

01. 0625_m23_ms_42 Q: 10

Question	Answer	Marks
(a)	24 km / s	A3
	$v = 2\pi r / T$ OR $(v =) 2\pi r / T$ OR $(2\pi \times 2.28 \times 10^8) / (690 \times 24 \times 60 \times 60)$	(C1)
	$(2\pi \times 2.28 \times 10^8) / (690 \times 24 \times 60 \times 60)$ OR $(T =) 690 \times 24 \times 60 \times 60$ OR $(T =) 59\,616\,000$ (s)	(C1)
(b)	elliptical / ellipse	B1

Question	Answer	Marks
(c)(i)	wavelength (of light from distant galaxies) increases	B1
	occurs when galaxies are moving away (from Earth)	B1
(c)(ii)	speed / velocity (that galaxy is moving away from Earth)	B1

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Question	Answer	Marks
(a)	$v = 2\pi r / T$	B1
	$r =$ (average) radius of the <u>orbit</u> AND $T =$ (orbital) period	B1
(b)	rays from Sun strike the country at different angles through the year OR rays from Sun strike the country for different number of hours per day through the year	B1
(c)	(first space:) red supergiant	B1
	(second space:) nebula	B1
	(3 rd and 4 th spaces:) neutron star	B1
	black hole	B1
(d)	1.6×10^8 (light-years)	A2
	$H_0 = v/d$ OR $(d =) v/H_0$ OR $(d =) [33\,000 \times 10^3] / [2.2 \times 10^{-18} \times 9.5 \times 10^{15}]$	C1

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Question	Answer	Marks
(a)	$v = s / t$ OR $(s =) vt$	B1
	$(c =) 3 \times 10^8$ (m / s)	B1
	(1 year =) $365 \times 24 \times 3600$ (s) OR 3.2×10^7 (s) OR 32×10^6 OR 8760×3600	B1
	$(s =)$ candidate's speed of light \times candidate's time (m)	B1
(b)(i)	change of wavelength (of galaxy's starlight) OR redshift	B1
(b)(ii)	$H_0 = v / d$	B1
(b)(iii)	brightness of a supernova	B1

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Question	Answer	Marks
(a)	hydrogen nuclei fuse to become helium nuclei	A3
	nuclear reactions OR (nuclear) fusion	C1
	hydrogen fuses into helium	C1
(b)(i)	(observed) wavelength is longer / wavelength is shifted towards the red end of the spectrum	A2
	(light from galaxy) redshifted / shifted towards red (end of spectrum)	C1
(b)(ii)	<u>change</u> in wavelength (or starlight due to redshift)	B1
(c)(i)	5.9×10^{24} m	A2
	$H_0 = v/d$ OR $(d =) v/H_0$ OR $1.3 \times 10^7 / 2.2 \times 10^{-18}$ OR 5.9×10^N (m)	C1
(c)(ii)	1.4×10^{10} (years)	A2
	(age =) $1/H_0$ or $1/2.2 \times 10^{-18}$ or 4.5×10^{17}	C1

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Question	Answer	Marks
(a)	(interstellar clouds of) gas and dust OR (stellar) nebula	B1
(b)	(inward) force of gravitational attraction (is balanced by)	B1
	(outward) force due to the high temperature (in the centre of the star)	B1
(c)	hydrogen	B1
(d)	planetary nebula	B1

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Question	Answer	Marks
(a)(i)	1 Hubble constant	B1
	2 $H_0 = v/d$	B1
(a)(ii)	per second OR s^{-1} OR 1/s	B1
(a)(iii)	4.5×10^{17} (s)	A2
	$d/v = 1/H_0$ OR (age of Universe =) $1/H_0$ OR (age of Universe =) d/v OR (age of Universe =) $1/2.2 \times 10^{-18}$	C1
(b)	shortly after the Universe was formed OR shortly after the Big Bang	B1
	all points in space	B1