SHENTON COLLEGE

**Mathematics Applications Year 12 ATMAA**
**Test 4 2020**
**Section One: Calculator-free.**
**No notes. Formula sheet provided.**

**NAME:**_____

Circle Teacher: Cheshire Le McRae Ryan

Time: 20 minutes Mark: 20

Total: $\frac{}{20}$ + $\frac{}{32}$ = $\frac{}{52}$

*Where appropriate, **show working** to receive all allocated marks.*

**Question 1** **[6 marks: 2, 2, 1, 1]**

The IT department at Shenton College will upgrade five mathematics classrooms using optical cable to allow data to travel from one classroom to another either directly or indirectly as shown in the table below. All measurements are in metres and the cable is estimated to cost $600 per metre.

| | **S19** | **S21** | **S23** | **S25** | **S28** |
|---|---|---|---|---|---|
| **S19** | - | 16 | 25 | 26 | 20 |
| **S21** | 16 | - | 7 | - | 24 |
| **S23** | 25 | 7 | - | 9 | 27 |
| **S25** | 26 | - | 9 | - | 18 |
| **S28** | 20 | 24 | 27 | 18 | - |

**(a)** Use Prim's algorithm to determine the minimal total length of cable required to connect the rooms.

**(b)** Calculate the minimum cost of the cable needed to connect this network.

**(c)** Construct a minimum spanning tree on the diagram below.

S19 ● ● S21

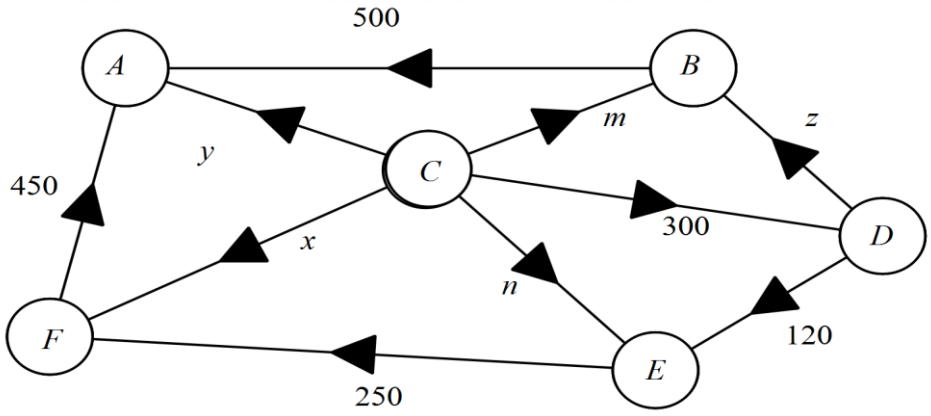
● S23

S25 ● ● S28

**(d)** The cable length between the two classrooms, S19 and S21 was measured incorrectly. The correct length is 17 metres. What effect does this have on the required minimum length of cable?

**Question 2** **[6 marks: 1, 4, 1]**

The directed network below shows a maximum flow between pumping stations on a cattle farm in Denmark, Western Australia. The number on each arc shows the maximum capacity in litres per minute from the source to the sink.




**(a)** Identify the source and the sink for this network. Source: _____ Sink: _____

The maximum flow of drinking water for the cattle through this network is 1000 litres per minute.

**(b)** Given that the value of *x* is 200, calculate the values of the four remaining pronumerals in the above diagram that will allow the maximum flow through this network.

$m =$ _____ $n =$ _____ $y =$ _____ $z =$ _____

**(c)** Verify the maximum flow through this network is 1000 litres per minute.

**Question 3** **[2 marks]**

A Rotary Club has invested $100 000 in a perpetuity which will provide financial assistance for local junior sporting clubs that guarantee a return of 2.5 % p.a. compounded annually.

Determine the annual amount the sporting clubs will receive from this perpetuity.

**Question 4** **[6 marks: 2, 1, 3]**

Mike's Plumbing installs deep sewerage to a new estate, 500 metres North of Shenton College Middle School. Ten activities required for project completion have been identified and their associated activity durations are given in the table below.

| Activity | Time (days) | Immediate Predecessor(s) |
|---|---|---|
| A | 15 | - |
| B | 10 | - |
| C | 20 | - |
| D | 10 | A |
| E | 15 | A |
| F | 15 | D |
| G | 5 | E |
| H | 8 | B |
| I | 15 | C, H |
| J | 10 | F, G, I |

**(a)** Construct a project network to represent the above information.

**(b)** State the minimum completion time for the project.

Assume the plumbers begin work at 9:00am, on the first of August.

**(c)** Determine the float time, earliest starting time, and latest starting time for Activity I.

**End of Section One**

SHENTON COLLEGE

**Mathematics Applications Year 12 ATMAA**
**Test 4 2020**
**Section Two: Calculator-assumed.**
**Notes allowed – one page of notes; both sides. Formula sheet provided.**

**NAME: _____**

Circle Teacher: Cheshire Le McRae Ryan

Time: 30 minutes Mark: ___/32

*Where appropriate, **show working** to receive all allocated marks.*
*Where applicable, answers should be given to **two decimal places**.*

Penalty:
□ Rounding error –1
□ Incorrect/no units –1

**Question 5** **[8 marks: 2, 2, 2, 2]**

Mike receives an inheritance of $85 000 and decides to invest the money in an annuity account. The fund will earn interest at the rate of 5.2% per annum, compounded annually, and he will receive annuity payments of $12 000 at the end of each year.

**(a)** Write a recurrence relation that models the amount, $A_n$, remaining in Mike's investment fund after he has received $n$ annuity payments.

**(b)** Determine the number of years Mike will be able to receive annuity payments of $12 000.

After Mike receives his final payment of $12 000 he will receive one last payment, which will be less than $12 000.

**(c)** Calculate the value of this final payment.

**(d)** At the interest rate of 5.2% per annum, how many extra years would the annuity last if Mike received payments of $7000 per year instead of $12 000 per year?

**Question 6** **[5 marks: 2, 3]**

Each Christmas, Kris has always given $50 cash to each of her four grandchildren. She now wishes to set up a perpetuity to provide a $200 Christmas gift every year, where $50 will be transferred to each of her four grandchildren on Christmas Day.

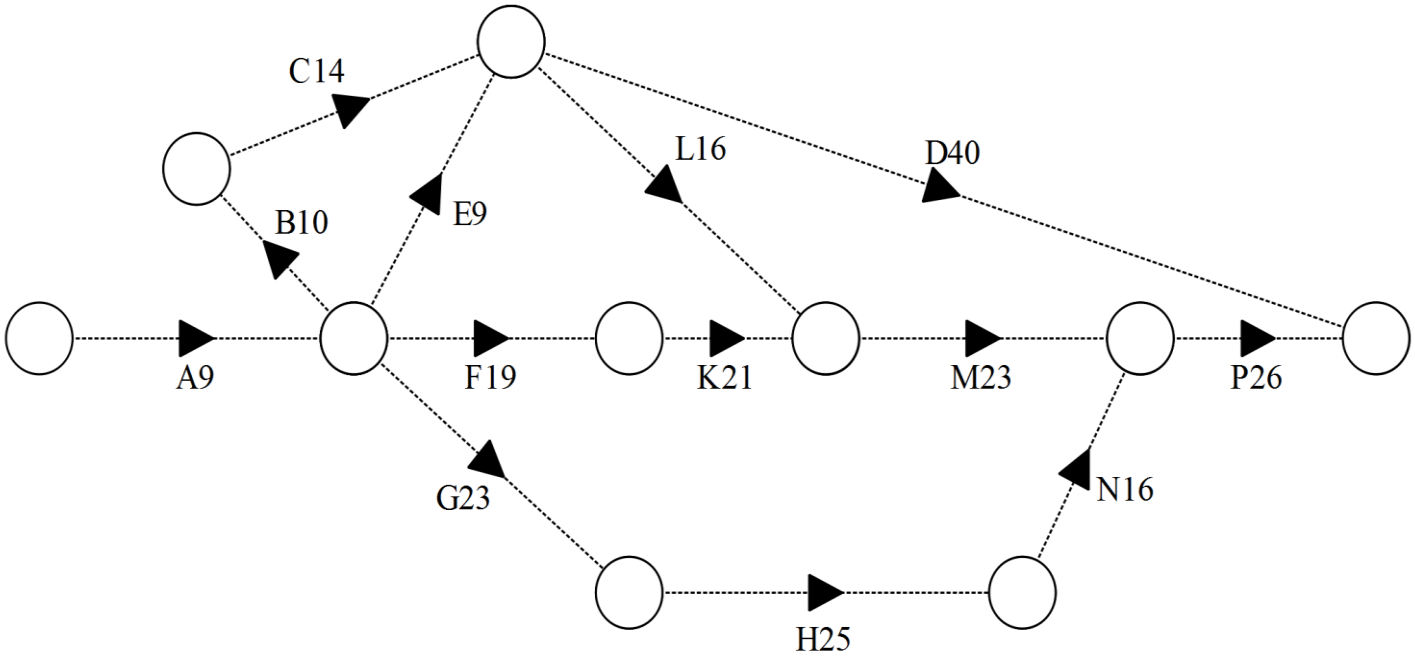
**(a)** Determine the amount Kris will need to invest into an account that pays 4.5% interest per annum, compounded annually, in order to transfer $200 every Christmas.

A financial institution has agreed to set-up an account for a $6000 perpetuity where the current interest rate of 4.5% per annum is now compounded quarterly.

**(b)** Determine the amount each of her four grandchildren will now receive at Christmas.

**Question 7** **[8 marks: 4, 1, 3]**

A car manufacturer has decided to make a significant investment into expanding its presence in Africa by setting up a large assembly facility in Kenya. The allocated time for all the activities displayed in the diagraph are in days.



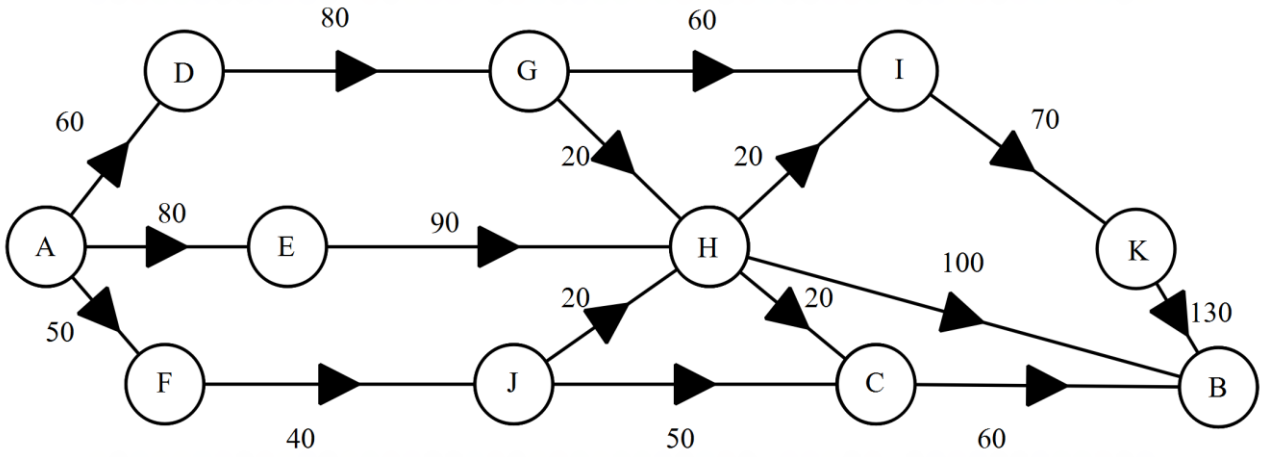

**(a)** Given that all tasks are completed in the specified time, state the critical path and determine the minimum completion time.

**(b)** For how many days can Activity E be delayed without affecting the minimum completion time?

**(c)** Activity H can now be completed in 22 days. Determine the effect (if any) this may have on the minimum completion time and critical path(s).

**Question 8** **[11 marks: 4, 1, 3, 3]**

The network below represents a system of pipes of a reticulation system at Perry Lakes. The arcs on the network represent the pipes and the weightings on the arcs give the maximum flow for that section of pipe in litres per minute.




**(a)** On the given network above, show how to calculate the maximum flow from the source to the sink and then calculate this value.

**(b)** Verify the maximum flow obtained in part (a) by showing the minimum cut on the given network.

**(c)** What effect (if any) will closing connection C have on the maximum flow? Explain your reasoning.

**(d)** There is capacity to increase flow in **one** reticulation pipe only. Assume connection C is open.

**(i)** Which pipe should be upgraded to increase the maximum flow the most?

**(ii)** How many more litres per minute would the maximum flow increase by? Justify your decision.

End of assessment