

Name of the Student: _____

Max. Marks : 26 Marks

Time : 26 Minutes

Q1.

- (a) (i) State **two** situations in which a charged particle will experience no magnetic force when placed in a magnetic field.

first situation _____

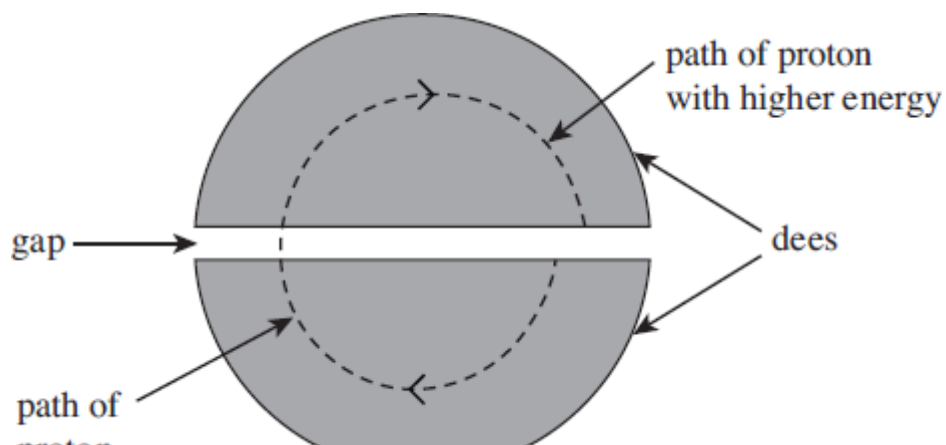
second situation _____

(2)

- (ii) A charged particle moves in a circular path when travelling perpendicular to a uniform magnetic field. By considering the force acting on the charged particle, show that the radius of the path is proportional to the momentum of the particle.

(2)

- (b) In a cyclotron designed to produce high energy protons, the protons pass repeatedly between two hollow D-shaped containers called 'dees'. The protons are acted on by a uniform magnetic field over the whole area of the dees. Each proton therefore moves in a semi-circular path at constant speed when inside a dee. Every time a proton crosses the gap between the dees it is accelerated by an alternating electric field applied between the dees. The diagram below shows a plan view of this arrangement.



- (i) State the direction in which the magnetic field should be applied in order for the protons to travel along the semicircular paths inside each of the dees as shown in the diagram above.

(1)

- (ii) In a particular cyclotron the flux density of the uniform magnetic field is 0.48 T. Calculate the speed of a proton when the radius of its path inside the dee is 190 mm.

speed _____ ms^{-1}

(2)

- (iii) Calculate the time taken for this proton to travel at constant speed in a semicircular path of radius 190 mm inside the dee.

time _____ s

(2)

- (iv) As the protons gain energy, the radius of the path they follow increases steadily, as shown in the diagram above. Show that your answer to part (b)(iii) does not depend on the radius of the proton's path.

- (c) The protons leave the cyclotron when the radius of their path is equal to the outer radius of the dees. Calculate the maximum kinetic energy, in Me V, of the protons accelerated by the cyclotron if the outer radius of the dees is 470 mm.

maximum kinetic energy _____ Me V

(3)

(Total 14 marks)

Q2.

- (a) Describe the energy changes that take place as the bob of a simple pendulum makes one complete oscillation, starting at its maximum displacement.

(2)

- (b)

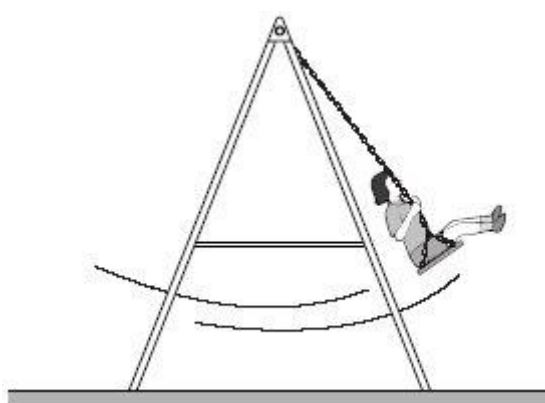
Figure 1

Figure 1 shows a young girl swinging on a garden swing. You may assume that the swing behaves as a simple pendulum. Ignore the mass of chains supporting the seat throughout this question, and assume that the effect of air resistance is negligible. 15 complete oscillations of the swing took 42s.

- (i) Calculate the distance from the top of the chains to the centre of mass of the girl and seat. Express your answer to an appropriate number of significant figures.

answer = _____ m

(4)

- (ii) To set her swinging, the girl and seat were displaced from equilibrium and released from rest. This initial displacement of the girl raised the centre of mass of the girl and seat 250 mm above its lowest position. If the mass of the girl was 18 kg, what was her kinetic energy as she first passed through this lowest point?

answer = _____ J

(2)

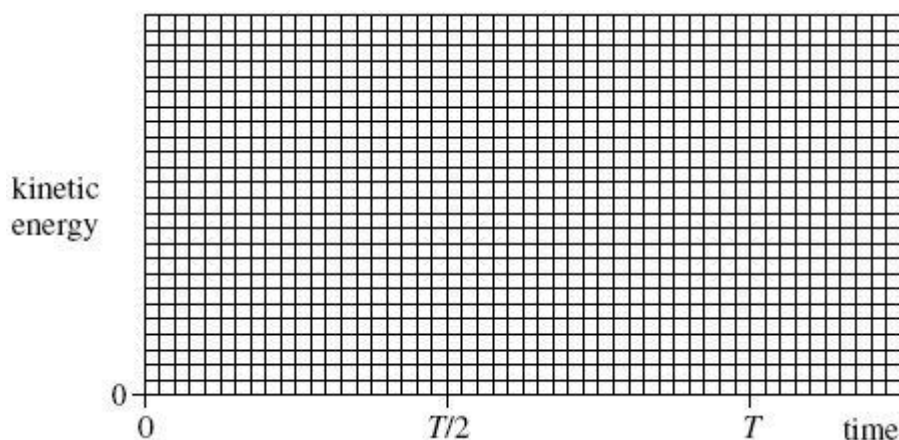
- (iii) Calculate the maximum speed of the girl during the first oscillation.

answer = _____ m s^{-1}

(1)

(c)

Figure 2



On **Figure 2** draw a graph to show how the kinetic energy of the girl varied with time during the first complete oscillation, starting at the time of her release from maximum displacement. On

the horizontal axis of the graph, T represents the period of the swing. You do not need to show any values on the vertical axis.

(3)

(Total 12 marks)