

1.

(a)	(i)	<p>Any <u>five</u> from:</p> <ol style="list-style-type: none"> Gas / dust (cloud) drawn together by gravitational forces Loss in (gravitational) PE / KE increases / PE changes KE / temperature increase Fusion of protons / hydrogen <u>nuclei</u> (produces helium nuclei and energy) A stable star is formed when radiation pressure is equal to gravitational pressure When hydrogen runs out the <u>outer layers</u> of the star expands / <u>core</u> shrinks <u>Red giant</u> formed / eventually (the core becomes) a <u>white dwarf</u> <p>QWC mark for 'correct sequencing of the processes from birth to death'</p>	B1 × 5
	(ii)	<p>Supernova followed by</p> <p>neutron star / black hole</p>	B1 B1
(b)		$\Delta E = \Delta mc^2$ energy = $2.0 \times 10^{30} \times 10^{-6} \times (3.0 \times 10^8)^2$ or $1.8(0) \times 10^{41}$ (J) time = $1.80 \times 10^{41} / 3.8 \times 10^{26}$ (= 4.74×10^{14} s) time = $4.74 \times 10^{14} / 3.2 \times 10^7$ time = 1.5×10^7 (y)	C1 C1 A1

2.

(a)	(i)	3 correct labels	B1	
	(ii)	the (three) colours add up/superpose to give white light or no dispersion/diffraction of incident white light/AW	B1	allow use of formula $d \sin \theta = n\lambda$ so constructive interference at $\theta = 0$ for all λ
	(iii)	select $\lambda = d \sin \theta$ $\lambda = 1.67 \times 10^{-9} \sin 19.1$ $\lambda = 546 \times 10^{-9}$ (m)	C1 C1 A1	allow 547×10^{-9} as answer is 546.46×10^{-9} do not allow 550×10^{-9} unless SF mark already deducted
(b)		select $E = hc/\lambda$ $E = 6.63 \times 10^{-34} \times 3.0 \times 10^8 / 436 \times 10^{-9}$ $E = 4.56 \times 10^{-19}$ (J)	C1 C1 A1	do not allow 4.6×10^{-19} unless SF mark already deducted
(c)	(i)	1 arrow correctly labelled 2 more arrows correctly labelled	B1 B1	

3.

a	i	light emitted from (excited isolated) atoms produces a line spectrum a series of (sharp/bright/coloured) lines against a dark background	B1 B1	max 2 marks from 3 marking points
	ii	in an absorption spectrum a series of <u>dark</u> lines (appears against a bright background/within a continuous spectrum)	B1	accept black
b	i	$\epsilon = hc/\lambda$ $= 6.63 \times 10^{-34} \times 3.00 \times 10^8 / 436 \times 10^{-9}$ $= 4.56 \times 10^{-19} \text{ (J)}$	C1 C1 A1	apply SF error if all numbers not to 3+ figures 4.54 if use 6.6
	ii	$3.64 \times 10^{-19} \text{ (J)}$	A1	allow mark if repeated error from b(i)
c	i	correct vertical lines; correct labels arrow(s) downwards	B1 B1 B1	1 mark for 1 vertical line + correct label
	ii	$- 8.86 + 4.56 = - 4.3 \times 10^{-19} \text{ (J)}$ $- 7.94 + 3.64 = - 4.3 \times 10^{-19} \text{ (J)}$	B1 B1	ecf b(i) do calculation for one line only correctly scores 2 marks; give answer as 4.3×10^{-19} or -4.3 scores 1 mark do calculation for both lines and give answer as 4.3×10^{-19} or -4.3 scores both marks