MOMENTUM

IB Physics HL

Electricity and magnetism - Set 1

D.2-D.4 | First assessment 2025 | Higher Level

Independent examination-style practice material

10 original problems

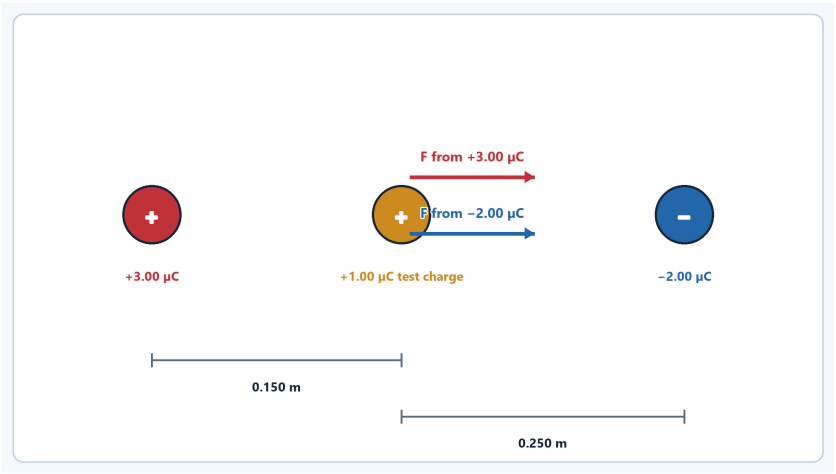
TASK 01

[6]

Three charges on a line

Paper 2 style | IB code D.2

Charges +3.00 microC and -2.00 microC are fixed 0.400 m apart. A +1.00 microC test charge is placed between them, 0.150 m from the positive charge. Use k = 8.99e9 N m^2 C^{-2}.



(a) Determine the magnitude and direction of each force on the test charge. [4]

(b) Determine the resultant electric field at the test charge. [2]

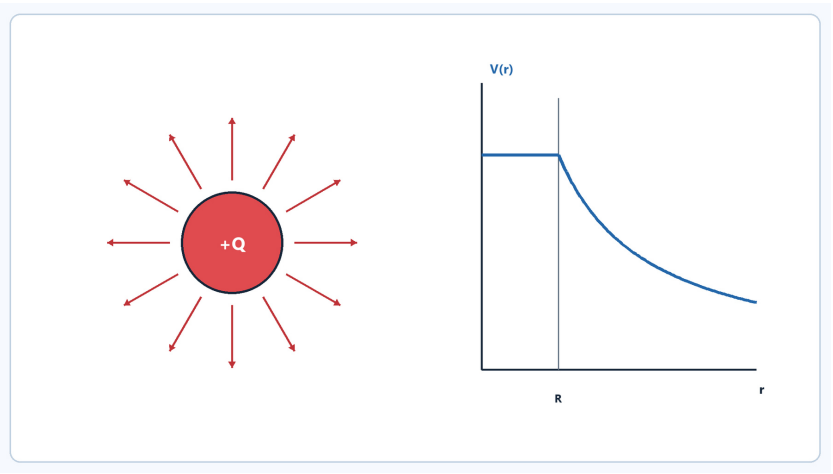
TASK 02

[6]

Potential around a charged conducting sphere

Paper 2 style | IB code D.2

An isolated conducting sphere has radius 0.120 m and charge +4.00 nC. Take electric potential as zero at infinity.



(a) Determine the potential at the surface. [2]

(b) Sketch how potential varies from the centre to far outside the sphere. [2]

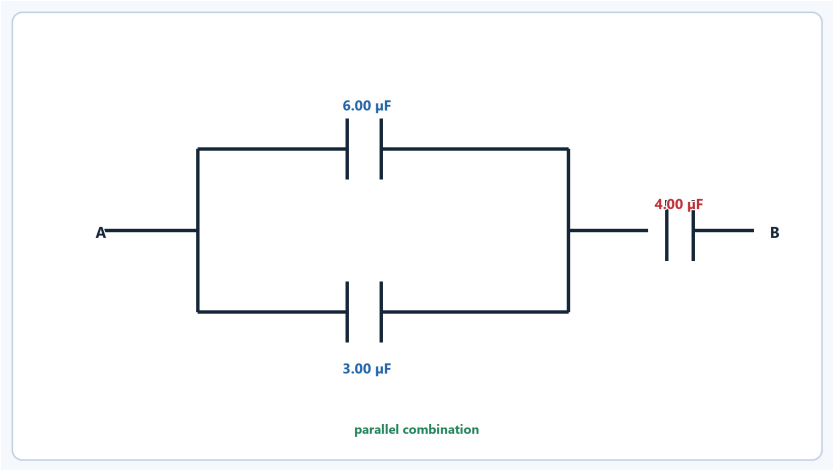
(c) Determine the work required to move an electron from infinity to the surface. [2]

TASK 03
[7]

A network of capacitors

Paper 2 style | IB code D.2

A 6.00 microF capacitor and a 3.00 microF capacitor are connected in parallel. This combination is connected in series with a 4.00 microF capacitor across 12.0 V.



(a) Determine the equivalent capacitance. [3]

(b) Determine the charge on the 4.00 microF capacitor. [2]

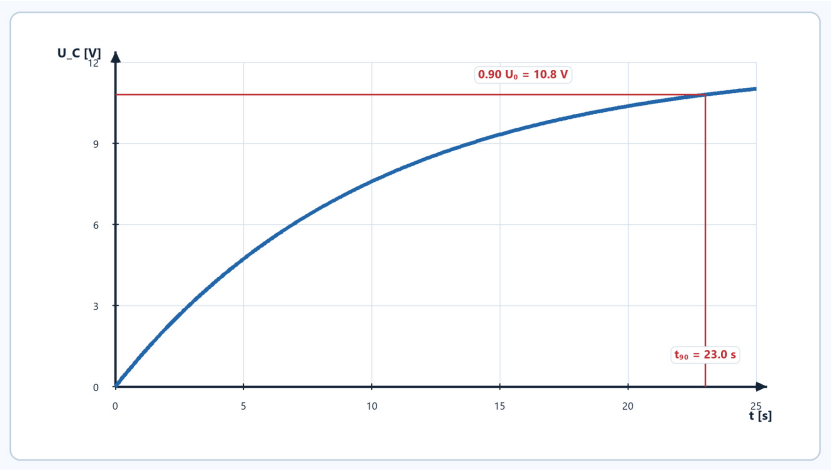
(c) Determine the energy stored in the complete network. [2]

TASK 04
[8]

Discharging a capacitor

Paper 2 style | IB code D.2

A 220 microF capacitor initially at 12.0 V discharges through a 47.0 kOhm resistor.



(a) Determine the time constant. [1]

(b) Determine the voltage and current after 15.0 s. [4]

(c) Determine the time at which the stored energy is 10.0% of its initial value. [3]

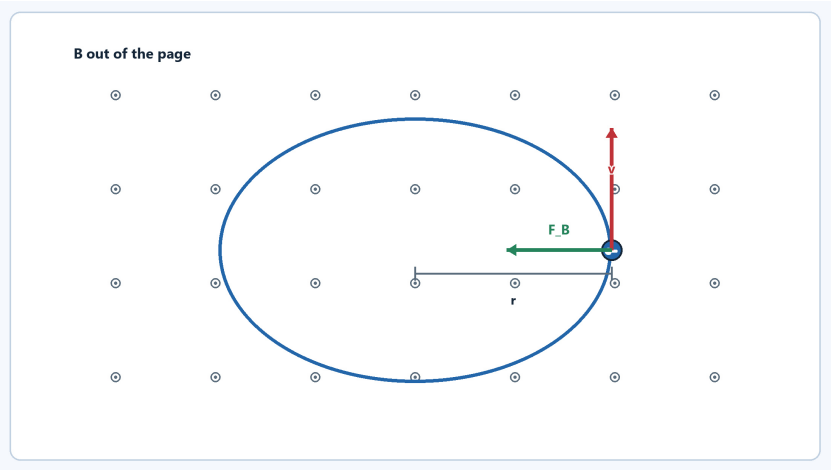
TASK 05

[6]

An electron in a magnetic field

Paper 2 style | IB code D.3

An electron enters a uniform 0.0800 T magnetic field perpendicular to the field with speed 3.00e6 m s^{-1}.



(a) Explain why its speed remains constant. [2]

(b) Determine the radius of its path. [2]

(c) Determine the period of the circular motion. [2]

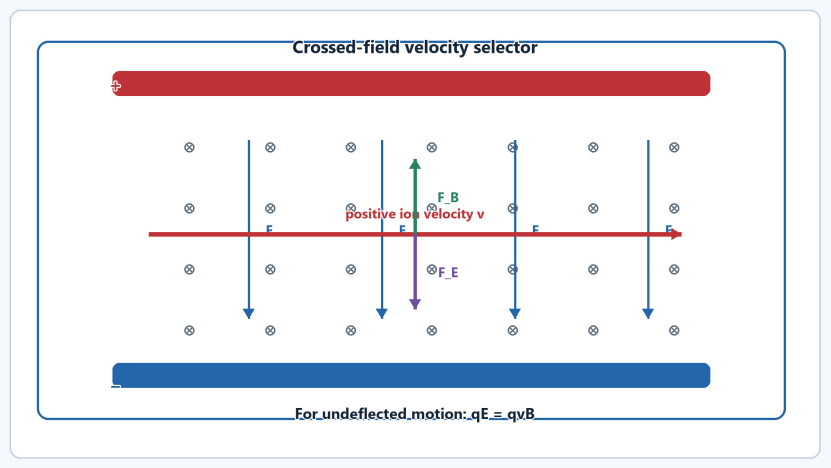
TASK 06

[5]

A velocity selector

Paper 2 style | IB code D.3

A beam of singly charged positive ions passes through perpendicular electric and magnetic fields. E = 2.40e4 V m^{-1} and B = 0.0800 T.



(a) State the required relative directions of electric and magnetic forces for undeflected motion. [1]

(b) Determine the selected speed. [2]

(c) Explain what happens to a positive ion moving faster than the selected speed. [2]

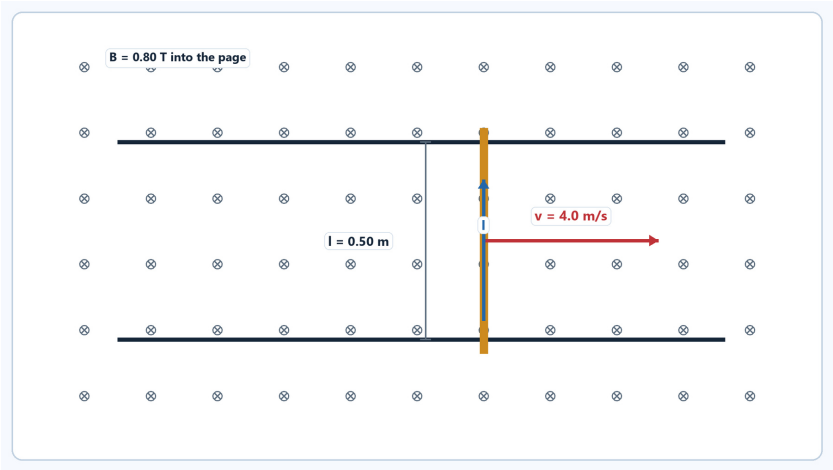
TASK 07

[8]

A conducting rod on rails

Paper 2 style | IB code D.4

A 0.400 m conducting rod moves at 6.00 m s^{-1} along horizontal rails in a uniform 0.750 T field perpendicular to the plane. Total circuit resistance is 2.00 Ohm.



(a) Determine the induced emf and current. [3]

(b) Determine the magnetic force on the rod. [2]

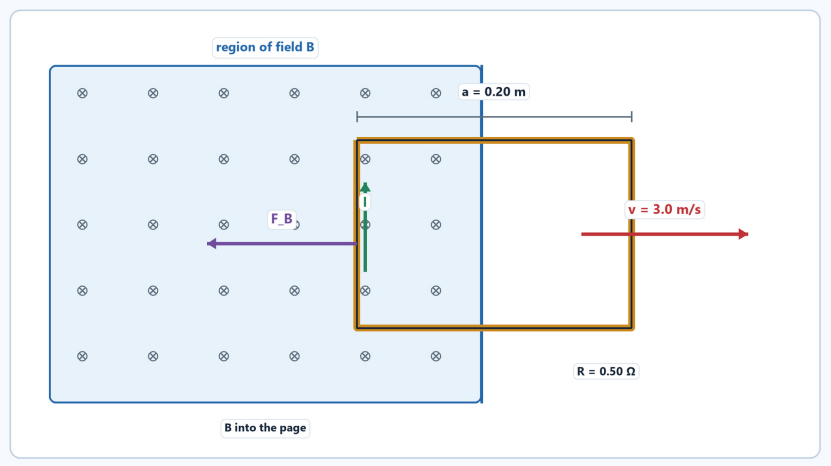
(c) Determine the external power needed to maintain constant speed and verify energy conservation. [3]

TASK 08
[8]

A loop leaving a magnetic field

Paper 2 style | IB code D.4

A square loop of side 0.200 m and resistance 0.500 Ohm moves at 3.00 m s^{-1} out of a uniform 0.600 T magnetic field.



(a) Determine the magnitude of the induced emf while one edge crosses the boundary. [2]

(b) Determine the induced current and its direction using Lenz's law. [3]

(c) Determine the charge that passes during the exit. [3]

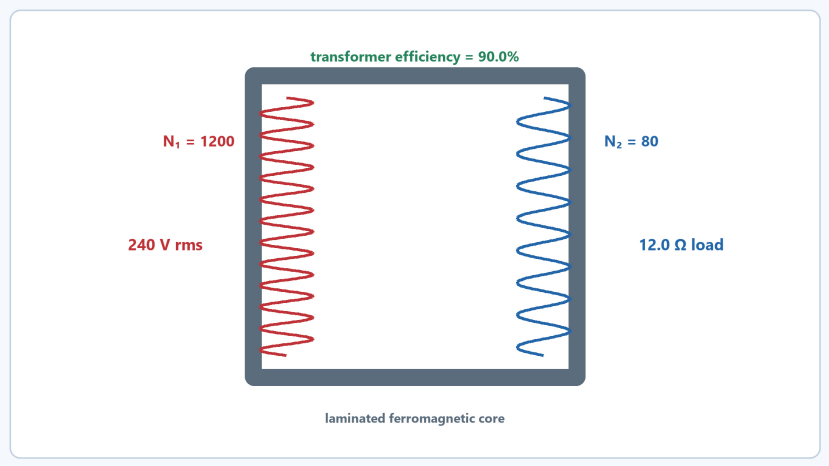
TASK 09

[6]

A practical transformer

Paper 2 style | IB code D.4

An ideal transformer has 1200 primary turns and 80 secondary turns. The primary is connected to 240 V rms. A 12.0 Ohm load is connected to the secondary. The actual efficiency is 90.0%.



(a) Determine the secondary voltage. [2]

(b) Determine the load current and output power. [2]

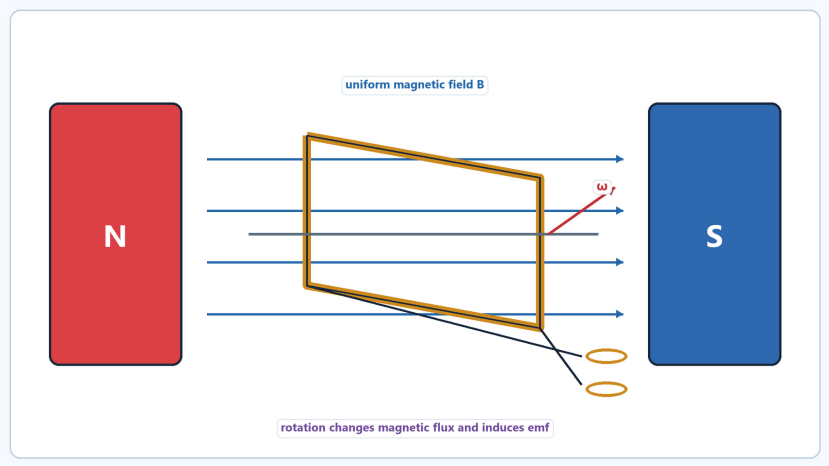
(c) Determine the primary current for the actual transformer. [2]

TASK 10
[7]

A rotating-coil generator

Paper 2 style | IB code D.4

A rectangular coil of 200 turns and area 3.00e-3 m^2 rotates at 50.0 revolutions per second in a uniform 0.400 T magnetic field.



(a) Write the magnetic flux linkage as a function of time. [2]

(b) Determine the peak induced emf. [3]

(c) Determine the rms emf and state the coil orientation when the emf is maximum. [2]