5.4 Magnetic Effects of Electric Currents

Question Paper

Course	DP IB Physics
Section	5. Electricity & Magnetism
Topic	5.4 Magnetic Effects of Electric Currents
Difficulty	Hard

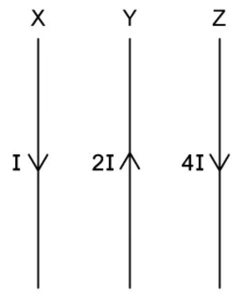
Time allowed: 20

Score: /11

Percentage: /100

Question 1

Three long parallel straight wires, X, Y and Z, are equally separated and placed in the same plane in a vacuum. They carry a current of *I*, 2*I* and 4*I* respectively, as shown:



It is known that the magnetic flux density *B* at a distance *r* due to a long straight wire carrying current *I* is given by:

$$B = \frac{\mu_0 I}{2\pi r}$$

where μ_0 is the permeability of free space.

What is the force per unit length acting on wire X?

A. 0

B. $\frac{\mu_0 I^2}{\pi r}$ N m^{-1}

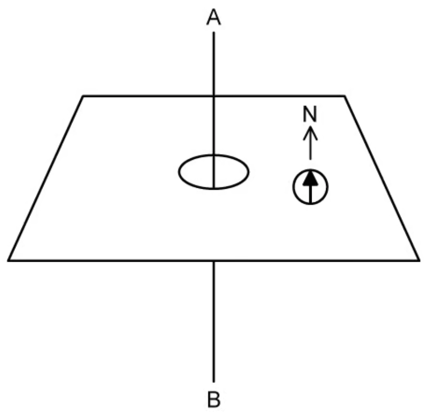
C. $\frac{\mu_0 I^2}{2\pi r}$ N m^{-1}

D. $\frac{\mu_0 I^2}{3\pi r}$ N m^{-1}

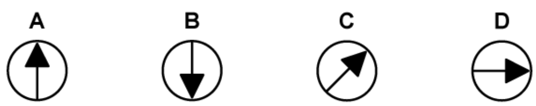
[1 mark]

Question 2

A plotting compass is placed next to a vertical wire AB. When there is no current in the wire, the compass is deflected North as shown in the image below:



Which diagram shows a possible direction for the compass when a current flows in the direction A to B?



[1 mark]

Question 3

The magnetic field produced by a straight current carrying wire is in

A. a single plane parallel to the current.

B. all planes parallel to the current.

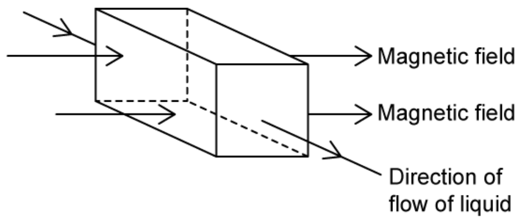
C. a single plane perpendicular to the current.

D. all planes perpendicular to the current.

[1 mark]

Question 4

A liquid that contains a suspension of positive and negative ions flows through a square pipe as shown.



An electric field is set up in the pipe

A. vertically downwards

B. vertically upwards

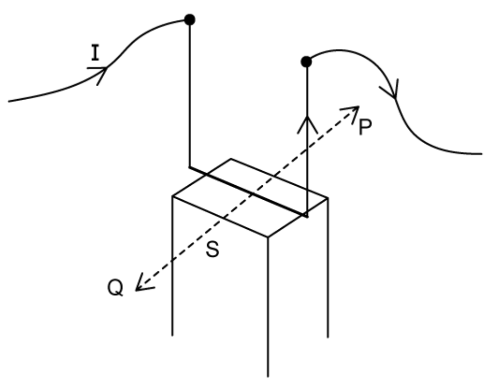
C. horizontally rightwards

D. horizontally leftwards

[1 mark]

Question 5

A direct current *I* is made to pass through a swing that is mounted to the ceiling, such that it can swing freely. A permanent magnet is fixed directly below, with its south pole S facing the swing.



The swing will

A. deflect in the direction of P and stay there.

B. oscillate back and forth along P.

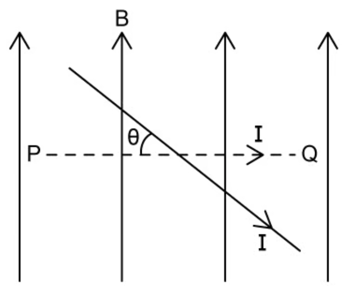
C. deflect in the direction of Q and stay there.

D. oscillate back and forth along Q.

[1 mark]

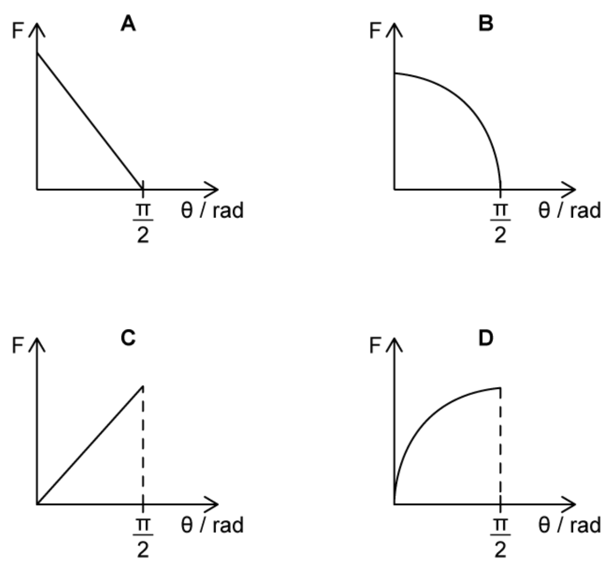
Question 6

A straight wire PQ carrying a constant current *I* is placed normally to a uniform magnetic field of flux density *B* as represented by the dotted line.



The current-carrying wire is then rotated clockwise through an angle θ about an axis perpendicular to the plane of the image.

Which of the following graphs shows how the magnitude of the magnetic force *F* on the wire varies for $0 \leq \theta \leq \frac{\pi}{2}$ radians?



[1 mark]

Question 7

Two long parallel wires carry equal currents in opposite directions. What exists at the point in space that is exactly midway between the wires and in the plane of the wires?

A. A magnetic field parallel to the wires

B. A magnetic field at right angles to the plane of the wires

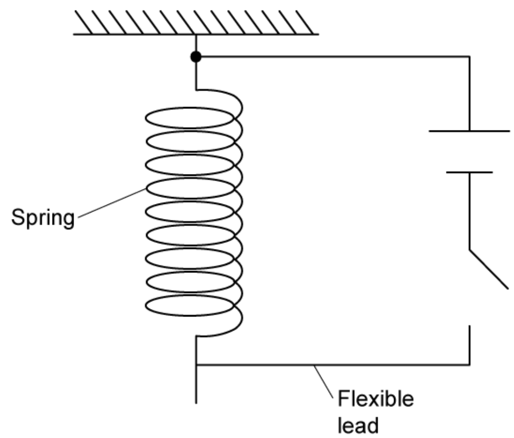
C. An electric field parallel to the wires

D. An electric field at right angles to the plane of the wires

[1 mark]

Question 8

A loosely-coiled light spring is suspended from a fixed point.



When the switch is closed,

A. the spring oscillates vertically.

B. the spring compresses.

C. the string stretches.

D. nothing happens to the spring.

[1 mark]

Question 9

A doubly charged ion moves in a uniform magnetic field of flux density *B* in a circle of orbital radius *r* at speed *v*. What is the flux density which would maintain an ion of charge 4e of the same mass in a circle of the same orbital radius at the same speed?

A. $\frac{B}{2}$

B. $\frac{3B}{4}$

C. $2B$

D. $4B$

[1 mark]

Question 10

An electron moves along the axis of a solenoid carrying a current.

Which of the following statements is correct about the magnetic force on the electron?

A. No force acts.

B. The forces acts normally to the electron's velocity.

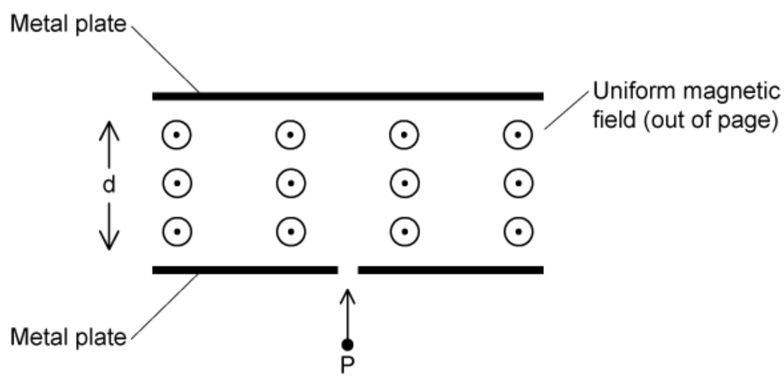
C. The force acts radially outwards.

D. The force acts radially inwards.

[1 mark]

Question 11

A particle P with charge *q* and mass *m* is fired with kinetic energy *K* into a region between two metal plates.



If the magnetic flux density between the plates is *B*, what is the minimum magnitude of *B* which ensures the particle does not collide with the opposite plate?

A. $\sqrt{\frac{mK}{qd}}$

B. $\frac{mK}{qd}$

C. $\frac{\sqrt{2mK}}{qd}$

D. $\frac{2mK}{qd}$

[1 mark]