FURTHER MATHEMATICS 3
0775

GENERAL CERTIFICATE OF EDUCATION BOARD

General Certificate of Education Examination

JUNE 2025 **ADVANCED LEVEL**

Subject Title	**Further Mathematics**
Paper No.	**Paper 3**
Subject Code No.	**0775**

Duration: Two and a Half Hours

Answer ALL questions.

For your guidance the approximate mark allocation for parts of each question is indicated in brackets.

Mathematical formulae and tables, published by the Board, and noiseless non-programmable electronic calculators are allowed.

In calculations, you are advised to show all the steps in your working, giving your answer at each stage.

©2025GCEB
Turn Over

1. The force $\mathbf{F} = (4\mathbf{i} - 7\mathbf{j} - 4\mathbf{k})\text{N}$ acts at the point with position vector $(3\mathbf{i} + 4\mathbf{j} - 6\mathbf{k})\text{m}$.

i) Write down a vector equation of the line of action of $\mathbf{F}$. **(2 marks)**

ii) Find the work done when a particle moves under the influence of $\mathbf{F}$ from the point $A(2,3,4)$ to the point $B(6,-1,10)$. **(3 marks)**

iii) Find the vector moment of $\mathbf{F}$ about the origin. **(2 marks)**

iv) Find the vector moment of $\mathbf{F}$ about the point with position vector $(\mathbf{i} + 2\mathbf{j} - 3\mathbf{k})\text{m}$. **(4 marks)**

v) Find the distance from the origin to the line of action of $\mathbf{F}$. **(3 marks)**

2. The function $y = f(x)$ satisfies the differential equation

$$\frac{dy}{dx} = f(x,y) \text{ where } f(x,y) = 2 - \frac{y}{x^2}$$

and the initial condition $y(1) = 1$.

a) Use the formula

b)

$$y_{r+1} \approx y_r + hf(x_r, y_r) \text{ with } h = 0.05$$

to obtain an approximation for $y(1.1)$, giving your answer correct to three decimal places. **(6 marks)**

c) Hence, use Simpson's rule to estimate the value of $\int_1^{1.1} y(x)dx$. **(4 marks)**

3. A particle, P, executes simple harmonic motion along a straight line with centre, O. The period of motion is 2π seconds and the amplitude is 5 metres. Initially, P passes through the point, A, while moving with velocity $-3\,ms^{-1}$. Find,

(i) the distance OA, **(4 marks)**

(ii) the time, in seconds, to four significant figures, taken by P to move directly from A to O. **(8 marks)**

4. A car of mass 800 kg moves along a straight level road against a resistance of magnitude $(4 + kv^2)N$ where v ms^{-1} is the speed and k is a positive constant. The constant tractive force exerted by the engine is 404 newtons. The maximum speed of the car is U.

i) Show that

$$v\frac{dv}{dx} = \frac{(U^2 - v^2)}{2U^2}.$$

(7 marks)

(ii) Find the distance covered as the speed increases from 0 to $\frac{U}{2}$. **(5 marks)**

5) A sphere A of mass $2m$ moving with velocity $3u\mathbf{i}$ collides obliquely with another sphere, B, of same radius but of mass m moving with velocity $u(-2\mathbf{i} + 4\mathbf{j})$, where $u > 0$. Just before the spheres collide, their line of centres is parallel to the unit vector $\mathbf{i}$. The coefficient of restitution between the two spheres is $\frac{1}{5}$.

(i) Find the velocities of A and B immediately after impact. **(7 marks)**

(ii) Find the total kinetic energy of the spheres before impact. **(3 marks)**

Show that

(iii) the total kinetic energy of the spheres after impact is $11mu^2$, **(2 marks)**

(iv) the kinetic energy loss as a result of the impact is $8mu^2$. **(2 marks)**

---

6. A particle, P, moves on the curve with polar equation

$$r = \frac{1}{1+\cos\theta}.$$

Given that at any time t during the motion, $r^2\frac{d\theta}{dt} = 2$,

(i) write an expression for $r\frac{d\theta}{dt}$ in terms of θ . **(2 marks)**

(ii) Show that $\frac{dr}{dt} = 2\sin\theta$. **(3 marks)**

When $\theta = \frac{\pi}{2}$, find

(iii) the speed of P, **(4 marks)**

(iv) the radial component of the acceleration of P. **(4 marks)**

---

7. A uniform circular disc of mass, m , and radius, a, performs small oscillations about a smooth horizontal axis in the plane of the disc, which is of distance x from the diameter of the disc, where $0 < x < a$.

(i) Show that the least period of oscillation is $2\pi\sqrt{\frac{a}{g}}$. **(8 marks)**

(ii) Find the length of the equivalent simple pendulum in this case. **(2 marks)**

(You may assume that the moment of inertia of the disc about its diameter is $\frac{1}{4}ma^2$)

---

8. a) A discrete random variable Y follows a binomial distribution with mean 1 and variance 0.8. Find, correct to 4 decimal places,

(i) $P(Y = 2)$

(ii) $P(Y < 2)$

(iii) $P(Y \geq 1)$ **(9 marks)**

b) The marks X in an examination are normally distributed with mean μ and standard deviation 8.

Find the value of μ to the nearest whole number, given that the probability that a candidate scores a mark more than 30 is 0.1038. **(6 marks)**
