Question	Answer	Marks
5(c)	field strength = $q / 4\pi\epsilon_0 x^2$	**C1**
	$2.0 \times 10^6 = q / (4 \times \pi \times 8.85 \times 10^{-12} \times 0.26^2)$	**C1**
	$q = 1.5 \times 10^{-5}$ C	**A1**

Question	Answer	Marks
6(a)	charge / potential (difference)	**M1**
	charge on one plate, p.d. between the plates	**A1**
6(b)(i)	all three capacitors connected in series	**B1**
6(b)(ii)	8 (μF) in parallel with the two 4 (μF) capacitors connected in series	**B1**
6(c)	discharge from 7.0 V to 4.0 V	**C1**
	Either energy = $\frac{1}{2}CV^2$ *or* energy = $\frac{1}{2}QV$ and $C = Q / V$	**C1**
	energy = $\frac{1}{2} \times 47 \times 10^{-6} \times (7^2 - 4^2)$ = 7.8×10^{-4} J	**A1**

Question	Answer	Marks
7(a)(i)	output voltage / input voltage	**B1**
7(a)(ii)	no time delay between input and output	**B1**
	clear reference to change(s) in input and / or output	**B1**
7(b)(i)	V_{IN} only connected to non-inverting input	**B1**
	midpoint between R_1 and R_2 only connected to inverting input	**B1**

Question	Answer	Marks
7(b)(ii)	gain = 1 + (R_1 / R_2) 25 = 1 + (12 × 10^3) / R_2	**C1**
	R_2 = 500 Ω	**A1**
7(b)(iii)	V_{MAX} = 9/25 = 0.36 V	**C1**
	range is –0.36 V to + 0.36 V	**A1**

Question	Answer	Marks
8(a)(i)	*Either* Newton's third law *or* equal and opposite forces	**B1**
	force on magnet is upwards	**B1**
	so force on wire downwards	**B1**
8(a)(ii)	using (Fleming's) left-hand rule	**M1**
	current from B to A	**A1**
8(b)	sinusoidal wave with at least 1 cycle	**B1**
	peaks at +6.4 mN and –6.4 mN	**B1**
	time period 25 ms	**B1**

Question	Answer	Marks
9	X-rays (are used)	**B1**
	(object is) scanned in sections / slices	**B1**
	either: scans taken at many angles / directions *or* images of each section / slice are 2-dimensional	**B1**
	scans of many sections / slices are combined	**B1**
	(to give) 3-dimensional image (of whole structure)	**B1**

Question	Answer	Marks
10(a)	single straight line along full length of solenoid	**B1**
	at least two more parallel lines along full length of solenoid	**B1**
	correct direction – right to left	**B1**
10(b)	(induced) e.m.f. proportional / equal to rate	**M1**
	of change of (magnetic) flux (linkage)	**A1**
10(c)	increasing current causes increasing flux	**B1**
	increasing flux induces e.m.f. in coil	**B1**
	(induced) e.m.f. opposes growth of current	**B1**

Question	Answer	Marks
11(a)	quantum / packet / discrete amount of energy	**M1**
	of electromagnetic radiation	**A1**
11(b)	$E = hc / \lambda$	**C1**
	$= (6.63 \times 10^{-34} \times 3.0 \times 10^{8}) / (540 \times 10^{-9})$	**C1**
	$= (3.68 \times 10^{-19}) / (1.6 \times 10^{-19})$ $= 2.3$ eV	**A1**
11(c)	Any 4 from: photon absorbed by electron in valence band (1) photon energy > energy of forbidden band (1) electron promoted to conduction band (1) hole left in valence band (1) more charge carriers so lower resistance (1)	**B4**

Question	Answer	Marks
12(a)(i)	fission	**B1**
12(a)(ii)	*either* $^{0}_{-1}$e *or* $^{0}_{-1}\beta$	**M1**
	7	**A1**
12(b)(i)	energy $= c^2 \Delta m$ $= 0.223 \times 1.66 \times 10^{-27} \times (3.00 \times 10^{8})^2$	**C1**
	$= 3.33 \times 10^{-11}$ J	**A1**

Question	Answer	Marks
12(b)(ii)	Any 2 from: kinetic energy of products gamma photons neutrinos	**B2**