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Surname	Other names

Pearson Edexcel
Level 3 GCE

Centre Number | Candidate Number

Further Mathematics

Advanced
Paper 1: Core Pure Mathematics 1

Sample Assessment Material for first teaching September 2017
Time: 1 hour 30 minutes

Paper Reference
9FM0/01

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 9 questions in this question paper. The total mark for this paper is 75.
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.

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Pearson

Answer ALL questions. Write your answers in the spaces provided.

1. Prove that

$$\sum_{r=1}^{n} \frac{1}{(r+1)(r+3)} = \frac{n(an+b)}{12(n+2)(n+3)}$$

where a and b are constants to be found.

(5)

Question 1 continued

(Total for Question 1 is 5 marks)

2. Prove by induction that for all positive integers n,

$$f(n) = 2^{3n+1} + 3(5^{2n+1})$$

is divisible by 17

(6)

Question 2 continued

(Total for Question 2 is 6 marks)

3. $$f(z) = z^4 + az^3 + 6z^2 + bz + 65$$

where a and b are real constants.

Given that $z = 3 + 2\mathbf{i}$ is a root of the equation $f(z) = 0$, show the roots of $f(z) = 0$ on a single Argand diagram.

(9)

Question 3 continued

(Total for Question 3 is 9 marks)

4.

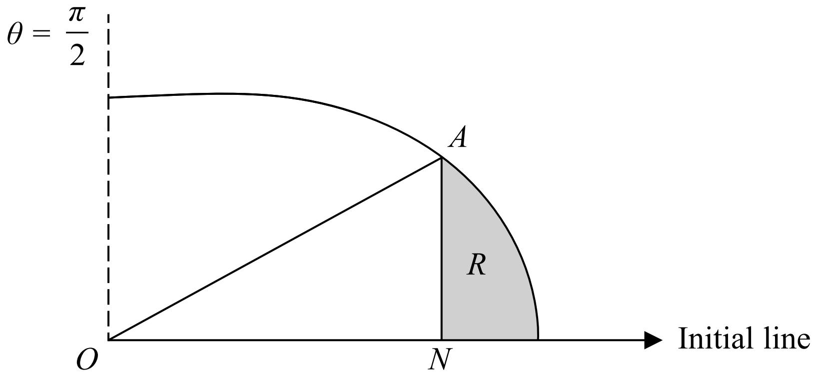

Figure 1

The curve C shown in Figure 1 has polar equation

$$r = 4 + \cos 2\theta \qquad 0 \leqslant \theta \leqslant \frac{\pi}{2}$$

At the point A on C, the value of r is $\frac{9}{2}$

The point N lies on the initial line and AN is perpendicular to the initial line.

The finite region R, shown shaded in Figure 1, is bounded by the curve C, the initial line and the line AN.

Find the exact area of the shaded region R, giving your answer in the form $p\pi + q\sqrt{3}$ where p and q are rational numbers to be found.

(9)

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Question 4 continued

(Total for Question 4 is 9 marks)

5. A pond initially contains 1000 litres of unpolluted water.

The pond is leaking at a constant rate of 20 litres per day.

It is suspected that contaminated water flows into the pond at a constant rate of 25 litres per day and that the contaminated water contains 2 grams of pollutant in every litre of water.

It is assumed that the pollutant instantly dissolves throughout the pond upon entry.

Given that there are x grams of the pollutant in the pond after t days,

(a) show that the situation can be modelled by the differential equation,

$$\frac{dx}{dt} = 50 - \frac{4x}{200 + t}$$

(4)

(b) Hence find the number of grams of pollutant in the pond after 8 days.

(5)

(c) Explain how the model could be refined.

(1)

Question 5 continued

(Total for Question 5 is 10 marks)

6.

$$f(x) = \frac{x+2}{x^2+9}$$

(a) Show that

$$\int f(x)\,dx = A\ln(x^2+9) + B\arctan\left(\frac{x}{3}\right) + c$$

where c is an arbitrary constant and A and B are constants to be found.

(4)

(b) Hence show that the mean value of f(x) over the interval [0, 3] is

$$\frac{1}{6}\ln 2 + \frac{1}{18}\pi$$

(3)

(c) Use the answer to part (b) to find the mean value, over the interval [0, 3], of

$$f(x) + \ln k$$

where k is a positive constant, giving your answer in the form $p + \frac{1}{6}\ln q$, where p and q are constants and q is in terms of k.

(2)

Question 6 continued

(Total for Question 6 is 9 marks)

7.

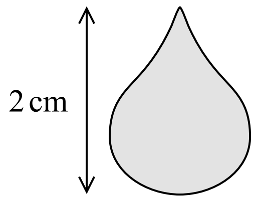

Figure 2

Figure 2 shows the image of a gold pendant which has height 2 cm. The pendant is modelled by a solid of revolution of a curve C about the y-axis. The curve C has parametric equations

$$x = \cos\theta + \frac{1}{2}\sin 2\theta, \quad y = -(1 + \sin\theta) \quad 0 \leqslant \theta \leqslant 2\pi$$

(a) Show that a Cartesian equation of the curve C is

$$x^2 = -(y^4 + 2y^3)$$

(4)

(b) Hence, using the model, find, in cm^3, the volume of the pendant.

(4)

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Question 7 continued

Question 7 continued

Question 7 continued

(Total for Question 7 is 8 marks)

8. The line l_1 has equation $\dfrac{x-2}{4} = \dfrac{y-4}{-2} = \dfrac{z+6}{1}$

The plane Π has equation $x - 2y + z = 6$

The line l_2 is the reflection of the line l_1 in the plane Π.

Find a vector equation of the line l_2

(7)

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Question 8 continued

Question 8 continued

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Question 8 continued

(Total for Question 8 is 7 marks)

9. A company plans to build a new fairground ride. The ride will consist of a capsule that will hold the passengers and the capsule will be attached to a tall tower. The capsule is to be released from rest from a point half way up the tower and then made to oscillate in a vertical line.

The vertical displacement, x metres, of the top of the capsule below its initial position at time t seconds is modelled by the differential equation,

$$m\frac{d^2x}{dt^2} + 4\frac{dx}{dt} + x = 200\cos t, \qquad t \geqslant 0$$

where m is the mass of the capsule including its passengers, in thousands of kilograms.

The maximum permissible weight for the capsule, including its passengers, is 30 000 N.

Taking the value of g to be $10\,\text{ms}^{-2}$ and assuming the capsule is at its maximum permissible weight,

(a) (i) explain why the value of m is 3

(ii) show that a particular solution to the differential equation is

$$x = 40\sin t - 20\cos t$$

(iii) hence find the general solution of the differential equation.

(8)

(b) Using the model, find, to the nearest metre, the vertical distance of the top of the capsule from its initial position, 9 seconds after it is released.

(4)

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Question 9 continued

Question 9 continued

Question 9 continued

(Total for Question 9 is 12 marks)

TOTAL FOR PAPER IS 75 MARKS

Paper 1: Core Pure Mathematics 1 Mark Scheme

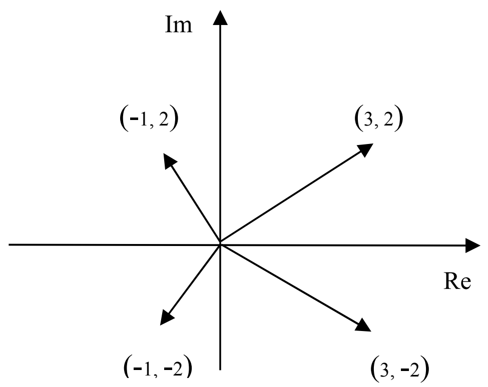
Question	Scheme	Marks	AOs
1	$\frac{1}{(r+1)(r+3)} \equiv \frac{A}{(r+1)} + \frac{B}{(r+3)} \Rightarrow A = ..., B = ...$	M1	3.1a
	$\sum_{r=1}^{n} \frac{1}{(r+1)(r+3)} =$ $\frac{1}{2\times2} - \frac{1}{2\times4} + \frac{1}{2\times3} - \frac{1}{2\times5} + ... + \frac{1}{2n} - \frac{1}{2(n+2)} + \frac{1}{2(n+1)} - \frac{1}{2(n+3)}$	M1	2.1
	$= \frac{1}{4} + \frac{1}{6} - \frac{1}{2(n+2)} - \frac{1}{2(n+3)}$	A1	2.2a
	$= \frac{5(n+2)(n+3) - 6(n+3) - 6(n+2)}{12(n+2)(n+3)}$	M1	1.1b
	$= \frac{n(5n+13)}{12(n+2)(n+3)}$	A1	1.1b
		(5)	
	Alternative by induction: $n = 1 \Rightarrow \frac{1}{8} = \frac{a+b}{12\times3\times4}, \ n = 2 \Rightarrow \frac{1}{8} + \frac{1}{15} = \frac{2(2a+b)}{12\times4\times5}$ $a + b = 18, \ 2a + b = 23 \Rightarrow a = ..., b = ...$	M1	3.1a
	Assume true for $n = k$ so $\sum_{r=1}^{k} \frac{1}{(r+1)(r+3)} = \frac{k(5k+13)}{12(k+2)(k+3)}$		
	$\sum_{r=1}^{k+1} \frac{1}{(r+1)(r+3)} = \frac{k(5k+13)}{12(k+2)(k+3)} + \frac{1}{(k+2)(k+4)}$	M1	2.1
	$\frac{k(5k+13)}{12(k+2)(k+3)} + \frac{1}{(k+2)(k+4)} = \frac{k(5k+13)(k+4) + 12(k+3)}{12(k+2)(k+3)(k+4)}$	A1	2.2a
	$= \frac{5k^3 + 33k^2 + 52k + 12k + 36}{12(k+2)(k+3)(k+4)} = \frac{(k+1)(k+2)(5k+18)}{12(k+2)(k+3)(k+4)}$	M1	1.1b
	$= \frac{(\underline{k+1})(5(\underline{k+1})+13)}{12(\underline{k+1}+2)(\underline{k+1}+3)}$ So true for $n = k + 1$ So $\sum_{r=1}^{n} \frac{1}{(r+1)(r+3)} = \frac{n(5n+13)}{12(n+2)(n+3)}$	A1	1.1b
		(5)	
			(5 marks)

Question 1 notes:	
Main Scheme	
M1:	Valid attempt at partial fractions
M1:	Starts the process of differences to identify the relevant fractions at the start and end
A1:	Correct fractions that do not cancel
M1:	Attempt common denominator
A1:	Correct answer
Alternative by Induction:	
M1:	Uses $n = 1$ and $n = 2$ to identify values for a and b
M1:	Starts the induction process by adding the $(k + 1)^{\text{th}}$ term to the sum of k terms
A1:	Correct single fraction
M1:	Attempt to factorise the numerator
A1:	Correct answer and conclusion

Question	Scheme	Marks	AOs
2	When $n = 1$, $2^{3n+1} + 3\left(5^{2n+1}\right) = 16 + 375 = 391$ 391 = 17 × 23 so the statement is true for $n = 1$	B1	2.2a
	Assume true for $n = k$ so $2^{3k+1} + 3\left(5^{2k+1}\right)$ is divisible by 17	M1	2.4
	$\mathrm{f}(k+1) - \mathrm{f}(k) = 2^{3k+4} + 3\left(5^{2k+3}\right) - 2^{3k+1} - 3\left(5^{2k+1}\right)$	M1	2.1
	$= 7 \times 2^{3k+1} + 7 \times 3\left(5^{2k+1}\right) + 17 \times 3\left(5^{2k+1}\right)$		
	$= 7\mathrm{f}(k) + 17 \times 3\left(5^{2k+1}\right)$	A1	1.1b
	$\mathrm{f}(k+1) = 8\mathrm{f}(k) + 17 \times 3\left(5^{2k+1}\right)$	A1	1.1b
	If the statement is true for $n = k$ then it has been shown true for $n = k + 1$ and as it is true for $n = 1$, the statement is true for all positive integers n	A1	2.4
		(6)	
			(6 marks)

Notes:

B1: Shows the statement is true for $n = 1$
M1: Assumes the statement is true for $n = k$
M1: Attempts f(k+1) – f(k)
A1: Correct expression in terms of f(k)
A1: Correct expression in terms of f(k)
A1: Obtains a correct expression for f(k + 1)
A1: Correct complete conclusion

Question	Scheme	Marks	AOs
3	$z = 3 - 2\text{i}$ is also a root	B1	1.2
	$\left(z-(3+2\text{i})\right)\left(z-(3-2\text{i})\right)=\ldots$ **or** Sum of roots = 6, Product of roots = $13 \Rightarrow \ldots$	M1	3.1a
	$= z^2 - 6z + 13$	A1	1.1b
	$\left(z^4 + az^3 + 6z^2 + bz + 65\right) = \left(z^2 - 6z + 13\right)\left(z^2 + cz + 5\right) \Rightarrow c = \ldots$	M1	3.1a
	$z^2 + 2z + 5 = 0$	A1	1.1b
	$z^2 + 2z + 5 = 0 \Rightarrow z = \ldots$	M1	1.1a
	$z = -1 \pm 2\text{i}$	A1	1.1b
		B1 $3 \pm 2\text{i}$ Plotted correctly	1.1b
		B1ft $-1 \pm 2\text{i}$ Plotted correctly	1.1b
			(9 marks)

Notes:

B1: Identifies the complex conjugate as another root
M1: Uses the conjugate pair and a correct method to find a quadratic factor
A1: Correct quadratic
M1: Uses the given quartic and their quadratic to identify the value of c
A1: Correct 3TQ
M1: Solves their second quadratic
A1: Correct second conjugate pair
B1: First conjugate pair plotted correctly and labelled
B1ft: Second conjugate pair plotted correctly and labelled (Follow through their second conjugate pair)

Question	Scheme	Marks	AOs
4	$4+\cos 2\theta = \frac{9}{2} \Rightarrow \theta = ...$	M1	3.1a
	$\theta = \frac{\pi}{6}$	A1	1.1b
	$\frac{1}{2}\int (4+\cos 2\theta)^2 \mathrm{d}\theta = \frac{1}{2}\int \left(16+8\cos 2\theta + \cos^2 2\theta\right)\mathrm{d}\theta$	M1	3.1a
	$\cos^2 2\theta = \frac{1}{2}+\frac{1}{2}\cos 4\theta \Rightarrow A = \frac{1}{2}\int\left(16+8\cos 2\theta + \frac{1}{2}+\frac{1}{2}\cos 4\theta\right)\mathrm{d}\theta$	M1	3.1a
	$=\frac{1}{2}\left[16\theta + 4\sin 2\theta + \frac{\sin 4\theta}{8} + \frac{\theta}{2}\right]$	A1	1.1b
	Using limits 0 and their $\frac{\pi}{6}$: $\frac{1}{2}\left[\frac{33\pi}{12} + 2\sqrt{3} + \frac{\sqrt{3}}{16} - (0)\right]$	M1	1.1b
	Area of triangle = $\frac{1}{2}(r\cos\theta)(r\sin\theta) = \frac{1}{2}\times\frac{81}{4}\times\frac{1}{2}\times\frac{\sqrt{3}}{2}$	M1	3.1a
	Area of $R = \frac{33\pi}{24} + \frac{33\sqrt{3}}{32} - \frac{81\sqrt{3}}{32}$	M1	1.1b
	$=\frac{11}{8}\pi - \frac{3\sqrt{3}}{2}\left(p = \frac{11}{8},\ q = -\frac{3}{2}\right)$	A1	1.1b
			(9 marks)

Notes:

M1: Realises the angle for *A* is required and attempts to find it
A1: Correct angle
M1: Uses a correct area formula and squares *r* to achieve a 3TQ integrand in $\cos 2\theta$
M1: Use of the correct double angle identity on the integrand to achieve a suitable form for integration
A1: Correct integration
M1: Correct use of limits
M1: Identifies the need to subtract the area of a triangle and so finds the area of the triangle
M1: Complete method for the area of *R*
A1: Correct final answer

Question	Scheme	Marks	AOs
5(a)	Pond contains 1000 + 5t litres after t days	M1	3.3
	If x is the amount of pollutant in the pond after t days Rate of pollutant out = $20\times\dfrac{x}{1000+5t}$ g per day	M1	3.3
	Rate of pollutant in = 25 × 2 g = 50g per day	B1	2.2a
	$\dfrac{dx}{dt}=50-\dfrac{4x}{200+t}$ *	A1*	1.1b
		(4)	
(b)	$I=e^{\int\frac{4}{200+t}dt}=(200+t)^4\Rightarrow x(200+t)^4=\int 50(200+t)^4\,dt$	M1	3.1b
	$x(200+t)^4=10(200+t)^5+c$	A1	1.1b
	$x=0,\ t=0\Rightarrow\ c=-3.2\times10^{12}$	M1	3.4
	$t=8\Rightarrow\ x=\ 10(200+8)-\dfrac{3.2\times10^{12}}{(200+8)^4}$	M1	1.1b
	= 370g	A1	2.2b
		(5)	
(c)	e.g. • The model should take into account the fact that the pollutant does not dissolve throughout the pond upon entry • The rate of leaking could be made to vary with the volume of water in the pond	B1	3.5c
		(1)	
		(10 marks)	

Notes:

(a)

M1: Forms an expression of the form 1000 + kt for the volume of water in the pond at time t

M1: Expresses the amount of pollutant out in terms of x and t

B1: Correct interpretation for pollutant entering the pond

A1*: Puts all the components together to form the correct differential equation

(b)

M1: Uses the model to find the integrating factor and attempts solution of their differential equation

A1: Correct solution

M1: Interprets the initial conditions to find the constant of integration

M1: Uses their solution to the problem to find the amount of pollutant after 8 days

A1: Correct number of grams

(c)

B1: Suggests a suitable refinement to the model

Question	Scheme	Marks	AOs
6(a)	$\mathrm{f}(x)=\frac{x+2}{x^2+9}=\frac{x}{x^2+9}+\frac{2}{x^2+9}$	B1	3.1a
	$\int\frac{x}{x^2+9}\,\mathrm{d}x=k\ln\left(x^2+9\right)(+c)$	M1	1.1b
	$\int\frac{2}{x^2+9}\,\mathrm{d}x=k\arctan\left(\frac{x}{3}\right)(+c)$	M1	1.1b
	$\int\frac{x+2}{x^2+9}\,\mathrm{d}x=\frac{1}{2}\ln\left(x^2+9\right)+\frac{2}{3}\arctan\left(\frac{x}{3}\right)+c$	A1	1.1b
		(4)	
(b)	$\int_0^3\mathrm{f}(x)\,\mathrm{d}x=\left[\frac{1}{2}\ln\left(x^2+9\right)+\frac{2}{3}\arctan\left(\frac{x}{3}\right)\right]_0^3$ $=\frac{1}{2}\ln 18+\frac{2}{3}\arctan\left(\frac{3}{3}\right)-\left(\frac{1}{2}\ln 9+\frac{2}{3}\arctan(0)\right)$ $=\frac{1}{2}\ln\frac{18}{9}+\frac{2}{3}\arctan\left(\frac{3}{3}\right)$	M1	1.1b
	Mean value $=\frac{1}{3-0}\left(\frac{1}{2}\ln 2+\frac{\pi}{6}\right)$	M1	2.1
	$\frac{1}{6}\ln 2+\frac{1}{18}\pi$ *	A1*	2.2a
		(3)	
(c)	$\frac{1}{6}\ln 2+\frac{1}{18}\pi+\ln k$	M1	2.2a
	$\frac{1}{6}\ln 2k^6+\frac{1}{18}\pi$	A1	1.1b
		(2)	
			(9 marks)

Notes:

(a)

B1: Splits the fraction into two correct separate expressions

M1: Recognises the required form for the first integration

M1: Recognises the required form for the second integration

A1: Both expressions integrated correctly and added together with constant of integration included

(b)

M1: Uses limits correctly and combines logarithmic terms

M1: Correctly applies the method for the mean value for their integration

A1*: Correct work leading to the given answer

(c)

M1: Realises that the effect of the transformation is to increase the mean value by ln *k*

A1: Combines ln's correctly to obtain the correct expression

Question	Scheme	Marks	AOs
7(a)	$x = \cos\theta + \sin\theta\cos\theta = -y\cos\theta$	M1	2.1
	$\sin\theta = -y-1$	M1	2.1
	$\left(\frac{x}{-y}\right)^2 = 1-(-y-1)^2$	M1	2.1
	$x^2 = -\left(y^4+2y^3\right)$*	A1*	1.1b
		(4)	
(b)	$V = \pi\int x^2\,\mathrm{d}y = \pi\int -\left(y^4+2y^3\right)\,\mathrm{d}y$	M1	3.4
	$= \pi\left[-\left(\frac{y^5}{5}+\frac{y^4}{2}\right)\right]$	A1	1.1b
	$= -\pi\left[\left(\frac{(0)^5}{5}+\frac{(0)^4}{2}\right)-\left(\frac{(-2)^5}{5}+\frac{(-2)^4}{2}\right)\right]$	M1	3.4
	$= 1.6\pi\,\text{cm}^3$ **or** awrt 5.03 cm^3	A1	1.1b
		(4)	
		(8 marks)	

Notes:

(a)

M1: Obtains x in terms of y and $\cos\theta$

M1: Obtains an equation connecting y and $\sin\theta$

M1: Uses Pythagoras to obtain an equation in x and y only

A1*: Obtains printed answer

(b)

M1: Uses the correct volume of revolution formula with the given expression

A1: Correct integration

M1: Correct use of correct limits

A1: Correct volume

Question	Scheme	Marks	AOs
8	$2+4\lambda-2(4-2\lambda)-6+\lambda=6 \Rightarrow \lambda=...$	M1	1.1b
	$\lambda=2 \Rightarrow$ Required point is $(2+2(4),\ 4+2(-2),\ -6+2(1))$ $(10,\ 0,\ -4)$	A1	1.1b
	$2+t-2(4-2t)-6+t=6 \Rightarrow t=...$	M1	3.1a
	$t=3$ so reflection of $(2,4,-6)$ is $(2+6(1), 4+6(-2), -6+6(1))$	M1	3.1a
	$(8,\ -8,\ 0)$	A1	1.1b
	$\begin{pmatrix}10\\0\\-4\end{pmatrix}-\begin{pmatrix}8\\-8\\0\end{pmatrix}=\begin{pmatrix}2\\8\\-4\end{pmatrix}$	M1	3.1a
	$\mathbf{r}=\begin{pmatrix}10\\0\\-4\end{pmatrix}+k\begin{pmatrix}1\\4\\-2\end{pmatrix}$ or equivalent e.g. $\left(\mathbf{r}-\begin{pmatrix}10\\0\\-4\end{pmatrix}\right)\times\begin{pmatrix}1\\4\\-2\end{pmatrix}=\mathbf{0}$	A1	2.5
		(7)	
			(7 marks)

Notes:

M1: Substitutes the parametric equation of the line into the equation of the plane and solves for λ

A1: Obtains the correct coordinates of the intersection of the line and the plane

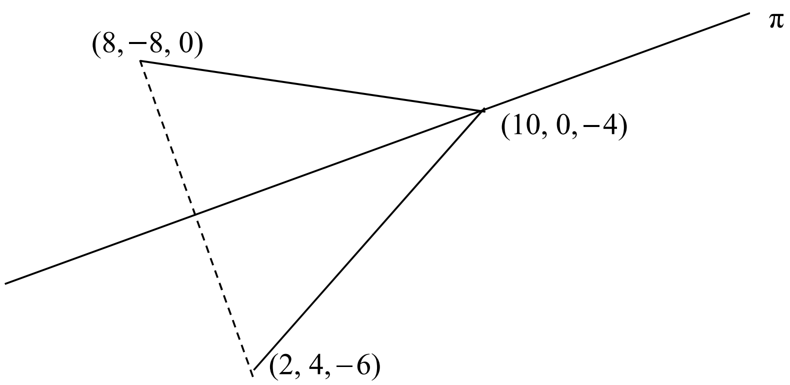
M1: Substitutes the parametric form of the line perpendicular to the plane passing through $(2, 4, -6)$ into the equation of the plane to find t

M1: Find the reflection of $(2, 4, -6)$ in the plane

A1: Correct coordinates

M1: Determines the direction of l by subtracting the appropriate vectors

A1: Correct vector equation using the correct notation



Question	Scheme	Marks	AOs
9(a)(i)	Weight = mass×g $\Rightarrow m = \dfrac{30\,000}{g} = 3000$ But mass is in thousands of kg, so $m = 3$	M1	3.3
(ii)	$\dfrac{dx}{dt} = 40\cos t + 20\sin t,\ \dfrac{d^2x}{dt^2} = -40\sin t + 20\cos t$	M1	1.1b
	$3(-40\sin t + 20\cos t) + 4(40\cos t + 20\sin t)$ $+40\sin t - 20\cos t = ...$	M1	1.1b
	$= 200\cos t$ so PI is $x = 40\sin t - 20\cos$	A1*	2.1
	or		
	Let $x = a\cos t + b\sin t$ $\dfrac{dx}{dt} = -a\sin t + b\cos t,\ \dfrac{d^2x}{dt^2} = -a\cos t - b\sin t$	M1	1.1b
	$4b - 2a = 200,\ -2b - 4a = 0 \Rightarrow a = ..., b = ...$	M1	2.1
	$x = 40\sin t - 20\cos t$	A1*	1.1b
(iii)	$3\lambda^2 + 4\lambda + 1 = 0 \Rightarrow \lambda = -1, -\dfrac{1}{3}$	M1	1.1b
	$x = Ae^{-t} + Be^{-\frac{1}{3}t}$	A1	1.1b
	$x = PI + CF$	M1	1.1b
	$x = Ae^{-t} + Be^{-\frac{1}{3}t} + 40\sin t - 20\cos t$	A1	1.1b
		(8)	
(b)	$t = 0, x = 0 \Rightarrow A + B = 20$	M1	3.4
	$x = 0, \dfrac{dx}{dt} = -Ae^{-t} - \dfrac{1}{3}Be^{-\frac{1}{3}t} + 40\cos t + 20\sin t = 0$ $\Rightarrow A + \dfrac{1}{3}B = 40$	M1	3.4
	$x = 50e^{-t} - 30e^{-\frac{1}{3}t} + 40\sin t - 20\cos t$	A1	1.1b
	$t = 9 \Rightarrow x = 33\text{m}$	A1	3.4
		(4)	
			(12 marks)

Question 9 notes:	
(a)(i)	
M1:	Correct explanation that in the model, $m = 3$
(ii)	
M1:	Differentiates the given PI twice
M1:	Substitutes into the given differential equation
A1*:	Reaches $200\cos t$ and makes a conclusion
or	
M1:	Uses the correct form for the PI and differentiates twice
M1:	Substitutes into the given differential equation and attempts to solve
A1*:	Correct PI
(iii)	
M1:	Uses the model to form and solve the auxiliary equation
A1:	Correct complementary function
M1:	Uses the correct notation for the general solution by combining PI and CF
A1:	Correct General Solution for the model
(b)	
M1:	Uses the initial conditions of the model, $t = 0$ at $x = 0$, to form an equation in A and B
M1:	Uses $\frac{dx}{dt} = 0$ at $x = 0$ in the model to form an equation in A and B
A1:	Correct PS
A1:	Obtains 33m using the assumptions made in the model

Write your name here

Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number

Further Mathematics

Advanced
Paper 2: Core Pure Mathematics 2

Sample Assessment Material for first teaching September 2017

Time: 1 hour 30 minutes

Paper Reference
9FM0/02

You must have:
Mathematical Formulae and Statistical Tables, calculator

Total Marks

Candidates may use any calculator permitted by Pearson regulations. Calculators must not have the facility for algebraic manipulation, differentiation and integration, or have retrievable mathematical formulae stored in them.

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions and ensure that your answers to parts of questions are clearly labelled.
- Answer the questions in the spaces provided – *there may be more space than you need.*
- You should show sufficient working to make your methods clear. Answers without working may not gain full credit.
- Answers should be given to three significant figures unless otherwise stated.

Information

- A booklet 'Mathematical Formulae and Statistical Tables' is provided.
- There are 7 questions in this question paper. The total mark for this paper is 75.
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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S 5 4 4 3 9 A 0 1 1 7

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Answer ALL questions. Write your answers in the spaces provided.

1. The roots of the equation

$$x^3 - 8x^2 + 28x - 32 = 0$$

are α, β and γ

Without solving the equation, find the value of

(i) $\dfrac{1}{\alpha} + \dfrac{1}{\beta} + \dfrac{1}{\gamma}$

(ii) $(\alpha + 2)(\beta + 2)(\gamma + 2)$

(iii) $\alpha^2 + \beta^2 + \gamma^2$

(8)

Question 1 continued

(Total for Question 1 is 8 marks)