

**A Level Mathematics B (MEI)**

**H640/01** MEI Pure Mathematics and Mechanics

Pure

**Question Set 1**

1 In this question you must show detailed reasoning.

Show that  $\int_4^9 (2x + \sqrt{x})dx = \frac{233}{3}$ . [3]

2 Show that the line which passes through the points  $(2, -4)$  and  $(-1, 5)$  does not intersect the line  $3x + y = 10$ . [3]

3 The function  $f(x)$  is given by  $f(x) = (1 - ax)^{-3}$ , where  $a$  is a non-zero constant. In the binomial expansion of  $f(x)$ , the coefficients of  $x$  and  $x^2$  are equal.

(a) Find the value of  $a$ . [3]

(b) Using this value for  $a$ ,

(i) state the set of values of  $x$  for which the binomial expansion is valid, [1]

(ii) write down the quadratic function which approximates  $f(x)$  when  $x$  is small. [1]

4 (a) Prove that  $\frac{\sin \theta}{1 - \cos \theta} - \frac{1}{\sin \theta} = \cot \theta$ . [4]

(b) Hence find the exact roots of the equation  $\frac{\sin \theta}{1 - \cos \theta} - \frac{1}{\sin \theta} = 3 \tan \theta$  in the interval  $0 \leq \theta \leq \pi$ . [3]

5 An arithmetic series has first term 9300 and 10th term 3900.

(a) Show that the 20th term of the series is negative. [3]

(b) The sum of the first  $n$  terms is denoted by  $S$ . Find the greatest value of  $S$  as  $n$  varies. [4]

6 (a) Express  $7 \cos x - 2 \sin x$  in the form  $R \cos(x + \alpha)$  where  $R > 0$  and  $0 < \alpha < \frac{1}{2}\pi$ , giving the exact value of  $R$  and the value of  $\alpha$  correct to 3 significant figures. [4]

(b) Give details of a sequence of two transformations which maps the curve  $y = \sec x$  onto the curve  $y = \frac{1}{7 \cos x - 2 \sin x}$ . [3]

7

Fig. 7 shows a circle with centre  $O$  and radius  $r$  cm. The chord  $AB$  is such that angle  $AOB = x$  radians. The area of the shaded segment formed by  $AB$  is 5% of the area of the circle.

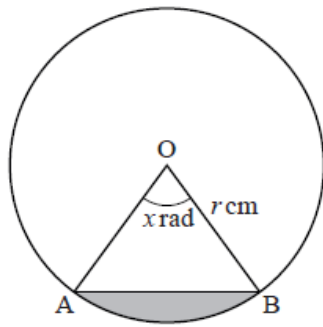


Fig. 7

- (a) Show that  $x - \sin x - \frac{1}{10}\pi = 0$ . [4]

The Newton-Raphson method is to be used to find  $x$ .

- (b) Write down the iterative formula to be used for the equation in part (a). [1]  
 (c) Use three iterations of the Newton-Raphson method with  $x_0 = 1.2$  to find the value of  $x$  to a suitable degree of accuracy. [3]

8

A model for the motion of a small object falling through a thick fluid can be expressed using the differential equation

$$\frac{dv}{dt} = 9.8 - kv,$$

where  $v \text{ ms}^{-1}$  is the velocity after  $t$  s and  $k$  is a positive constant.

- (a) Given that  $v = 0$  when  $t = 0$ , solve the differential equation to find  $v$  in terms of  $t$  and  $k$ . [7]  
 (b) Sketch the graph of  $v$  against  $t$ . [2]

Experiments show that for large values of  $t$ , the velocity tends to  $7 \text{ ms}^{-1}$ .

- (c) Find the value of  $k$ . [2]  
 (d) Find the value of  $t$  for which  $v = 3.5$ . [1]

**Total Marks for Question Set 1: 52**

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