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Pearson Edexcel
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COMPUTER SCIENCE
PAPER 2: APPLICATION OF COMPUTATIONAL THINKING
PROGRAMMING LANGUAGE SUBSET VERSION 2

PLS BOOKLET

Do not return this booklet with the question paper.

Y71103A

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CONTENTS

Page

5 – 6 Introduction
7 Comments
7 Identifiers
8 Data types and conversion
8 Primitive data types
9 Conversion
9 Constants
10 Combining declaration and initialisation
10 Structured data types
11 Dimensions
12 Operators
12 Arithmetic operators
13 Relational operators
13 Logical / Boolean operators
14 Programming constructs
14 Assignment
14 Sequence
14 Blocking
15 Selection

Turn over

CONTENTS continued

Page

16 Repetition
16 Iteration
17 Subprograms
18 Inputs and outputs
18 Screen and keyboard
19 Files
20 Supported subprograms
20 Built–in subprograms
21 List subprograms
22 – 23 String subprograms
24 Formatting strings
25 Library modules
25 Random library module
26 Math library module
26 Time library module
27 Turtle graphics library module
27 – 28 Tips for using turtle
28 – 29 Turtle window and drawing canvas

Turn over

CONTENTS continued

Page

Page	
30	Turtle creation, visibility and movement
31	Turtle positioning and direction
32	Turtle filling shapes
33	Turtle controlling the pen
34	Turtle circles
35	Turtle colours
35	Console session
36	Code style
37 – 38	Line continuation
39 – 40	Carriage return and line feed

INTRODUCTION

The Programming Language Subset (PLS) is a document that specifies which parts of Python 3 are required in order that the assessments can be undertaken with confidence. Students familiar with everything in this document will be able to access all parts of the Paper 2 assessment. This does not stop a teacher / student from going beyond the scope of the PLS into techniques and approaches that they may consider to be more efficient or engaging.

(continued on the next page)

INTRODUCTION continued

Pearson will NOT go beyond the scope of the PLS when setting assessment tasks. Any student successfully using more esoteric or complex constructs or approaches not included in this document will still be awarded marks in Paper 2 if the solution is valid.

The pair of < > symbols indicate where expressions or values need to be supplied. They are not part of the PLS.

COMMENTS

Anything on a line after the character # is considered a comment.

IDENTIFIERS

Identifiers are any sequence of letters, digits and underscores, starting with a letter.

Both upper and lower case are supported.

DATA TYPES AND CONVERSION

PRIMITIVE DATA TYPES

Variables may be explicitly assigned a data type during declaration.

Variables may be implicitly assigned a data type during initialisation.

Supported data types are:

DATA TYPE	PLS
integer	int
real	float
Boolean	bool
character	str

CONVERSION

Conversion is used to transform the data types of the contents of a variable using int ( ), str ( ), float ( ), bool ( ) or list ( ). Conversion between any allowable types is permitted.

CONSTANTS

Constants are conventionally named in all uppercase characters.

COMBINING DECLARATION AND INITIALISATION

The data type of a variable is implied when a variable is assigned a value.

STRUCTURED DATA TYPES

A structured data type is a sequence of items, which themselves are typed. Sequences start with an index of zero.

DATA TYPE	EXPLANATION	PLS
string	A sequence of characters	str
array	A sequence of items with the same (homogeneous) data type	list
record	A sequence of items, usually of mixed (heterogenous) data types	list

DIMENSIONS

The number of dimensions supported by the PLS is two.

The PLS does not support ragged data structures. Therefore, in a list of records, each record will have the same number of fields.

Turn over

OPERATORS

ARITHMETIC OPERATORS

ARITHMETIC OPERATOR	MEANING
/	division
*	multiplication
**	exponentiation
+	addition
–	subtraction
/ /	integer division
%	modulus

RELATIONAL OPERATORS

LOGICAL OPERATOR	MEANING
= =	equal to
! =	not equal to
>	greater than
> =	greater than or equal to
<	less than
< =	less than or equal to

LOGICAL / BOOLEAN OPERATORS

OPERATOR	MEANING
and	both sides of the test must be true to return true
or	either side of the test must be true to return true
not	inverts

Turn over

PROGRAMMING CONSTRUCTS

ASSIGNMENT

Assignment is used to set or change the value of a variable.

< variable identifier > = < value >
< variable identifier > = < expression >

SEQUENCE

Every instruction comes one after the other, from the top of the file to the bottom of the file.

BLOCKING

Blocking of code segments is indicated by indentation and subprogram calls. These determine the scope and extent of variables they declare.

Turn over

SELECTION

if < expression > : < command >	If < expression > is true, then command is executed.
if < expression > : < command > else: < command >	If < expression > is true, then first < command > is executed, otherwise second < command > is executed.
if < expression > : < command > elif < expression > : < command > else: < command >	If < expression > is true, then first < command > is executed, otherwise the second < expression > test is checked. If true, then second < command > is executed, otherwise third < command > is executed. Supports multiple instances of ‘elif’. The ‘else’ is optional with the ‘elif’.

REPETITION

while < condition > : < command >	Pre – conditioned loop. This executes < command > while < condition > is true.

ITERATION

for < id > in < structure > : < command >	Executes < command > for each element of a data structure, in one dimension
for < id > in range (< start >, < stop >) : < command >	Count – controlled loop. Executes < command > a fixed number of times, based on the numbers generated by the range function
for < id > in range (< start >, < stop >, < step >) : < command >	Same as above, except that < step > influences the numbers generated by the range function

Turn over

SUBPROGRAMS

def < procname > ( ) : < command >	A procedure with no parameters
def < procname > (< paramA >, < paramB >) : < command >	A procedure with parameters
def < funcname > ( ) : < command > return (< value >)	A function with no parameters
def < funcname > (< paramA >, < paramB >) : < command > return (< value >)	A function with parameters

Turn over

INPUTS AND OUTPUTS

SCREEN AND KEYBOARD

print (< item >)	Displays < item > on the screen
input (< prompt >)	Displays < prompt > on the screen and returns the line typed in

FILES

The PLS supports manipulation of comma separated value text files.

File operations include open, close, read, write and append.

<fileid> = open (<filename>, “r”)	Opens file for reading
for <line> in <fileid>:	Reads every line, one at a time
<alist> = <fileid>.readlines ( )	Returns a list where each item is a line from the file
<aline> = <fileid>.readline ( )	Returns a line from a file. Returns an empty string on the end of the file
<fileid> = open (<filename>, “w”)	Opens a file for writing
<fileid> = open (<filename>, “a”)	Opens a file for appending
<fileid>.writelines (<structure>)	Writes <structure> to a file. <structure> is a list of strings
<fileid>.write (<aString>)	Writes a single string to a file
<fileid>.close ( )	Closes file

Turn over

SUPPORTED SUBPROGRAMS

BUILT–IN SUBPROGRAMS

The PLS supports these built–in subprograms.

SUBPROGRAM	DESCRIPTION
chr (< integer >)	Returns the string which matches the Unicode value of < integer >
input (< prompt >)	Displays the content of prompt to the screen and waits for the user to type in characters followed by a new line
len (< object >)	Returns the length of the < object >, such as a string, one – dimensional or two – dimensional data structure
ord (< char >)	Returns the integer equivalent to the Unicode string of the single character < char >
print (< item >)	Prints < item > to the display
range (< start >, < stop >, < step >)	Generates a list of numbers using < step >, beginning with < start > and up to, but not including, < stop >. A negative value for < step > goes backwards
round (< x >, < n >)	Rounds < x > to the number of < n > digits after the decimal (uses the 0.5 rule)

Turn over

LIST SUBPROGRAMS

The PLS supports these list subprograms.

SUBPROGRAM	DESCRIPTION
< list > . append (< item >)	Adds < item > to the end of the list
del < list > [< index >]	Removes the item at < index > from list
< list > . insert (< index >, < item >)	Inserts < item > just before an existing one at < index >
< aList > = list ( ) < aList > = [ ]	Two methods of creating a list structure. Both are empty

Turn over

STRING SUBPROGRAMS

The PLS supports these string subprograms.

SUBPROGRAM	DESCRIPTION
len (<string>)	Returns the length of <string>
<string>.find (<substring>)	Returns the location of <substring> in the original <string>. Returns – 1, if not found
<string>.index (<substring>)	Returns the location of <substring> in the original <string>. Raises an exception if not found
<string>.isalpha ( )	Returns True, if all characters are alphabetic, A–Z
<string>.isalnum ( )	Returns True, if all characters are alphabetic, A–Z and digits (0–9)
<string>.isdigit ( )	Returns True, if all characters are digits (0–9), exponents are digits
<string>.replace (<s1>, <s2>)	Returns original string with all occurrences of <s1> replaced with <s2>

Turn over

Table continued

< string > . split (< char >)	Returns a list of all substrings in the original, using < char > as the separator
< string > . strip (< char >)	Returns original string with all occurrences of < char > removed from the front and back
< string > . upper ( )	Returns the original string in uppercase
< string > . lower ( )	Returns the original string in lowercase
< string > . isupper ( )	Returns True, if all characters are uppercase
< string > . islower ( )	Returns True, if all characters are lowercase
< string > . format (< placeholders >)	Formats values and puts them into the < placeholders >

Turn over

FORMATTING STRINGS

Output can be customised to suit the problem requirements and the user's needs by forming string output.

< string > . format ( ) can be used with positional placeholders and format descriptors.

Here is an example:

```
layout = " { : > 10 } { : ^ 5d } { : 7.4f } "
print ( layout . format ( "Fred", 358, 3.14159 ) )
```

```
      Fred   358   3.1416
```

CATEGORY	DESCRIPTION
Numbers	Decimal integer (d), Fixed point (f)
Alignment	Left (<), Right (>), Centre (^)
Field size	The total width of a field, regardless of how many columns are occupied

The * can be used to generate a line of repeated characters, for example " = " * 10, will generate " = = = = = = = = = = " .

Concatenation of strings is done using the + operator.

String slicing is supported. myName [0 : 2] gives the first two characters in the variable myName.

Turn over

LIBRARY MODULES

The functionality of a library module can only be accessed once the library module is imported into the program code.

STATEMENT	DESCRIPTION
import < library >	Imports the < library > module into the current program

RANDOM LIBRARY MODULE

The PLS supports these random library module subprograms.

SUBPROGRAM	DESCRIPTION
random . randint (< a >, < b >)	Returns a random integer X so that < a > < = X < = < b >
random . random ( )	Returns a float number in the range of 0.0 and 1.0

MATH LIBRARY MODULE

The PLS supports these math library module subprograms and constant.

SUBPROGRAM OR CONSTANT	DESCRIPTION
math . ceil (< r >)	Returns the smallest integer not less than < r >
math . floor (< r >)	Returns the largest integer not greater than < r >
math . sqrt (< x >)	Returns the square root of < x >
math . pi	The constant Pi (π)

TIME LIBRARY MODULE

The PLS supports this time library module subprogram.

SUBPROGRAM	DESCRIPTION
time . sleep (< sec >)	The current process is suspended for the given number of seconds, then resumes at the next line of the program

Turn over

TURTLE GRAPHICS LIBRARY MODULE

TIPS FOR USING TURTLE

The default mode for the PLS turtle is "standard". This means that when a turtle is created, it initially points to the right (east) and angles are counterclockwise. You can change modes using turtle.mode ( ).

The turtle window is one size and the turtle drawing canvas (inside the window) can be a different size. To make the turtle window bigger, a screen needs to be created and setup. Here is an example:

```
WIDTH  =  800
HEIGHT  =  400
screen  =  turtle . Screen  ( )
screen . setup  (WIDTH, HEIGHT)
```

To make the drawing canvas bigger use < turtle > . screensize ( ).

Turn over

TIPS FOR USING TURTLE continued

In some development environments, the turtle window will close as soon as the program completes.
There are two ways to keep it open:

- **Add turtle . done ( ) as the last line in the code file. This will keep the window open until closed with the exit cross in the upper right – hand corner. It also allows scrollbars on the window.**

- **Add a line asking for keyboard input, such as input ( ), as the last line. This will keep the window open until the user presses a key in the console session. The scrollbars will not work.**

TURTLE WINDOW AND DRAWING CANVAS

The PLS supports these turtle library module subprograms to control the window and drawing canvas. Notice that these subprograms do not use the name of the turtle you create to the left of the dot, but the library name, “ turtle ” or a < window > variable.

Turn over

SUBPROGRAM	DESCRIPTION
<window>.setup (<width>, <height>)	Sets the size of the turtle window to <width> x <height> in pixels. Requires use of turtle.Screen ( ) to create <window> first
turtle.done ( )	Use as the last line of the file to keep the turtle window open until it is closed using the exit cross in the upper right–hand corner of the window
turtle.mode (<type>)	<type> is one of the strings "standard" or "logo". A turtle in standard mode, initially points to the right (east) and angles are counterclockwise. A turtle in logo mode, initially points up (north) and angles are clockwise
turtle.Screen ( )	Returns a variable to address the turtle window. Use with <window>.setup( )
turtle.screensize (<width>, <height>)	Makes the scrollable drawing canvas size equal to <width> x <height> in pixels. Note, use with turtle.done ( ) so scrollbars will be active

Turn over

TURTLE CREATION, VISIBILITY AND MOVEMENT

The PLS supports these turtle library module subprograms to control the turtle creation, visibility and movement.

SUBPROGRAM	DESCRIPTION
<turtle> = turtle.Turtle ( )	Creates a new turtle with the variable name <turtle>
<turtle>.back (<steps>)	Moves backward (opposite – facing direction) for number of <steps>
<turtle>.forward (<steps>)	Moves forward (facing direction) for number of <steps>
<turtle>.hideturtle ( )	Makes the <turtle> invisible
<turtle>.left (<degrees>)	Turns anticlockwise the number of <degrees>
<turtle>.right (<degrees>)	Turns clockwise the number of <degrees>
<turtle>.showturtle ( )	Makes the turtle visible
<turtle>.speed (<value>)	The <value> can be set to "fastest", "fast", "normal", "slow", "slowest". Alternatively, use the numbers 1 to 10 to increase speed. The value of 0 is the fastest

Turn over

TURTLE POSITIONING AND DIRECTION

The PLS supports these turtle library module subprograms to control the positioning and direction.

SUBPROGRAM	DESCRIPTION
< turtle > . home ( )	Moves to canvas origin (0, 0)
< turtle > . reset ( )	Clears the drawing canvas, sends the turtle home and resets variables to default values
< turtle > . setheading (< degrees >)	Sets the orientation to < degrees >
< turtle > . setposition (< x >, < y >)	Positions the turtle at coordinates (< x >, < y >)

Turn over

TURTLE FILLING SHAPES

The PLS supports these turtle library module subprograms to control filling.

SUBPROGRAM	DESCRIPTION
< turtle > . begin_fill ( )	Call just before drawing a shape to be filled
< turtle > . end_fill ( )	Call just after drawing the shape to be filled. You must call < turtle > . begin_fill ( ) before drawing.
< turtle > . fillcolor (< colour >)	Sets the colour used to fill. The input argument can be a string or an RGB colour. For example: “ red ”, “ #551A8B2 ”, “ (0, 35, 102) ”

Turn over

TURTLE CONTROLLING THE PEN

The PLS supports these turtle library module subprograms to control the pen.

SUBPROGRAM	DESCRIPTION
< turtle > . pencolor (< colour >)	Sets the colour of the pen. The input argument can be a string or an RGB colour. For example: “ red ”, “ #551A8B ”, “ (0, 35, 102) ”
< turtle > . pendown ( )	Puts the pen down
< turtle > . pensize (< width >)	Makes the pen the size of < width > (positive number)
< turtle > . penup ( )	Lifts the pen up

Turn over

TURTLE CIRCLES

The PLS supports this turtle library module subprogram to draw a circle.

SUBPROGRAM	DESCRIPTION
< turtle > . circle (< radius >, < extent >)	Draws a circle with the given < radius >. The centre is the < radius > number of units to the left of the turtle. That means, the turtle is sitting on the edge of the circle. The parameter < extent > does not need to be given, but provides a way to draw an arc, if required. For example, an extent of 180 would be half a circle

Turn over

TURTLE COLOURS

Python colours can be given by using a string name. There are many colours and you can find information online for lists of all the available colours.

Here are a few to get you started:

blue	black	green	yellow
orange	red	pink	purple
indigo	olive	lime	navy
orchid	salmon	peru	sienna
white	cyan	silver	gold

CONSOLE SESSION

A console session is the window or command line where the user interacts with a program. It is the default window that displays the output from print ( ) and echoes the keys typed from the keyboard.

It will appear differently in different development tools.

Turn over

CODE STYLE

Although Python does not require all arithmetic and logical / Boolean expressions be fully bracketed, it might help the readability to bracket them. This is especially useful if the programmer or reader is not familiar with the order of operator precedence.

The same is true of spaces. The logic of a line can be more easily understood if a few extra spaces are introduced.
This is especially helpful if a long line of nested subprogram calls is involved.
It can be difficult to read where one ends and another begins. The syntax of Python is not affected, but it can make understanding the code much easier.

Turn over

LINE CONTINUATION

Long code lines may also be difficult to read, especially if they scroll off the edge of the display window. It's always better for the programmer to limit the amount of scrolling.

There are several ways to break long lines in Python.

Python syntax allows long lines to be broken inside brackets ( ), square brackets [ ], and braces { }. This works very well, but care should be taken to ensure that the next line is indented to a level that aids readability. It is even possible and recommended to add an extra set of brackets ( ) to expressions to break long lines.

Turn over

LINE CONTINUATION continued

Python also has a line continuation character, the backslash \ character.
It can be inserted, following strict rules, into some expressions to cause a continuation.

Some editors will automatically insert the line continuation character if the enter key is pressed.

Turn over

CARRIAGE RETURN AND LINE FEED

These affect the way outputs appear on the screen and in a file. Carriage return means to go back to the beginning of the current line without going down to the next line.
Line feed means to go down to the next line. Each is a non – printable ASCII character, that has an equivalent string in programming languages.

NAME	ABBREVIATION	ASCII HEXADECIMAL	STRING
Carriage return	CR	0 x 0 D	" \ r "
Line feed	LF	0 x 0 A	" \ n "

These characters are used in some combination to control outputs. Unfortunately, not every operating system uses the same. However, editors automatically convert input and output files to make sure they work properly.

Turn over

CARRIAGE RETURN AND LINE FEED continued

In Python, print ( ) automatically adds them so that the console output appears on separate lines.

When writing code to handle files, a programmer will need to remove some of these characters when reading lines from files and add them when writing lines to files. If needed, they are added with string concatenation. If needed to be removed, they are removed using the strip ( ) subprogram.