

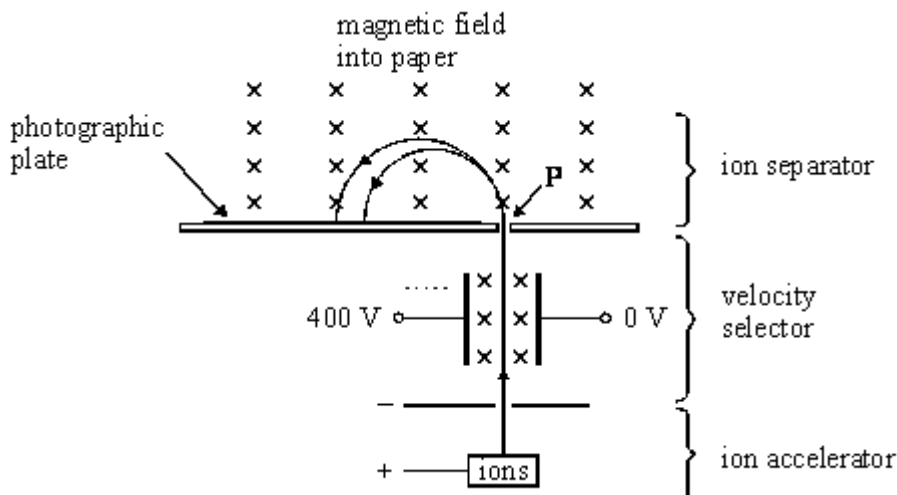
Name of the Student: \_\_\_\_\_

Max. Marks : 21 Marks

Time : 21 Minutes

**Q1.**

The diagram below shows a diagram of a mass spectrometer.



(a) The magnetic field strength in the velocity selector is 0.14 T and the electric field strength is 20 000 V m<sup>-1</sup>.

(i) Define the unit for magnetic flux density, the tesla.

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(2)

(ii) Show that the velocity selected is independent of the charge on an ion.

(2)

(iii) Show that the velocity selected is about 140 km s<sup>-1</sup>.

(1)

(b) A sample of nickel is analysed in the spectrometer. The two most abundant isotopes of nickel

are  ${}^{58}_{28}\text{Ni}$  and  ${}^{60}_{28}\text{Ni}$ . Each ion carries a single charge of  $+1.6 \times 10^{-19} \text{ C}$ .

mass of a proton or neutron =  $1.7 \times 10^{-27} \text{ kg}$

The  ${}^{58}_{28}\text{Ni}$  ion strikes the photographic plate 0.28 m from the point **P** at which the ion beam enters the ion separator.

Calculate:

(i) the magnetic flux density of the field in the ion separator;

(3)

(ii) the separation of the positions where the two isotopes hit the photographic plate.

(2)

(Total 10 marks)

## Q2.

(a) State the conditions necessary for a mass to undergo simple harmonic motion.

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(2)

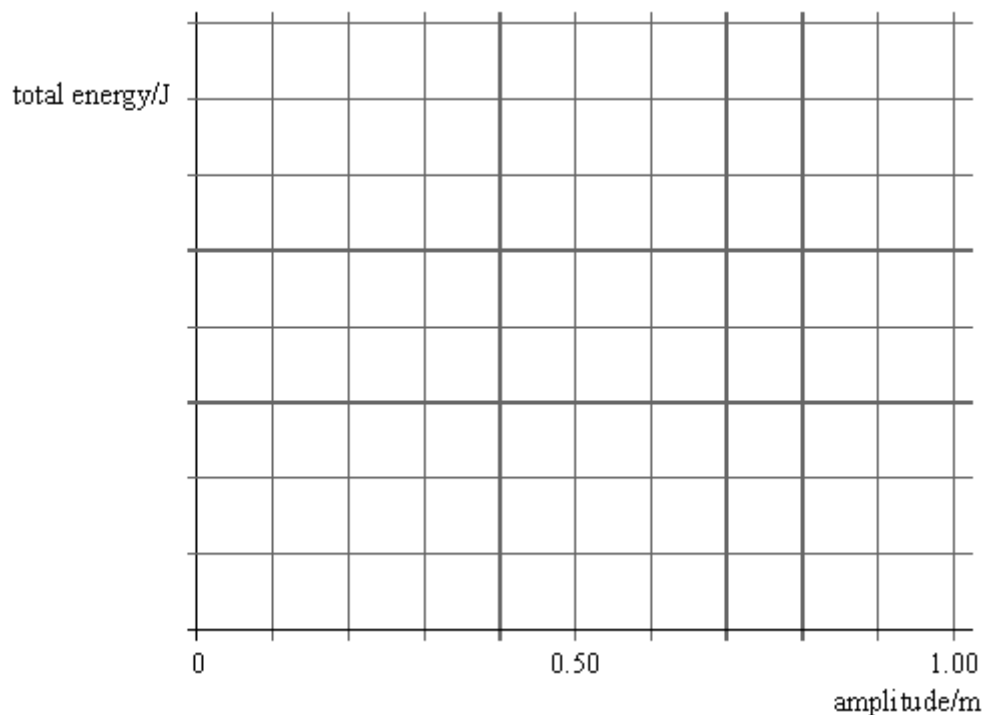
(b) A child on a swing oscillates with simple harmonic motion of period 3.2 s.

acceleration of free fall =  $9.8 \text{ m s}^{-2}$

(i) Calculate the distance between the point of support and the centre of mass of the system.

(2)

- (ii) The total energy of the oscillations is 40 J when the amplitude of the oscillations is 0.50 m. Sketch a graph showing how the total energy of the child varies with the amplitude of the oscillations for amplitudes between 0 and 1.00 m. Include a suitable scale on the total energy axis.

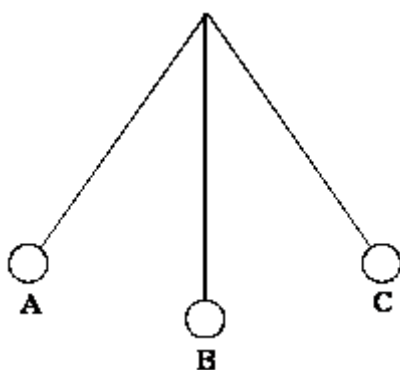


(2)

(Total 6 marks)

### Q3.

The diagram below shows a simple pendulum that consists of a large mass at the end of a long string. **A**, **B** and **C** are positions of the pendulum as it oscillates in the air. **A** and **C** are the extreme positions of the motion and **B** is the centre of the motion.



- (a) State clearly in terms of the positions shown on the diagram what is meant by the *period of oscillation* of the pendulum.

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(2)

- (b) The diagram shows positions of the bob during an oscillation. State at which position the damping is greatest. Explain why the damping is greatest in the position you have quoted.

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(3)

(Total 5 marks)