11.1 Electromagnetic Induction

Question Paper

Course	DP IB Physics
Section	11. Electromagnetic Induction (HL only)
Topic	11.1 Electromagnetic Induction
Difficulty	Hard

Time allowed: 20

Score: /10

Percentage: /100

Question 1

An oscillating magnetic field, B, is applied perpendicular to the plane of a small flat coil of copper wire. The equation for the changing flux density is given by:

$$B = B_0 \sin(\omega t)$$

where B_0 is the amplitude and ω is the angular frequency of the oscillating magnetic field.

If the period of the oscillating magnetic field is T, at what time t, is the magnitude of the induced e.m.f in the coil a maximum?

A. $\frac{T}{8}$

B. $\frac{3T}{8}$

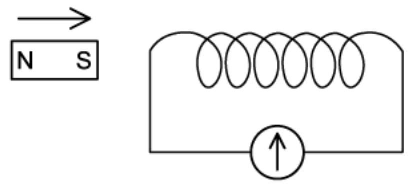
C. $\frac{T}{2}$

D. $\frac{T}{4}$

[1 mark]

Question 2

The south pole of a bar magnet is pushed into one end of a coil of wire, which is connected to a sensitive galvanometer as shown:



A galvanometer measures the amount of current through a moving coil, shown by a deflecting needle. A maximum deflection of the galvanometer needle of 7 units to the right is observed.

Next, the north pole of the magnet is pushed into the other end of the coil at twice the speed.

What would be the maximum deflection of the galvanometer needle?

A. Less than 7 units to the right

B. Less than 7 units to the left

C. More than 7 units to the right

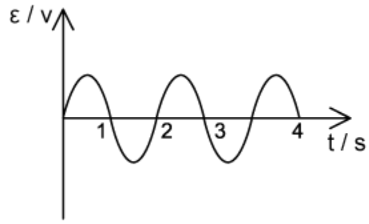
D. More than 7 units to the left

[1 mark]

Question 3

A coil with 100 turns and an area of 0.30 m^2 is set up inside a uniform magnetic field, of magnitude 60 mT.

When the coil spins at a constant rate about the rotation axis, an alternating e.m.f ϵ is induced as shown in the image below:



The magnitude of the induced e.m.f ϵ can be calculated at any time t using the equation:

$$\varepsilon = X\sin(Yt)$$

Which line correctly identifies the best estimate of X and Y?

You may use the fact that $N\frac{d(BA\cos(\omega t))}{dt} = BANsin(\omega t)$.

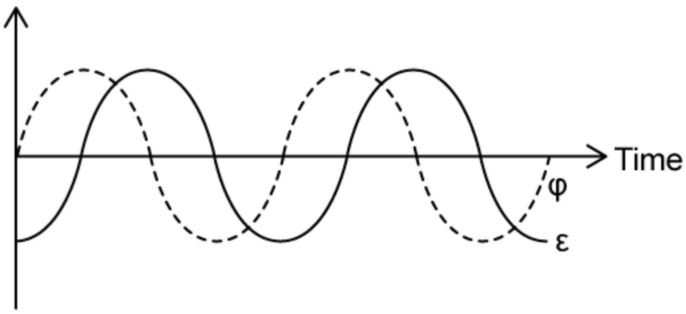
	X / V	Y
A.	2.5	6
B.	6.0	3
C.	2.0	2
D.	5.5	3

[1 mark]

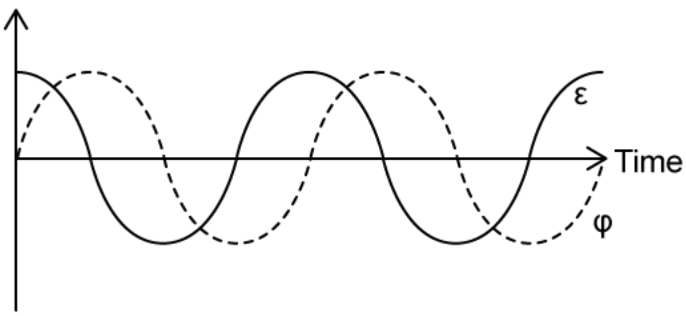
Question 4

A coil is rotated in a uniform magnetic field. An alternating emf is induced in the coil. What is a possible phase relationship between the magnetic flux through the coil and the induced emf in the coil when the variations of both coils are plotted with time?

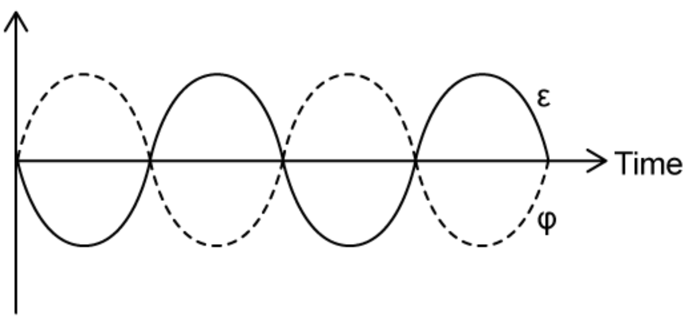
A



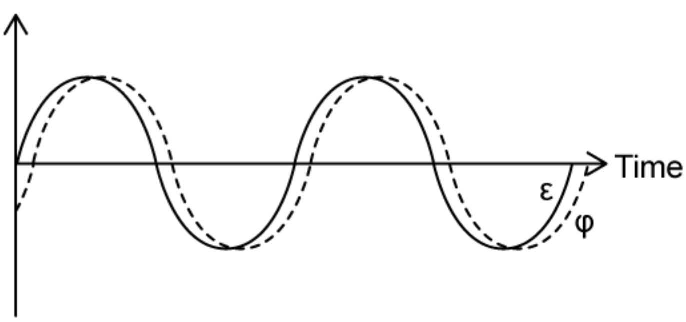
B



C



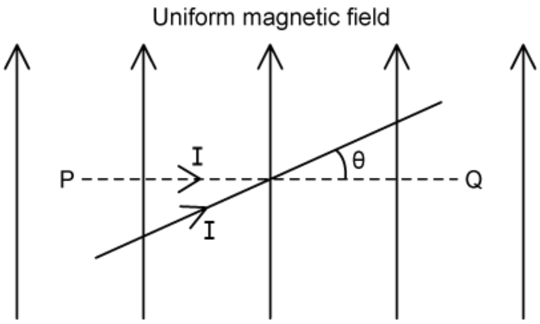
D



[1 mark]

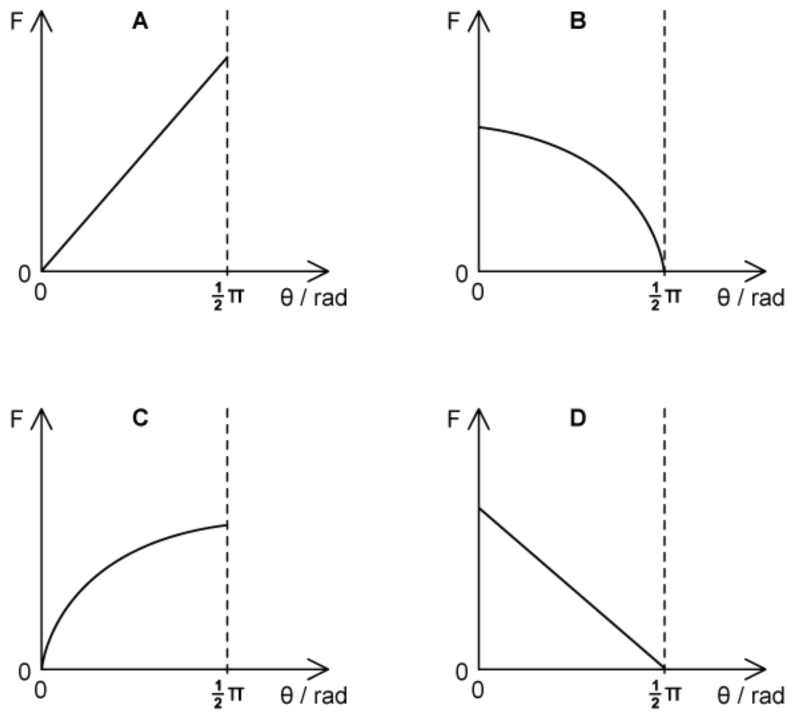
Question 5

A straight wire PQ carrying a constant current *I* is placed perpendicularly to a uniform magnetic field, as represented by the dotted line in the diagram below.



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

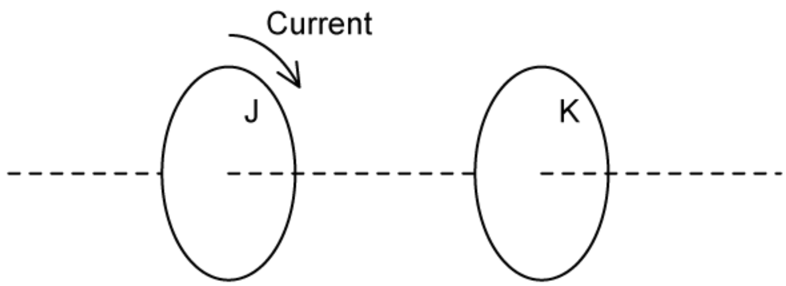
Which of the following graphs shows how the magnitude of the magnetic force *F* on the wire varies with θ in the range $0 \leq \theta \leq \frac{1}{2}\pi$ radians?



[1 mark]

Question 6

Two circular coils, J and K, share a common axis and are parallel to each other. A constant direct current passes through coil J.



Coil K is moved towards coil J and then moved back to its original position.

As coil K moves, what is the direction of the current induced in coil K relative to the current in coil J?

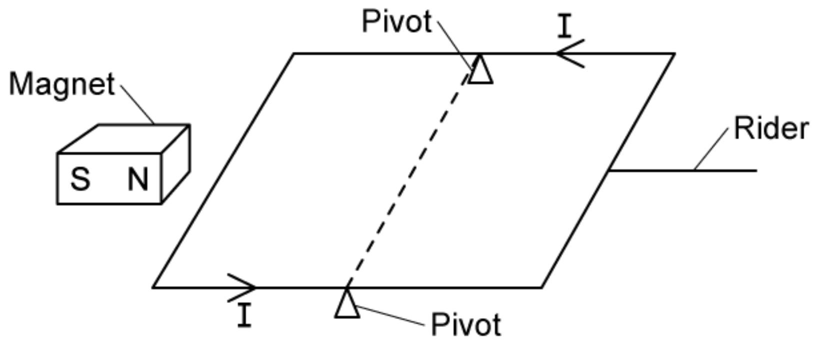
	Current direction in coil K when moving towards coil J	**Current direction in coil K when moving away from coil J**
A.	same direction as J	same direction as J
B.	same direction as J	opposite direction to J
C.	opposite direction to J	same direction as J
D.	opposite direction to J	opposite direction to J

[1 mark]

Question 7

A current I = 200 mA is passed through a pivoted square wire frame, of side length 50 cm, which is initially balanced.

A bar magnet is placed near one of the edges of the frame, which causes it to tilt. A rider of mass m = 10 g and length 10 cm is then placed at the midpoint of the opposite edge on the wire frame, such that the frame regains its balance, as shown in the diagram below.



What is the magnitude of the magnetic flux density near the magnet?

A. $\frac{3}{50}g$ T

B. $\frac{2}{25}g$ T

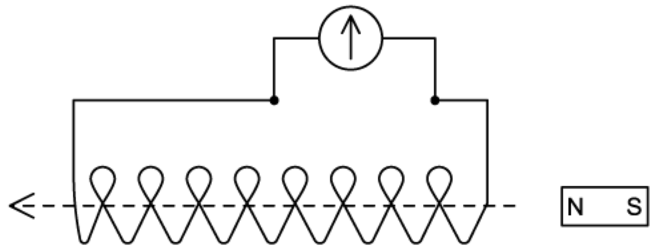
C. $\frac{3}{25}g$ T

D. $\frac{9}{50}g$ T

[1 mark]

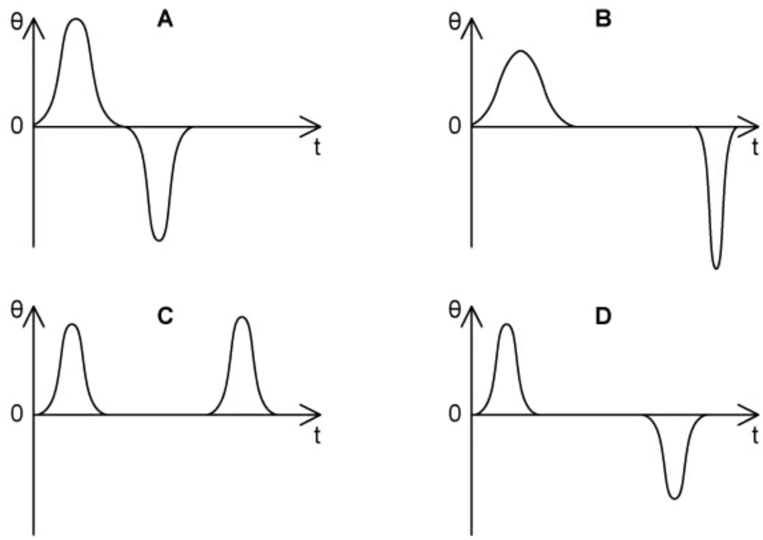
Question 8

A bar magnet moves steadily from right to left through a very long solenoid.



A galvanometer is connected across the solenoid. A galvanometer measures the amount of current (and voltage) through a moving coil, shown by a deflecting needle.

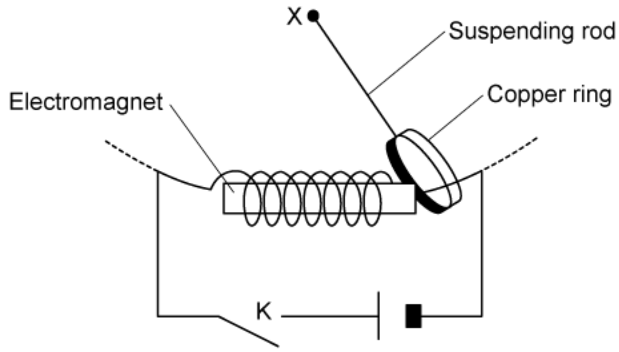
Which graph shows the deflection of the galvanometer, θ with time, t?



[1 mark]

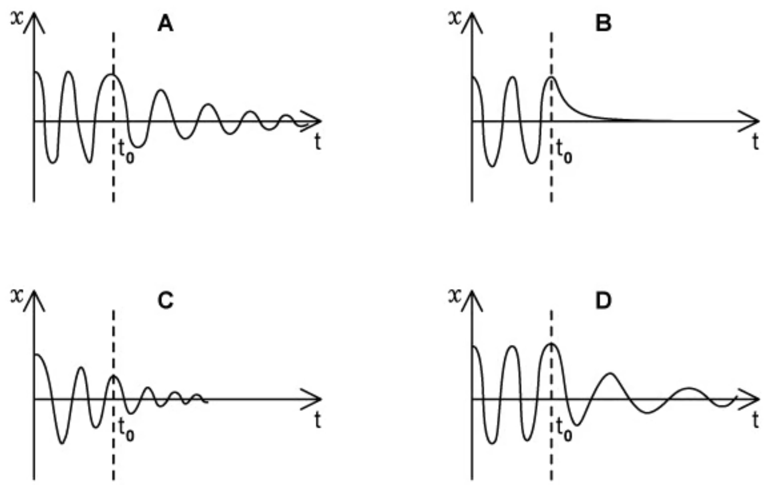
Question 9

A copper ring is suspended by a long, light rod pivoted at X so that it may swing as a pendulum, as shown in the diagram below:



An electromagnet is set up so that the ring can pass over it as it swings. The ring is then set into oscillation at time $t = 0$, with switch K open. It completes two full oscillations, at which point the switch K is closed at time $t = t_0$

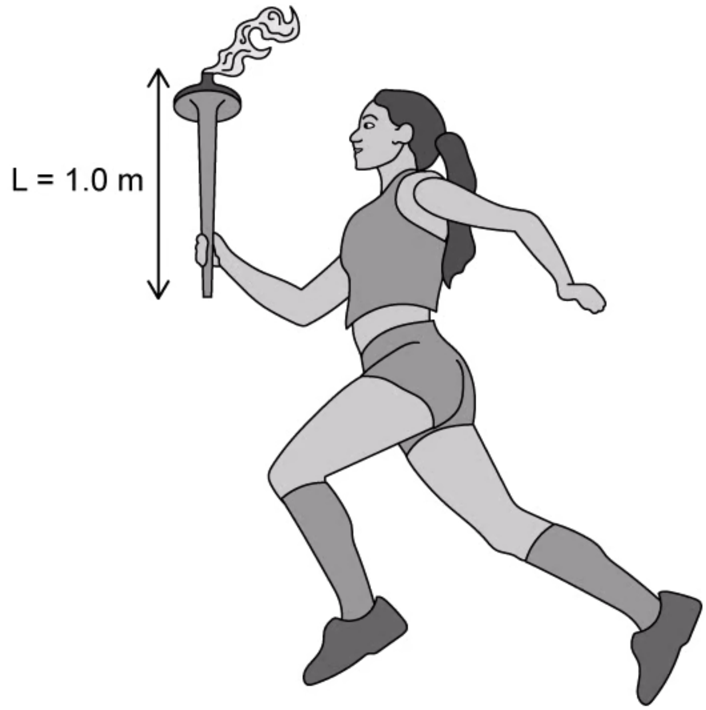
Which graph correctly shows the variation of the displacement x with time t?



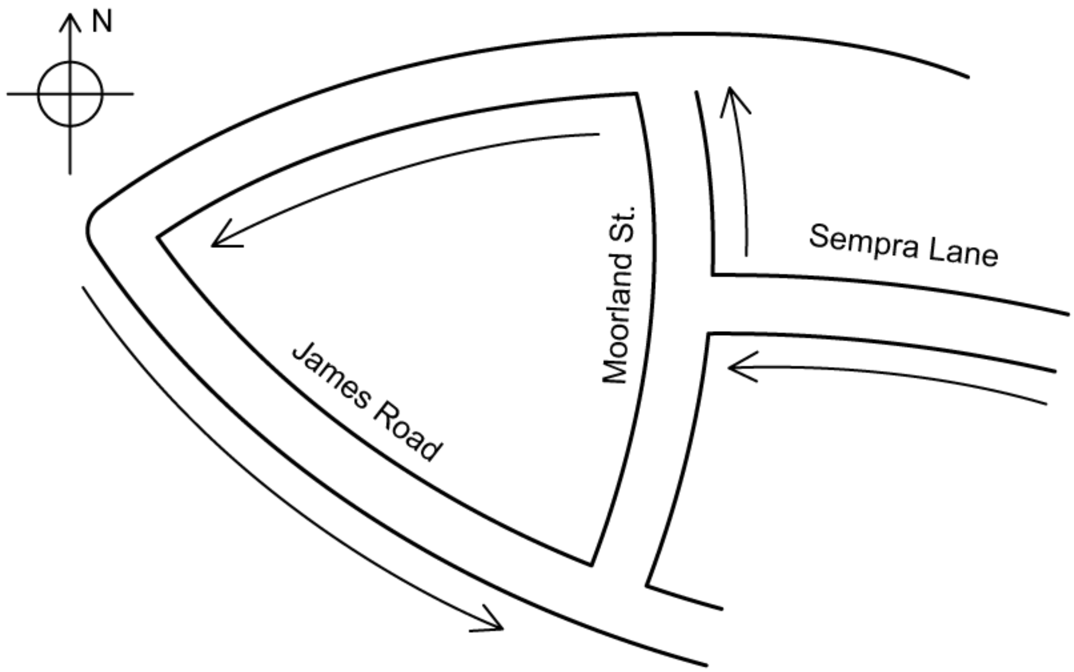
[1 mark]

Question 10

The Olympic torch can be modelled as a 1.0 m long conducting rod. People jogging can be said to average between 6.4 – 9.7 km h^{-1}.



The torch is carried along streets in towns around the world. On which part of the route shown is the induced e.m.f. at a maximum, and what is the approximate motional e.m.f. induced in the metal of the torch when carried along this street by a brisk jogger?



Assume that the Earth's field has magnetic flux density, B = 50 μT.

	route	motional e.m.f.
A.	Sempra Lane	125 μV
B.	Moorlands Street	125 nV
C.	Sempra Lane	45 mV
D.	Moorlands Street	45 μV

[1 mark]