PART II

This part carries 35 per cent of the total examination marks.

You should attempt **ALL** *the questions 12–16 in this part. The marks allocated to each question are shown.*

Write your answer in the thick answer book provided. Do **NOT** *use the same answer book for this part as for either question in Part III.*

Question 12

(6 marks)

(*a*) A particle is moving with constant angular speed ω in a circular path in the x–y plane (Figure 4). The particle crosses the x-axis moving in the positive y-direction at $t = 0$ and has a period of rotation of 2 s. Write down an expression for the y-component of the force on the object in terms of the magnitude F of the centripetal force and the angle θ. Hence sketch a graph showing how the y-component of force on the particle varies with time during one orbit, calibrating the time axis.

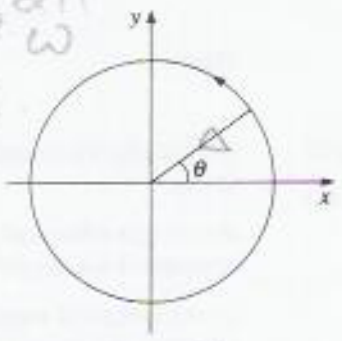

Figure 4

(*b*) What is the magnitude of the centripetal force if the particle has mass 3 kg and is moving in an orbit of radius 10 m?

Question 13

(8 marks)

(*a*) Draw a diagram showing the fundamental (lowest frequency) standing wave on a given string, and the next two harmonics (i.e. next highest frequency waves).

(*b*) A certain musical instrument has a string of length 0.4 m and is stretched between two fixed points. The wave speed for vibrations on this string is 200 m s^{-1}. Calculate the lowest possible frequency of a note played on this string (corresponding to a standing wave).

(*c*) What is the wavelength of the sound wave carrying this note through air to your ear?

[speed of sound in air = 330 m s^{-1}]

Question 14

(6 marks)

(*a*) Give a careful statement, including a vector equation, of Coulomb's law in free space.

(*b*) Two identical positive ions are separated by a distance of 4.0×10^{-10} m and the electrostatic force between them is of magnitude 5.8×10^{-9} N. How many electrons have been removed from neutral atoms to form each of these ions?