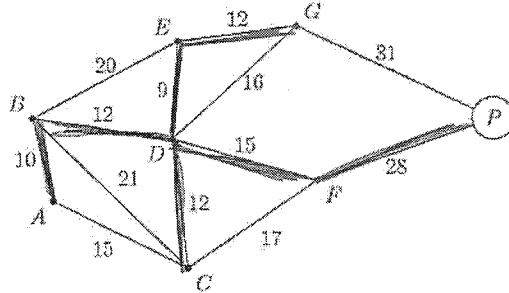
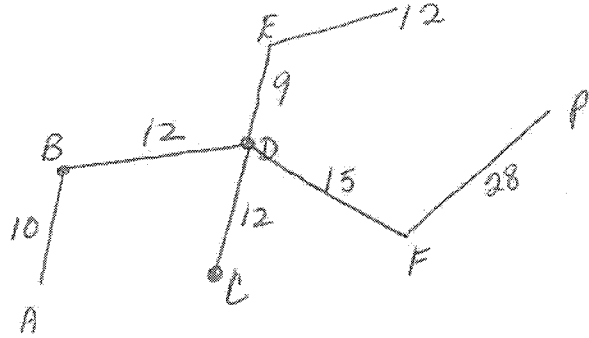
(A) 4

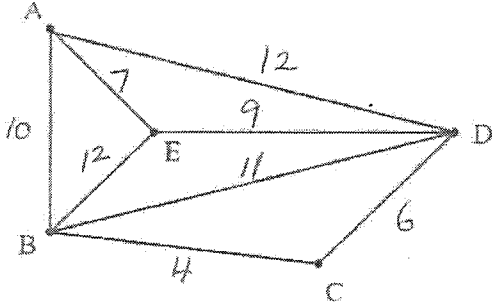
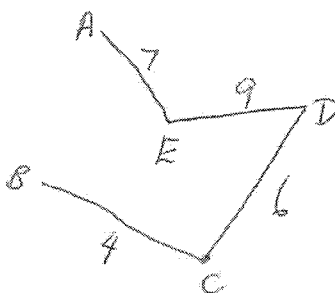
(B) 3

(C) 2

(D) 1

4.	<p>Which one of the following graphs is a tree?</p> <div style="display: flex; justify-content: space-around; align-items: flex-start;"> <div style="text-align: center;"> <p>(A)</p>  </div> <div style="text-align: center;"> <p>(B)</p>  </div> <div style="text-align: center;"> <p>(C)</p>  </div> <div style="text-align: center;"> <p>(D)</p>  </div> </div>	
5.	<p>In the graph below, the number of vertices of odd degree is:</p> <div style="text-align: center;">  </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <span>(A) 1</span> <span>(B) 2</span> <span>(C) 3</span> <span>(D) 4</span> </div>	
6.	<p>In the directed graph below, which is the only vertex with a label that can be reached from vertex Y?</p> <div style="text-align: center;">  </div> <div style="display: flex; justify-content: space-around; margin-top: 10px;"> <span>(A) vertex A</span> <span>(B) vertex B</span> <span>(C) vertex C</span> <span>(D) vertex D</span> </div>	
7.	<p>A park has five areas, A, B, C, D and E, which are connected by pathways, as shown in the minimum spanning tree diagram below.</p> <div style="text-align: center;">  </div> <p>Explain why AE and BC were not included a part of the minimum spanning tree.</p> <ul style="list-style-type: none"> <li>• They form a cycle.</li> <li>• There are 5 vertices <math>\therefore</math> 4 edges maximum</li> </ul> <p style="text-align: center;">A spanning tree has one less edge than number of vertices.</p>	1

8.	<p>A map of the roads connecting five suburbs of a city, Alooma (A), Beachton (B), Campville (C), Dovenest (D) and Easyside (E) is shown below.</p>  <p>A graph that represents the map of the roads is shown below.</p> 	
	<p>Explain what the loop at D represents in terms of a driver who is departing from Dovenest.</p> <p><i>Represents a route that a driver can depart from Dovenest and return to Dovenest without passing thru another suburb or turning back.</i></p>	1
9.	<p>Cabins in a national park are to be connected to the power source at P. The weighted graph below shows the distances in metres between certain cabins and the power source.</p> 	
	<p>Use Kruskal's algorithm to draw a minimum spanning tree for this network.</p> 	3

10.	<p>A university IT department has done a study to analyse the cost of installing a new high-speed fibre optic network on the campus, taking into account the distances and current infrastructure.</p> <p>The cost, in thousands of dollars, to connect cables between the main buildings is provided in the table below.</p> <table border="1"><tr><th></th><th>A</th><th>B</th><th>C</th><th>D</th><th>E</th></tr><tr><th>A</th><td></td><td>10</td><td></td><td>12</td><td>7</td></tr><tr><th>B</th><td>10</td><td></td><td>4</td><td>11</td><td>12</td></tr><tr><th>C</th><td></td><td>4</td><td></td><td>6</td><td></td></tr><tr><th>D</th><td>12</td><td>11</td><td>6</td><td></td><td>9</td></tr><tr><th>E</th><td>7</td><td>12</td><td></td><td>9</td><td></td></tr></table>		A	B	C	D	E	A		10		12	7	B	10		4	11	12	C		4		6		D	12	11	6		9	E	7	12		9		
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C		4		6																																		
D	12	11	6		9																																	
E	7	12		9																																		
	<p>a) Using the table complete the weighted network diagram below, representing the cost to connect the buildings in thousands of dollars.</p>  <p style="text-align: right;">-1 mark each mistake</p>	2																																				
	<p>b) Use your network diagram in part (a) to draw a minimum spanning tree for the campus in the space provided below.</p>  <p style="text-align: right;">-1 mark each mistake</p>	2																																				
	<p>c) What is the minimum cost (in dollars) to connect all the buildings on the campus with fibre optic cabling?</p> <p>..... <math>7 + 9 + 6 + 4 = 26</math> ①</p> <p>..... <math>26 \times 1000 = 26\,000</math> ①</p>	2																																				

The End

<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$	<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$
<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$	<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$
<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$	<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$
<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$	<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$
<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$	<p><b>Financial Mathematics</b></p> $FV = PV(1 + r)^n$