Q1. The magnetic flux through a coil of N turns is increased uniformly from zero to a maximum value in a time t. An emf, E, is induced across the coil.
What is the maximum value of the magnetic flux through the coil?

A $\dfrac{Et}{N}$

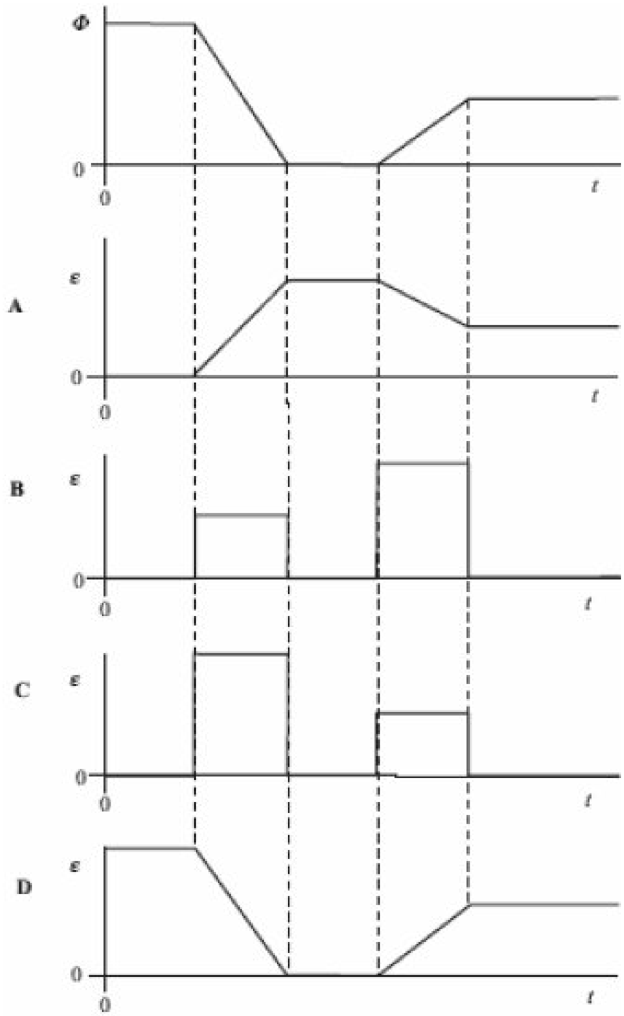
B $\dfrac{N}{Et}$

C $E\,t\,N$

D $\dfrac{E}{Nt}$

(Total 1 mark)

Q2. The magnetic flux, Φ, through a coil varies with time, t, as shown by the first graph. Which one of the following graphs, A to D, best represents how the magnitude, ϵ, of the induced emf varies in this same period of time?



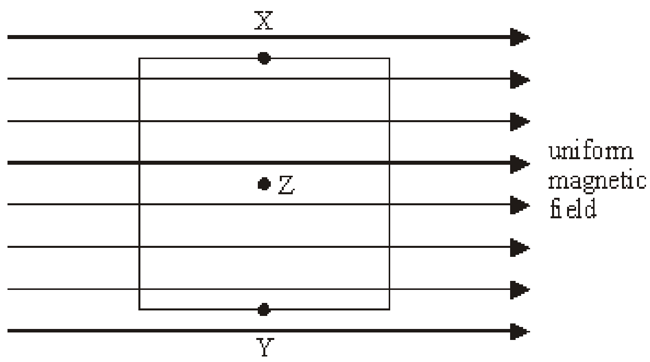
(Total 1 mark)

Q3. The primary winding of a perfectly efficient transformer has 200 turns and the secondary has 1000 turns. When a sinusoidal pd of rms value 10 V is applied to the input, there is a primary current of rms value 0.10 A rms. Which line in the following table, **A** to **D**, gives correct rms output values obtainable from the secondary when the primary is supplied in this way?

	rms output emf/V	**rms output current/A**
A	50	0.10
B	50	0.02
C	10	0.10
D	10	0.02

(Total 1 mark)

Q4.



The diagram shows a square coil with its plane parallel to a uniform magnetic field. Which one of the following would induce an emf in the coil?

A movement of the coil slightly to the left

B movement of the coil slightly downwards

C rotation of the coil about an axis through XY

D rotation of the coil about an axis perpendicular to the plane of the coil through Z

(Total 1 mark)

Q5. Why, when transporting electricity on the National Grid, are high voltages and low currents used?

A The energy lost by radiation from electromagnetic waves is reduced.

B The electrons move more rapidly.

C The heat losses are reduced.

D The resistance of the power lines is reduced.

(Total 1 mark)

Q6.

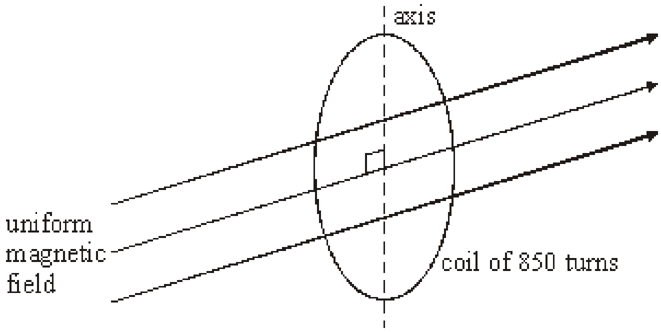


Figure 1

A circular coil of diameter 140 mm has 850 turns. It is placed so that its plane is perpendicular to a horizontal magnetic field of uniform flux density 45 mT, as shown in **Figure 1**.

(a) Calculate the magnetic flux passing through the coil when in this position.

....

....

(2)

(b) The coil is rotated through 90° about a vertical axis in a time of 120 ms.

Calculate

(i) the change of magnetic flux linkage produced by this rotation,

....

....

(ii) the average emf induced in the coil when it is rotated.

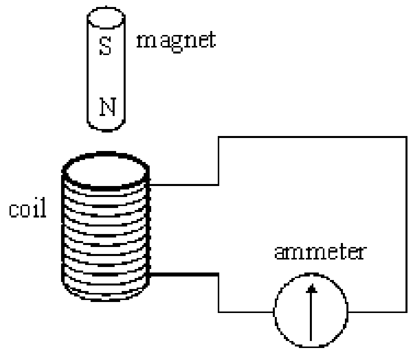
....

....

....

(4)
(Total 6 marks)

Q7. A coil is connected to a centre zero ammeter, as shown. A student drops a magnet so that it falls vertically and completely through the coil.



(a) Describe what the student would observe on the ammeter as the magnet falls through the coil.

....

....

....

(2)

(b) If the coil were not present the magnet would accelerate downwards at the acceleration due to gravity. State and explain how its acceleration in the student's experiment would be affected, if at all,

(i) as it entered the coil,

....

....

....

(ii) as it left the coil.

....

....

(c) Suppose the student forgot to connect the ammeter to the coil, therefore leaving the circuit incomplete, before carrying out the experiment. Describe and explain what difference this would make to your conclusions in part (b).

You may be awarded marks for the quality of written communication provided in your answer.

....

....

....

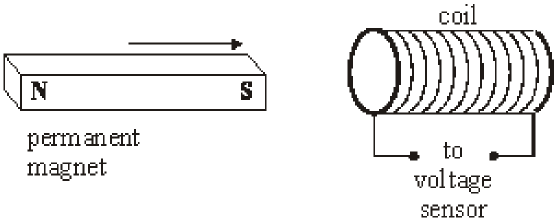
....

....

(3)
(Total 9 marks)

Q8. (a) In an experiment to illustrate electromagnetic induction, a permanent magnet is moved towards a coil, as shown in **Figure 1**, causing an emf to be induced across the coil.

Figure 1



Using Faraday's law, explain why a larger emf would be induced in this experiment if a stronger magnet were moved at the same speed.

You may be awarded additional marks to those shown in brackets for the quality of written communication in your answer.

....

....

....

....

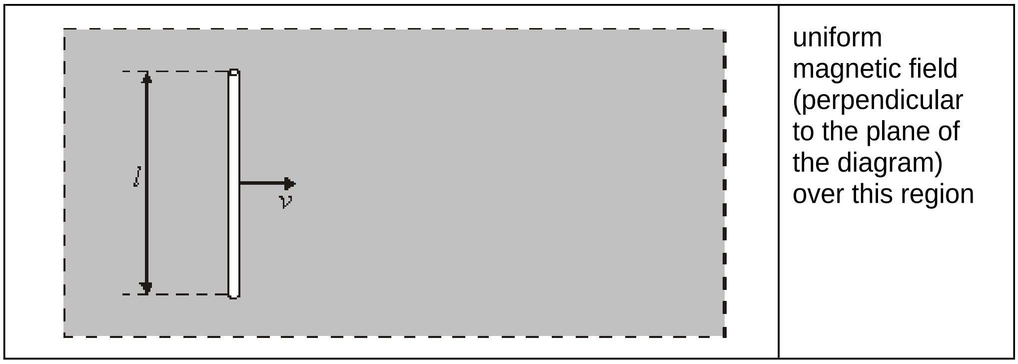
....

....

(3)

(b) A conductor of length *l* is moved at a constant speed *v* so that it passes perpendicularly through a uniform magnetic field of flux density *B*, as shown in **Figure 2**.

Figure 2



(i) Give an expression for the area of the magnetic field swept out by the conductor in time Δt.

....

(ii) Show that the induced emf, ϵ, across the ends of the conductor is given by $\epsilon = Blv$.

....

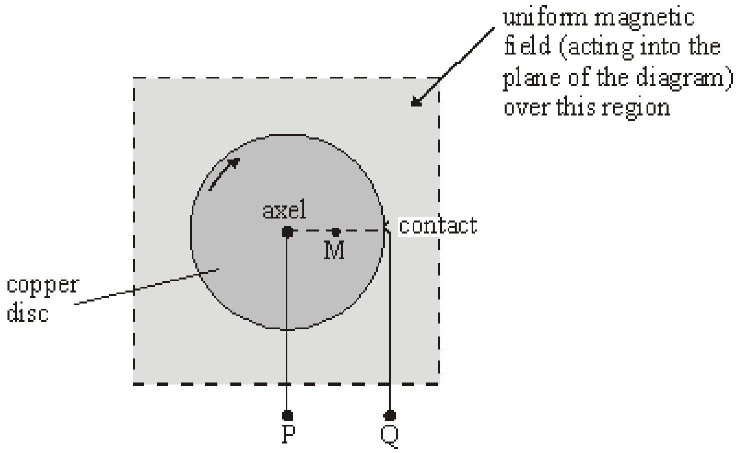
....

....

(3)

(c) A simple electrical generator can be made from a copper disc, which is rotated at right angles to a uniform magnetic field, directed into the plane of the diagram (**Figure 3**). An emf is developed across terminals P (connected to the axle) and Q (connected to a contact on the edge of the disc).

Figure 3



The radius of the disc is 64 mm and it is rotated at 16 revolutions per second in a uniform magnetic field of flux density 28 mT.

(i) Calculate the angular speed of the disc.

....

....

....

(ii) Calculate the linear speed of the mid-point M of a radius of the disc.

....

....

....

(iii) Hence, or otherwise, calculate the emf induced across terminals P and Q.

....

....

....

(5)
(Total 11 marks)

M1. A **[1]**

M2. C **[1]**

M3. B **[1]**

M4. C **[1]**

M5. C **[1]**

M6. (a) Φ (= BA) = $45 \times 10^{-3} \times \pi \times (70 \times 10^{-3})^2$ **(1)**
= 6.9×10^{-4} Wb **(1)** (6.93×10^{-4} Wb)

2

(b) (i) $N\Delta\Phi$ (= NBA – 0) = $850 \times 6.93 \times 10^{-4}$ **(1)**

= 0.59 (Wb turns) **(1)** (0.589 (Wb turns))

(if $\Phi = 6.9 \times 10^{-4}$, then 0.587 (Wb turns))

(allow C.E. for value of Φ from (a))

(ii) induced emf (= $N \frac{\Delta\Phi}{\Delta t}$) = $\frac{0.589}{0.12}$ **(1)**

= 4.9 V **(1)** (4.91 V)

(allow C.E. for value of Wb turns from (ii)

4

[6]

M7. (a) deflects one way **(1)**
then the other way **(1)**

2

(b) (i) acceleration is less than *g* [or reduced] **(1)**
suitable argument **(1) (**e.g. correct use of Lenz's law)

(ii) acceleration is less than *g* [or reduced] **(1)**
suitable argument **(1) (**e.g. correct use of Lenz's law)

4

(c) magnet now falls at acceleration *g* **(1)**
emf induced **(1)**
but no current **(1)**
no energy lost from circuit **(1)**
[or no opposing force on magnet, or no force from magnetic field or no magnetic field produced]

3
QWC 2

[9]

M8. (a) greater flux (linkage) or more flux lines (at same distance)
[or stronger magnet produces flux lines closer together] **(1)**
greater rate of change of flux (linkage)
[or more flux lines cut per unit time] **(1)**
emf $\propto$ rate of change of flux (linkage) **(1)**

[or using $\epsilon = N\frac{\Delta\phi}{\Delta t}$, where $\Delta\Phi = A\,\Delta B$, v and Δt are the same **(1)**
ΔB is larger since magnet is stronger **(1)**
N and A are constant, $\therefore \epsilon$ is larger **(1)**]

3

(b) (i) area swept out, $\Delta A = lv\Delta t$ **(1)**

$\Delta\Phi (= B\Delta A) = Blv\,\Delta t$ **(1)**

[redacted] gives result **(1)**

(c) (i) $w(=2\pi f) = 2\pi \times$ l6 **(1)** = 101 rads^{-1} **(1)**

(ii) $v(= rw) = 32 \times 10^{-3} \times 101 = 3.2(3)$ms^{-1} **(1)**

(allow C.E. for value of w from (i))

(iii) $\in (= Blv) = 28 \times 10^{-3} \times 64 \times 10^{-3} \times 3.23$ **(1)**

$= 5.7(9) \times 10^{-3}$V **(1)**

(allow C.E. for values of v from (ii))

(solutions using $\in$ $Bf\pi r^2$ to give 5 7(6) × 10^{-3} V acceptable)

5

[11]