Question	Answer	Marks
6(a)(i)	product of (magnetic) flux density and area	**M1**
	area perpendicular to the (magnetic) field	**A1**
6(a)(ii)	flux $= B \times \pi r^2$ $= 0.17 \times \pi \times 0.36^2$	**C1**
	$= 6.9 \times 10^{-2}$ Wb	**A1**
6(b)	time for one revolution = 1 / 25 s	**C1**
	e.m.f. = rate of cutting flux **or** $\Delta\Phi / \Delta t$	**C1**
	$= 0.069 \times 25$ = 1.7 V	**A1**
6(c)	current (in disc) is perpendicular to magnetic field **or** current causes force to act on disc	**B1**
	force opposes rotation of disc	**B1**
	left-hand rule indicates current is from rim to axle	**B1**

Question	Answer	Marks
7(a)(i)	full-wave (rectification)	**B1**
7(a)(ii)	lower left diode shown pointing left	**B1**
	lower right and upper left diodes shown pointing left	**B1**
7(a)(iii)	arrow indicating current direction in resistor to the right	**B1**
7(b)(i)	sketch: periodic line showing minimum V_{OUT} = 0 and maximum V_{OUT} = $+V_0$	**B1**
	line showing peak V_{OUT} at t = 0, 0.5T, 1.0T, 1.5T and 2.0T, with V_{OUT} going to zero half-way in between each peak	**B1**
	line showing correct modulated sine shape	**B1**
7(b)(ii)	sketch: sinusoidal curve with troughs sitting on the time axis	**B1**
	peak power at t = 0, 0.5T, 1.0T, 1.5T and 2.0T and zero power half-way in between each peak	**B1**
7(b)(iii)	same power-time graph with or without rectification, so same V_{rms} **or** V^2-time graph is same for both V_{OUT} and V_{IN}, so same V_{rms} **or** power does not depend on sign of V, so same V_{rms}	**B1**

Question	Answer	Marks
8(a)	transition (emits) (one) photon with energy equal to the difference in energy between the two levels	**B1**
	frequency of radiation corresponds to energy of photon	**B1**
8(b)(i)	line to the left of the pair in Fig. 8.2, labelled A	**B1**
	larger gap between line A and the nearest of the pair in Fig. 8.2 than between the lines in the pair	**B1**
8(b)(ii)	line to the left of both the pair in Fig. 8.2 and line A, labelled B	**B1**
	larger gap between line B and line A than between line A and the nearest one of the pair in Fig. 8.2	**B1**
8(c)	$E = hf$	**C1**
	$E_3 = E_1 + h(f_A + f_B)$	**A1**

Question	Answer	Marks
9(a)	difference between mass of nucleus and (total) mass of nucleons	M1
	when infinitely separated	A1
9(b)(i)	neutron	B1
9(b)(ii)	$E = \Delta m\, c^2$	C1
	Δm = (0.030377 – 0.002388 – 0.009105)u (= 0.018884u)	C1
	energy release = (0.030377 – 0.002388 – 0.009105) × 1.66 × 10^{-27} × (3.00 × 10^8)^2 = 2.8 × 10^{-12} J	A1
9(c)(i)	number of atoms per unit time = (1.4 × 10^{28}) / (2.8 × 10^{-12}) (= 5.0 × 10^{39} s^{-1})	C1
	mass of one atom = 4 × 1.66 × 10^{-27} or (4 × 10^{-3}) / (6.02 × 10^{23}) (= 6.64 × 10^{-27} kg)	C1
	mass per unit time = 6.64 × 10^{-27} × 5.0 × 10^{39} = 3.3 × 10^{13} kg s^{-1}	A1
9(c)(ii)	$L = 4\pi\sigma r^2 T^4$ 1.4 × 10^{28} = 4π × 5.67 × 10^{-8} × (2.3 × 10^9)^2 × T^4	C1
	T = 7800 K	A1

Question	Answer	Marks
10(a)(i)	electrons	B1
10(a)(ii)	electrons are decelerated / stopped on impact with the target	B1
	(kinetic) energy lost by electrons emitted as (X-ray) photons	B1
10(a)(iii)	$eV = hc / \lambda$	C1
	$\lambda = (6.63 \times 10^{-34} \times 3.00 \times 10^{8}) / (1.60 \times 10^{-19} \times 5800)$	C1
	$= 2.14 \times 10^{-10}$ m	A1
10(b)	$I = I_0 \exp(-\mu x)$	C1
	$I_T / I_0 = \exp(-(1.4 \times 2.8))$ $= 0.020$	C1
	% absorbed $= (1.000 - 0.0198) \times 100$ $= 98\%$	A1