**Instructions**

**Transformations: Trig graphs**

* Use **black** ink or ball-point pen.
	+ **Fill in the boxes** at the top of this page with your name,
	centre number and candidate number.
* Answer **all** questions.
* Answer the questions in the spaces provided
*– there may be more space than you need.*
* You must **show all your working.**
* Diagrams are **NOT** accurately drawn, unless otherwise indicated.
* If your calculator does not have a *π* button, take the value of *π* to be3.142

unless the question instructs otherwise.

**Information**

* The total mark for this paper is **30**. There are **11** questions.
* Questions have been arranged in an ascending order of mean difficulty, as found by all students in the June 2017–November 2019 examinations.
* The marks for **each** question are shown in brackets
*– use this as a guide as to how much time to spend on each question.*

**Advice**

* Read each question carefully before you start to answer it.
* Keep an eye on the time.
* Try to answer every question.
* Check your answers if you have time at the end.

**1** Here is the graph of *y* = sin *x*° for –180 ⩽ *x* ⩽ 180

**

On the grid, sketch the graph of *y* = sin *x*° – 2 for –180 ⩽ *x* ⩽ 180

(**Total for Question 1 is 2 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**2** Sketch the graph of *y* = tan *x*° for 0 ⩽ *x* ⩽ 360



**(Total for Question 2 is 2 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**3** The graph of *y* = f(*x*) is shown on the grid.

**

Graph **A** is a reflection of the graph of *y* = f(*x*).

(a)Write down the equation of graph **A**.

.........................................

**(1)**

The graph of *y* = g(*x*) is shown on the grid.



Graph **B** is a translation of *y* = g(*x*).

(b)Write down the equation of graph **B**.

.........................................

**(1)**

The graph of *y* = cos *x*° is shown.

**

(c)Write down the coordinates of the point marked *C*.

(............................ , ............................)

**(1)**

**(Total for Question 3 is 3 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**4** The equation of a curve is *y* = *ax*

*A* is the point where the curve intersects the *y*-axis.

(*a*)State the coordinates of *A*.

( .......................... , ..........................)

**(1)**

The equation of circle **C** is *x*2 + *y*2 = 16

The circle **C** is translated by the vector  to give circle **B**.

(*b*)Draw a sketch of circle **B**.

 Label with coordinates

the centre of circle **B**

and any points of intersection with the *x*-axis.

**(3)**

**(Total for Question 4 is 4 marks)**

**5** The graph of the curve C with equation *y* = f(*x*) is transformed to give the graph of

the curve S with equation *y* = f(−*x*) − 3

The point on C with coordinates (7, 2) is mapped to the point *Q* on S.

Find the coordinates of *Q*.

(............................ , ............................)

**(Total for Question 5 is 2 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**6** The graph of *y* = f(*x*) is shown on the grid below.



(*a*)On the grid above, sketch the graph of *y* = f(*x* – 2)

**(1)**

****

On the grid, graph **A** has been reflected to give graph **B**.

The equation of graph **A** is *y* = g(*x*)

(*b*)Write down the equation of graph **B**.

......................................................

**(1)**

**(Total for Question 6 is 2 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**7** The graph of *y* = f(*x*) is shown on the grid.



(*a*)On the grid, draw the graph with equation *y* = f(*x* + 1) ̶ 3

**(2)**

Point *A*(–2, 1) lies on the graph of *y* = f(*x*).

When the graph of *y* = f(*x*) is transformed to the graph with equation *y* = f(–*x*), point *A* is

mapped to point *B*.

(*b*)Write down the coordinates of point *B*.

(............................ , ............................)

**(1)**

**(Total for Question 7 is 3 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**8** Here is a sketch of the curve *y* = sin (*x* + *a*)° + *b*

**

Given that 0 < *a* < 360

find the value of *a* and the value of *b*.

*a* = ......................................................

*b* = ......................................................

**(Total for Question 8 is 2 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**9** The graph of *y* = *x*2 is reflected in the line with equation *y* = *x* to give the curve **C**.

(a) Sketch the graph of *y* = *x*2 and the curve **C**.

 Clearly label the graphs.

**

**(Total for Question 9 is 3 marks)**

**10** Here is a sketch of the graph of a trigonometric function for 0 ≤ *x* ≤ 360



(a) Write down a possible equation of the graph.

.......................................................

**(1)**

Here is a sketch of the graph of *y* = cos (*x* – *p*)° + *r* for 0 ≤ *x* ≤ 360

**

(b) Find the value of *p* and the value of *r*.

*p* = .......................................................

*r* = .......................................................

**(2)**

**(Total for Question 10 is 3 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**11** (*a*)Sketch the graph of *y* = cos *x*° for 0 ≤ *x* ≤ 360



**(2)**

(*b*)The graph of *y* = f(*x*) is shown on both grids below.

 (i) On this grid, draw the graph of *y* = –f(*x*)

 (ii) On the grid below, draw the graph of *y* = f(*x* − 3)



**(2)**

**(Total for Question 11 is 4 marks)**

**\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**TOTAL MARKS FOR PAPER: 30**