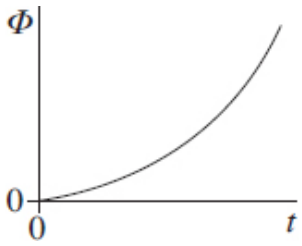
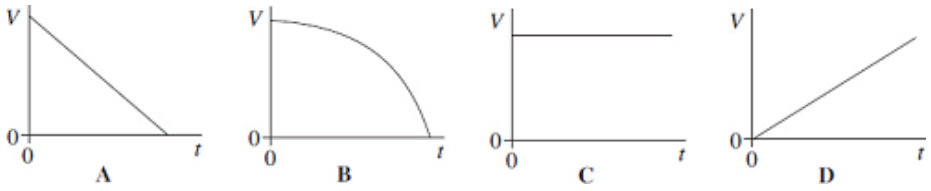
Q1. The graph shows how the magnetic flux, Φ, passing through a coil changes with time, t.



Which one of the following graphs could show how the magnitude of the emf, V, induced in the coil varies with t?



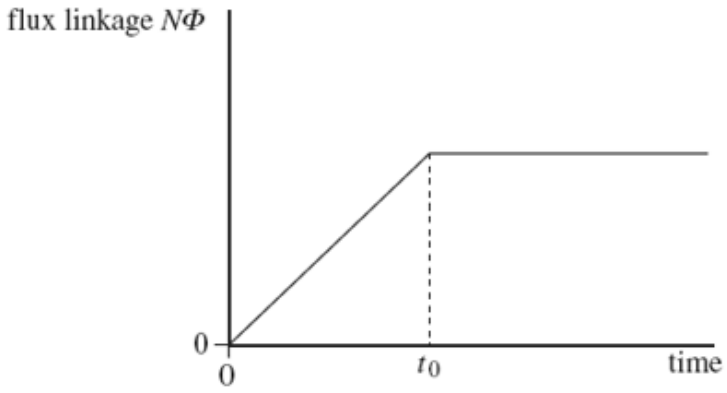
(Total 1 mark)

Q2. A 500 turn coil of cross-sectional area 4.0×10^{-3} m^2 is placed with its plane perpendicular to a magnetic field of flux density 7.5×10^{-4} T. What is the value of the flux linkage for this coil?

A 3.0×10^{-6} Wb turns
B 1.5×10^{-3} Wb turns
C 0.19 Wb turns
D 94 Wb turns

(Total 1 mark)

Q3. The graph shows how the flux linkage, $N\Phi$, through a coil changes when the coil is moved into a magnetic field.



The emf induced in the coil

A increases then becomes constant after time t_0.

B is constant then becomes zero after time t_0.

C is zero then increases after time t_0.

D decreases then becomes zero after time t_0.

(Total 1 mark)

Q4. An aircraft, of wing span 60 m, flies horizontally at a speed of 150 m s^{-1}. If the vertical component of the Earth's magnetic field in the region of the plane is 1.0×10^{-5} T, what is the magnitude of the magnetic flux cut by the wings in 10 s?

A 1.0×10^{-5} Wb

B 1.0×10^{-4} Wb

C 9.0×10^{-2} Wb

D 9.0×10^{-1} Wb

(Total 1 mark)

Q5. 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 $\frac{Et}{N}$

B $\frac{N}{Et}$

C $E\,t\,N$

D $\frac{E}{Nt}$

(Total 1 mark)

Q6. (a) State Lenz's law.

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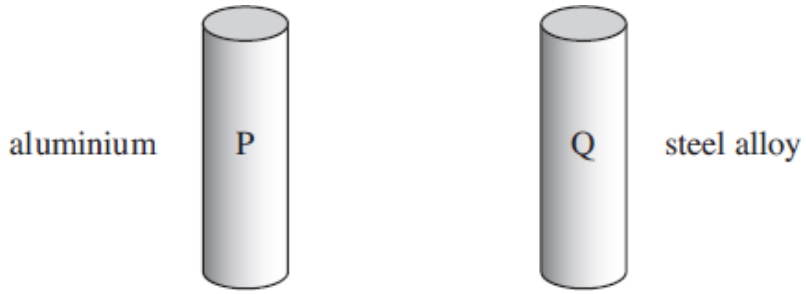
.....

(2)

(b) **Figure 1** shows two small, solid metal cylinders, **P** and **Q**. **P** is made from aluminium. **Q** is made from a steel alloy.

Figure 1



(i) The dimensions of **P** and **Q** are identical but **Q** has a greater mass than **P**. Explain what material property is responsible for this difference.

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.....

.....

(1)

(ii) When **P** and **Q** are released from rest and allowed to fall freely through a vertical distance of 1.0 m, they each take 0.45 s to do so. Justify this time value and explain why the times are the same.

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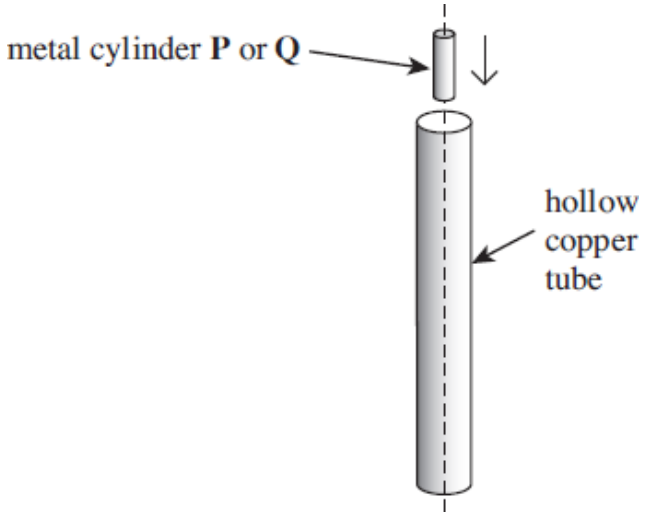
(2)

(c) The steel cylinder **Q** is a strong permanent magnet. **P** and **Q** are released separately from the top of a long, vertical copper tube so that they pass down the centre of the tube, as shown in **Figure 2**.

Figure 2



The time taken for **Q** to pass through the tube is much longer than that taken by **P**.

(i) Explain why you would expect an emf to be induced in the tube as **Q** passes through it.

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(2)

(ii) State the consequences of this induced emf, and hence explain why **Q** takes longer than **P** to pass through the tube.

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(3)

(d) The copper tube is replaced by a tube of the same dimensions made from brass. The resistivity of brass is much greater than that of copper. Describe and explain how, if at all, the times taken by **P** and **Q** to pass through the tube would be affected.

P: .....

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Q: .....

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(3)
(Total 13 marks)

M1. D

[1]

M2. B

[1]

M3. B

[1]

M4. D

[1]

M5. A

[1]

M6. (a) direction of induced emf (or current) ✓
opposes change (of magnetic flux) that produces it ✓

2

(b) (i) (volumes are equal and mass of Q is greater than that of P) density of steel > density of aluminium ✓

Allow density of Q greater (than density of P).

1

(ii) use of $s = \frac{1}{2} g t^2$ gives $t^2 = \frac{2 \times 1.0}{9.81}$ (from which $t = 0.45$ s) ✓

Backwards working is acceptable for 1st mark

(vertical) acceleration [**or** acceleration due to gravity] is independent of mass of falling object
[**or** correct reference to $F = mg = ma$ with m cancelling] ✓

2nd mark must refer to mass.
Do not allow "both in free fall" for 2nd mark.

2

(c) (i) moving magnet [**or** magnetic field] passes through tube ✓ there is a change of flux (linkage)(in the tube)

[**or** flux lines are cut **or** appropriate reference to $\varepsilon = N(\Delta\phi / \Delta t)$] ✓

In this part marks can be awarded for answers which mix and match these schemes.

[**Alternative:**
(conduction) electrons in copper (or tube) acted on by (moving) magnetic field of Q ✓
induced emf (or current) is produced by redistributed electrons ✓]

2

(ii) emf produces current (in copper) ✓
this current [*allow* emf] produces a magnetic field ✓
this field opposes magnetic field (or motion) of Q
[**or** acts to reduce relative motion **or** produces upward force] ✓
no emf is induced by P because it is not magnetised (or not magnet)
[**or** movement of P is not opposed by an induced emf or current] ✓

***Alternative** to 3rd mark:*
current gives heating effect in copper and energy for this comes from ke of Q ✓

max 3

(d) time for P is unaffected because there is still no (induced) emf
[**or** because P is not magnetised
or because there is no repulsive force on P] ✓
time for Q is shorter (than in (c)) ✓
current induced by Q would be smaller ✓
because resistance of brass $\propto$ resistivity and is therefore higher
[**or** resistance of brass is higher because resistivity is greater] ✓
giving weaker (opposing) magnetic field
[**or** less opposition to Q's movement] ✓

Condone "will pass through faster" for 2nd mark.
If emf is stated to be smaller for Q, mark (d) to max 2.

max 3

[13]