Question	Answer	Marks
6(a)(i)	energy stored = area under graph	**C1**
	$= ½ \times 450 \times 10^{-6} \times 8.0 = 1.8 \times 10^{-3}$ J **or** 1.8 mJ	**A1**
6(a)(ii)	$C = Q / V$ **or** $E = ½CV^2$	**C1**
	$C = (450 \times 10^{-6}) / 8.0$ **or** $(2 \times 1.8 \times 10^{-3}) / 8.0^2$ $= 5.6 \times 10^{-5}$ F	**A1**
6(b)(i)	$V = V_0 \exp(-t / RC)$ **and** $\tau = RC$	**C1**
	$V = V_0 \exp(-t / \tau)$ $V_0 = 8.0$ V, and at one time constant, $t = \tau$ $V / 8.0 = \exp(-\tau / \tau)$, so $\ln(V / 8.0) = -1.0$ **or** $-\ln(V / 8.0) = 1.0$	**A1**
6(b)(ii)	[t read from graph at $-\ln(V / 8.0) = 1.0$]: $\tau = 3.2$ s	**A1**
6(b)(iii)	$\tau = RC$	**C1**
	$R = 3.2 / (5.6 \times 10^{-5})$ $= 5.7 \times 10^{4}\ \Omega$	**A1**

Question	Answer	Marks
7(a)(i)	V_H = *BI* / *ntq* = (4.0 × 10^{-6} × 5.4) / (1.5 × 10^{16} × 1.8 × 10^{-3} × 1.60 × 10^{-19}) = 5.0 V	A1
7(a)(ii)	sketch: straight diagonal line from (0, 0) to *t* = 0.020 s **and** straight diagonal line between two non-zero V_H values of same sign from *t* = 0.040 to 0.050 s	B1
	horizontal straight line at V_H = 5.0 V from *t* = 0.020 to 0.040 s	B1
	horizontal straight line at V_H = 2.5 V from *t* = 0.050 to 0.080 s	B1
7(b)(i)	e.m.f. = rate of change of (magnetic) flux (linkage)	C1
	$E = NA\,\Delta B / \Delta t$ **or** $E = NA$ × gradient (at *t* = 0.010 s)	C1
	E = 3000 × 3.4 × 10^{-4} × (4.0 × 10^{-6}) / (0.020) = 2.0 × 10^{-4} V	A1
7(b)(ii)	sketch: line showing non-zero *E* from *t* = 0 to *t* = 0.020 s and from *t* = 0.040 s to *t* = 0.050 s, and *E* = 0 at all other times	B1
	'top hats' showing constant non-zero *E* from *t* = 0 to *t* = 0.020 s and from *t* = 0.040 s to *t* = 0.050 s	B1
	magnitude of *E* shown as 2.0 × 10^{-4} V in both non-zero sections	B1
	sign of *E* in the *t* = 0 to *t* = 0.020 s region opposite to the sign of *E* in the *t* = 0.040 s to *t* = 0.050 s region	B1

Question	Answer	Marks
8(a)	packet / quantum of energy	**M1**
	of electromagnetic radiation	**A1**
8(b)(i)	photoelectric effect	**B1**
8(b)(ii)	• electron needs a minimum energy to escape **or** electron emitted if energy in packet is enough • energy must be absorbed in packets that are related to frequency • intensity relates to number of packets (not to energy in packet) • electron absorbs only a single whole packet *Any three points, 1 mark each*	**B3**
8(c)(i)	Planck constant	**B1**
8(c)(ii)	– work function (energy)	**B1**

Question	Answer	Marks
9(a)(i)	material introduced into the body **and** (position in body) can be detected **or** absorbed by the tissue (being studied)	**B1**
9(a)(ii)	X = β^+ **or** e^+ **and** $P = 1$	**B1**
	$Q = 0$ **and** $R = 18$	**B1**
9(b)(i)	positrons (emitted in the decay) and electrons annihilate	**B1**
	mass of particles becomes energy of gamma photons	**B1**
9(b)(ii)	arrival times of photons are processed	**B1**
	image built up of tracer concentration in the tissue	**B1**
9(c)(i)	$A = \lambda N$ **and** $\lambda = \ln 2 / T$	**C1**
	$N = n \times N_A$	**C1**
	2 photons produced from each decay, so $R_0 = 2 \times \lambda \times n \times N_A$ $R_0 = (2 \ln 2)\ nN_A / T$ (*allow 0.693 for ln 2*)	**A1**
9(c)(ii)	sketch: exponential decay curve from $t = 0$ to $t = 2T$, starting at $(0, R_0)$ and with a negative gradient of continuously decreasing magnitude	**B1**
	line with negative gradient passing through $(T, R_0 / 2)$ and $(2T, R_0 / 4)$	**B1**

Question	Answer	Marks
10(a)	temperature inversely proportional to wavelength	**M1**
	temperature is thermodynamic temperature of surface, and wavelength is the wavelength at which maximum emission rate occurs	**A1**
10(b)(i)	(astronomical) object of known luminosity	**B1**
10(b)(ii)	star / galaxy is moving away from the student	**B1**
10(b)(iii)	one tick placed in correct column in each row: wavelength: too high	**B1**
	surface temperature: too low	**B1**
	distance: unchanged	**B1**
	radius: too high	**B1**