**Instructions**

* 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 **48**. There are **9** 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** f and g are functions such that

f(*x*) = and g(*x*) = 4*x*3

(*a*)Find f(–5)

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

(**1**)

(*b*)Find fg(1)

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

(**2**)

(**Total for Question 1 is 3 marks**)

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

**2** The functions f and g are such that

f(*x*) = 3*x* – 1 and g(*x*) = *x*2 + 4

(*a*)Find f –1(*x*)

f –1(*x*) = .......................................................

**(2)**

Given that fg(*x*) = 2gf(*x*),

(*b*)show that 15*x*2 – 12*x* – 1 = 0

**(5)**

**(Total for Question 2 is 7 marks)**

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

**3** f(*x*) = 4sin *x*°

(*a*)Find f(23)

Give your answer correct to 3 significant figures.

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

**(1)**

g(*x*) = 2*x* – 3

(*b*)Find fg(34)

Give your answer correct to 3 significant figures.

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

**(2)**

h(*x*) = (*x* + 4)2

Ivan needs to solve the following equation h(*x*) = 25

He writes

(*x* + 4)2 = 25

*x* + 4 = 5

*x* = 1

This is not fully correct.

(*c*)Explain why.

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**(1)**

**(Total for Question 3 is 4 marks)**

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**4** The function f is given by

f(*x*) = 2*x*3 – 4

(*a*)Show that f –1(50) = 3

**(2)**

The functions g and h are given by

g(*x*) = *x* + 2 and h(*x*) = *x*2

(*b*)Find the values of *x* for which

hg(*x*) = 3*x*2 + *x* – 1

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

**(4)**

**(Total for Question 4 is 6 marks)**

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**5** For all values of *x*

f(*x*) = (*x* + 1)2 and g(*x*) = 2(*x* – 1)

(*a*)Show that gf(*x*) = 2*x*(*x* + 2)

**(2)**

(*b*)Find g–1(7)

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

**(2)**

**(Total for Question 5 is 4 marks)**

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

**6** For all values of *x*

f(*x*) = 2*x* – 3 and g(*x*) = *x*2 + 2

(a)Find g(−4)

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

**(1)**

(b)Show that gf(*x*) = 4*x*2 − 12*x* + 11

**(2)**

(c)Solve fg(*x*) = gf(*x*)

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

**(4)**

**(Total for Question 6 is 7 marks)**

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

**7** f(*x*) = *x*3

g(*x*) = 4*x* – 1

(*a*) Find fg(2)

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

**(2)**

h(*x*) = fg(*x*)

(*b*) Find an expression for h–1(*x*)

h–1(*x*) = .......................................................

**(3)**

**(Total for Question 7 is 5 marks)**

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

**8** f(*x*) = 

(a) Show that ff(*x*) = *x*

**(3)**

(b) Hence, write down f –1(*x*)

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

**(1)**

**(Total for Question 8 is 4 marks)**

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

**9** f(*x*) =  + 

(a) Work out f(5)

 Give your answer as a fraction.

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**(2)**

(b) Write down a value of *x* for which f(*x*) is not defined.

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

**(1)**

Given that f(*x*) = 4

(c) find the possible values of *x*.

 Give your answer in the form , where *p*, *q* and *r* are positive integers.

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

**(5)**

**(Total for Question 9 is 8 marks)**

**TOTAL MARKS FOR PAPER: 48**