0 1 **Figure 5** shows three commonly used mathematical functions: `add`, `square` and `pred`.

Figure 5

`add(x,y) = x + y`

`square(x) =` x^2

`pred(x) = x - 1`

For example:

- `add(3,2)` evaluates to 5
- `square(2)` evaluates to 4
- `pred(8)` evaluates to 7

The domain of the functions `square` and `pred` in **Figure 5** is the set of integers $\mathbb{Z}$ and the domain of the `add` function is $\mathbb{Z} \times \mathbb{Z}$.

0 1 . 1 What is the co-domain of the `pred` function?

[1 mark]

0 1 . 2 What is the result of applying `square ∘ pred` to the argument 3?

[1 mark]

0 1 . 3 The `add` function takes two arguments.

Describe how the `add` function could be partially applied to the arguments 4 and 6.

[3 marks]

0 2 . 1 One approach to dealing with Big Data is to write code that can be distributed to run across more than one server.

State **two** features of functional programming languages that make it easier to write code that can be distributed to run across more than one server.

[2 marks]

Feature 1 _____

_____

_____

Feature 2 _____

_____

_____

0 3 **Figure 11** shows a function, `FunctionZ`, written in a functional programming language.

Figure 11

```
FunctionZ [] = 0
FunctionZ (x:xs) = x + 2 * FunctionZ (xs)
```

- `[]` is the empty list.
- `(x:xs)` as the argument to a function splits a list into two parts, the head `x` and tail `xs`.

0 3 . 1 Complete **Table 5** by writing the value of the argument passed to each call of `FunctionZ` and the value returned by each call, when `FunctionZ [4, 2, 5, 3]` is evaluated.

[3 marks]

Table 5

Call number	Argument	Value returned
1	`[4, 2, 5, 3]`	
2		
3		
4		
5		

0 3 . 2 All of the values in lists passed to `FunctionZ` as the argument are members of the set of integers.

Shade **one** lozenge to indicate the co-domain of the function.

[1 mark]

A The set of integers ⬭

B The set of irrational numbers ⬭

C The set of natural numbers ⬭

D The set of rational numbers ⬭

E The set of real numbers ⬭

0 4 . 1 A functional programming function `f` has the function type:

$$\texttt{f}: \mathbb{N} \rightarrow \mathbb{R}$$

Describe the co-domain of the function `f`.

[1 mark]