0 1

0 1 . 1 Explain the functionality of the `*` metacharacter when it is used in a regular expression.

[1 mark]

0 1 . 2 Explain the functionality of the `?` metacharacter when it is used in a regular expression.

[1 mark]

0 1 . 3 Complete **Table 2** to show which of the strings belong to the language defined by the regular expression `1|01+`.

Table 2

String	Belongs to language (Y/N)?
1	
11	
01	
0111	
0101	
111	
0011	

Copy the contents of the unshaded cells in **Table 2** into the table in your Electronic Answer Document.

[3 marks]

0 2 A set is an unordered collection of values in which each value occurs at most once. The items in the game can be described using sets.

The set **A** contains all the items in the game.

The set **B** contains all the items that have "use" in their `Commands`.

The set **C** contains all the items that have "gettable" in their `Status`.

The set **D** contains all the items in the player's inventory.

The set **E** contains all the items which have a `Location` equal to the `CurrentLocation` of the player and that have "usable" in their `Status`.

The set **F** contains all the items which have a `Location` equal to the `CurrentLocation`.

Four operations that can be performed on sets are union, difference, intersection and membership.

0 2 . 1 Explain how the operations can be used with some of the sets **A–F** to produce the set of items that the player can use in the current game state.

[3 marks]

0 2 . 2 The set described in question **08.1** is a proper subset of some of the sets **A**–**F**.

List all of the sets (**A–F**) that it is a proper subset of.

[1 mark]

0 2 . 3 Explain why the intersection of sets **F** and **C** does not contain all the items that the player can currently get.

[1 mark]

0 2 . 4 Explain the difference between a subset and a proper subset.

[1 mark]

0 3 A regular language is a language that can be defined by a regular expression.

0 3 . 1 Complete the unshaded cells of **Table 1** to show which of the statements about regular languages are true and which are false.

Table 1

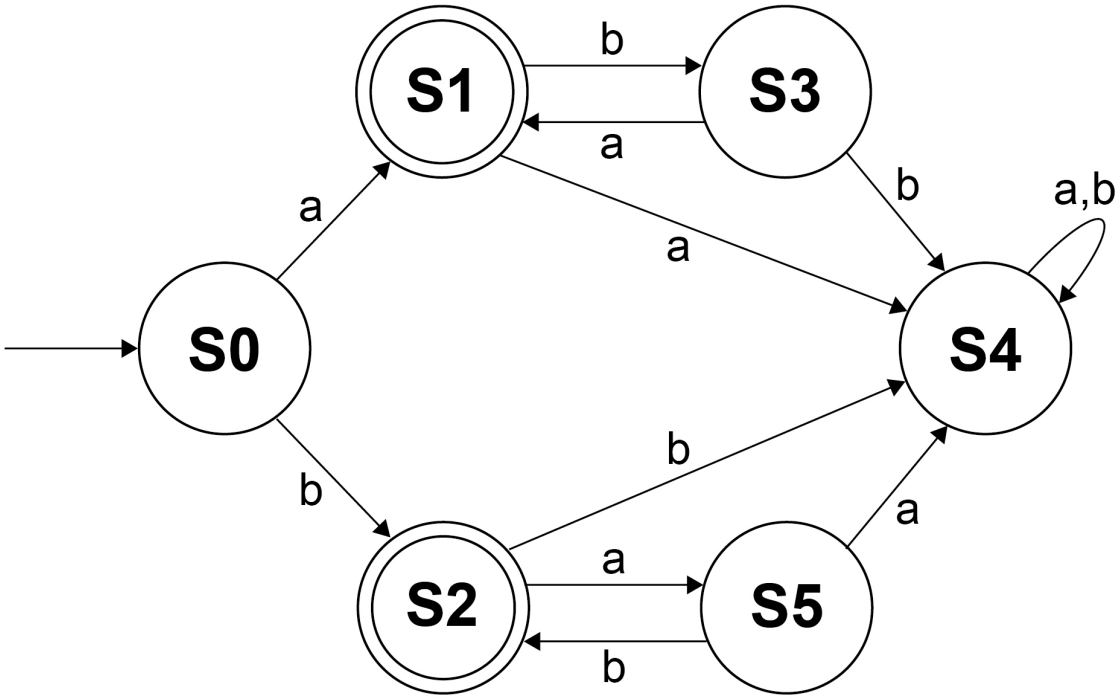
Statement	True or False?
All regular languages can be represented using a finite state machine without outputs.	
The set of strings defined by a regular language is always finite in size.	
There are some languages which can be represented in Backus-Naur Form (BNF) that are not regular languages.	

Copy the contents of the unshaded cells in **Table 1** into the table in your Electronic Answer Document.

[2 marks]

0 4 The state transition diagram for a finite state machine (FSM) is shown in **Figure 4**.

Figure 4



0 4 . 1 An FSM can also be represented as a state transition table.

Complete the state transition table, **Table 3**, so that it represents the parts of the state transition diagram shown in **Figure 4** that involve state **S2**.

Table 3

Current state	Input	New state

Copy the contents of the unshaded cells in **Table 3** into the table in your Electronic Answer Document.

[2 marks]

0 4 . 2 Regular expressions can be used to recognise the same strings as FSMs without output.

Write a regular expression that will recognise the same set of strings that are accepted by the FSM shown in **Figure 4**.

[3 marks]

0 5 The user must input a `D` or `P` to select Discard or Play during a game.

Write a regular expression that would match the character `D` or `P`.

You should **not** make any changes to the Skeleton Program to answer this question.

[1 mark]

0 6 A regular language is one that can be defined using a regular expression.

Figure 4 shows definitions for six different languages.

Figure 4

Language A

```
<string> ::= <term> <op> <term>
<string> ::= ( <string> )
<op>     ::= ÷ | -
<term>   ::= a | b
```

Language B

$(a|b)+ab^*$

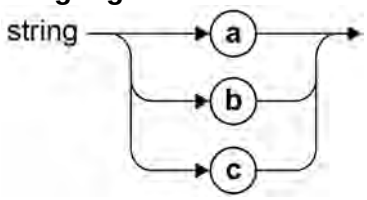
Language C

```
<string> ::= a | b | <num>
<string> ::= <string> a | <string> b
<digit>  ::= 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9
<num>    ::= <digit> <num> | <digit>
```

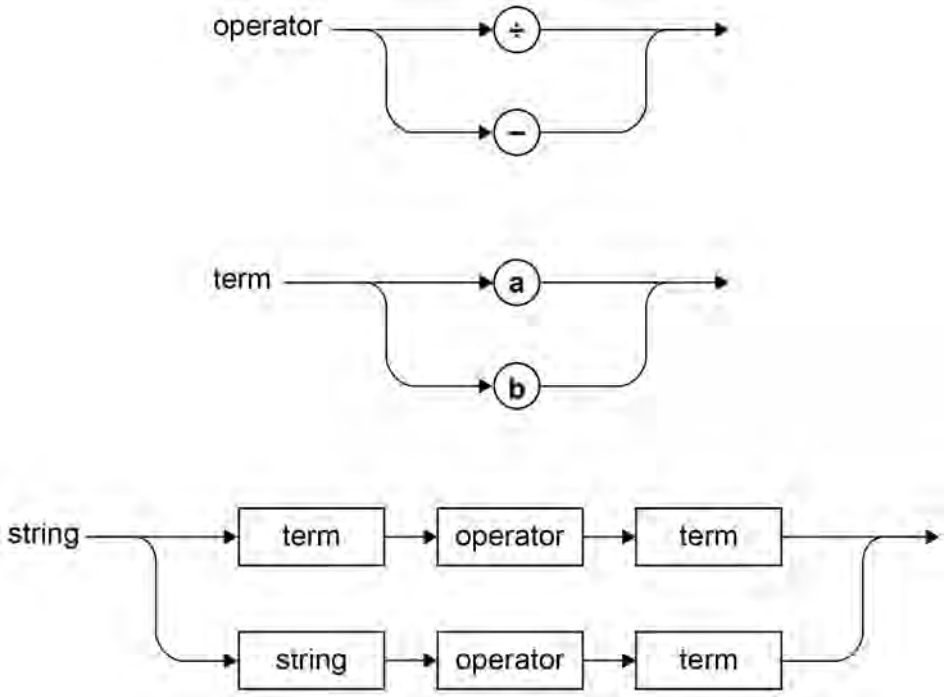
Language D

$\{a^n b \mid n \geq 1\}$

Language E



Language F



0 6 . 1 Complete **Table 2** to show which of the languages in **Figure 4** are regular languages.

Table 2

Language	Regular language (Y/N)?
Language A	
Language B	
Language C	
Language D	
Language E	
Language F	

Copy the contents of the unshaded cells in **Table 2** into the table in your Electronic Answer Document.

[3 marks]

0 6 . 2 Show that the language defined by the union of the sets $\{b^n \mid n > 0\}$ and $\{a, ab\}$ is a regular language by writing a regular expression for the language.

[2 marks]

0 6 . 3 Explain what is meant by the cardinality of a set.

[1 mark]

0 7 **Figure 1** shows four sets **R**, **S**, **T** and **U**. Three dots (…) means the remaining members of the set follow the same pattern as the previous members of the set.

Figure 1

R = {a, b}
S = {a, abb, abbbb, abbbbbb, …}
T = {bb, bbbb, bbbbbb, …}
U = {c, d, bb, b}

0 7 . 1 What is meant by the cardinality of a set?

[1 mark]

0 7 . 2 Explain what is wrong with the statement:

'The only subsets of **R** are the sets {a}, {b} and {a, b}'.

[1 mark]

0 7 . 3 How many members are there in the set formed by the intersection of **R** and **U**?

[1 mark]

0 7 . 4 The language defined by a regular expression can be represented as a set.

Explain the functionality of the | (vertical bar) metacharacter when it is used in a regular expression.

[1 mark]

The members of the set **V** are strings that match the regular expression a?b+

Set **W** is formed by the union of sets **S** and **T**.

Set **X** is formed by the set operation **V – W**.

0 7 . 5 Write a regular expression that would match with all the members of the set **W**.

[2 marks]

0 7 . 6 Write a regular expression that would match with all the members of the set **X**.

[2 marks]