MOMENTUM

IB Physics HL

Electricity and magnetism - Set 1 - Markscheme

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

Independent examination-style practice material

10 original problems

Task 01 - Three charges on a line

Paper 2 style | IB code D.2 | Total [6]

Part	Marking guidance	Marks
(a)	Uses Coulomb's law to obtain 1.20 N away from +3.00 microC and 0.288 N towards -2.00 microC; both are in the same direction.	**4**
(b)	Resultant force is 1.49 N, so E = F/q = 1.49e6 N C^{-1} towards the negative charge.	**2**

Task 02 - Potential around a charged conducting sphere

Paper 2 style | IB code D.2 | Total [6]

Part	Marking guidance	Marks
(a)	V = kQ/R = 300 V.	**2**
(b)	Potential is constant inside the conductor and decreases as 1/r outside.	**2**
(c)	Delta U = qV = -4.80e-17 J; the electric field does +4.80e-17 J of work.	**2**

Task 03 - A network of capacitors

Paper 2 style | IB code D.2 | Total [7]

Part	Marking guidance	Marks
(a)	Parallel capacitance is 9.00 microF; series combination gives C_eq = 36/13 = 2.77 microF.	**3**
(b)	Series charge Q = C_eq V = 33.2 microC.	**2**
(c)	U = C_eq V^2/2 = 1.99e-4 J.	**2**

Task 04 - Discharging a capacitor

Paper 2 style | IB code D.2 | Total [8]

Part	Marking guidance	Marks
(a)	tau = RC = 10.34 s.	**1**
(b)	Uses V = V0 exp(-t/tau) to obtain 2.81 V and I = V/R = 59.8 microA.	**4**
(c)	Since U/U0 = (V/V0)^2 = exp(-2t/tau), t = -(tau/2)ln(0.10) = 11.9 s.	**3**

Task 05 - An electron in a magnetic field

Paper 2 style | IB code D.3 | Total [6]

Part	Marking guidance	Marks
(a)	The magnetic force is perpendicular to velocity, so it does no work.	**2**
(b)	Uses r = mv/(eB), giving r = 2.13e-4 m.	**2**
(c)	T = 2 pi m/(eB) = 4.47e-10 s.	**2**

Task 06 - A velocity selector

Paper 2 style | IB code D.3 | Total [5]

Part	Marking guidance	Marks
(a)	The electric and magnetic forces must be opposite.	**1**
(b)	qE = qvB gives v = E/B = 3.00e5 m s^{-1}.	**2**
(c)	The magnetic force exceeds the electric force, so the ion deflects in the magnetic-force direction.	**2**

Task 07 - A conducting rod on rails

Paper 2 style | IB code D.4 | Total [8]

Part	Marking guidance	Marks
(a)	emf = Blv = 1.80 V and I = emf/R = 0.900 A.	**3**
(b)	F = BIl = 0.270 N opposing motion.	**2**
(c)	P_ext = Fv = 1.62 W, equal to I^2R = 1.62 W.	**3**

Task 08 - A loop leaving a magnetic field

Paper 2 style | IB code D.4 | Total [8]

Part	Marking guidance	Marks
(a)	emf = Blv = 0.360 V.	**2**
(b)	I = 0.720 A; its magnetic field opposes the decrease of the original flux.	**3**
(c)	Q = Delta flux/R = B l^2/R = 0.0480 C.	**3**

Task 09 - A practical transformer

Paper 2 style | IB code D.4 | Total [6]

Part	Marking guidance	Marks
(a)	$V_s/V_p = N_s/N_p$ gives $V_s = 16.0$ V.	**2**
(b)	$I_s = 1.33$ A and $P_{out} = 21.3$ W.	**2**
(c)	$P_{in} = P_{out}/0.900 = 23.7$ W, so $I_p = 0.0988$ A.	**2**

Task 10 - A rotating-coil generator

Paper 2 style | IB code D.4 | Total [7]

Part	Marking guidance	Marks
(a)	N Phi = NBA cos(omega t), with omega = 100 pi rad s^{-1}.	**2**
(b)	E0 = NBA omega = 75.4 V.	**3**
(c)	E_rms = E0/sqrt(2) = 53.3 V; maximum emf occurs when the coil plane is parallel to the field.	**2**