6. Space physics

6.2 Stars and the universe

Paper 3 and 4

Answer Key

Paper 3

Q1.

(b)	any **four** from: • (particles of) dust OR gas • (gas / dust / rocks) orbiting Sun / protostar / star • (idea of forming) a disc of material • material (in the disc) colliding • (and) smaller objects join to make larger objects owtte • (accretion / combining due to) force of gravity • (small) rocky planets formed near the Sun • (large) gaseous planets formed furthest from Sun	**B4**

Q2.

Question	Answer	Marks
(a)	any **two** from: • minor / dwarf planet(s) • asteroid(s) **OR** asteroid belt • comet(s) • (planetary) moon(s)	**B2**
(b)	Milky Way (galaxy)	**B1**
(c)	any **three** from: • (light from distant galaxies or it) is redshifted • compared to light on Earth • (redshift is an) increase in (the observed) wavelength (of light) • (because) galaxies are moving away / receding (from Earth) **OR** moving apart • (Big Bang theory predicts / has) an expanding Universe	**B3**

Q3.

(b)	any **four** from: • dust and gas (clouds orbit the Sun) • contain many different elements • rotation of material (around Sun) • (leads to) particles accrete / combine / join • (subsequently) forming larger rocks / boulders • (because of) gravitational attraction • material moves to form (protoplanetary) disks (orbiting Sun) • (continued collisions lead to) formation of planetary core	**B4**

Paper 4

Q4.

Question	Answer	Marks
(a)	ultraviolet **AND** visible light **AND** infrared **only**	**A2**
	any **two** from: ultraviolet; visible light; infrared **and** no more than **one** incorrect addition	C1
(b)	1.5×10^{11} m	**A2**
	$v = s / t$ **OR** ($s =$) vt **OR** $3.0 \times 10^{8} \times 500$ **OR** 1.5×10^{N}	C1
(c)(i)	any **two** from: • cloud / nebula / it collapses • due to (internal) gravitational attraction • (internal) temperature increases	**B2**
(c)(ii)	any **three** from: • (nuclear) fusion / nuclear reactions (in the star) • forces are balanced • gravitational force is inwards • outwards force is due to high temperature	**B3**

Q5.

(a)	Milky Way	**B1**
(b)	Big Bang (Theory)	**B1**
(c)(i)	shortly after the Universe was formed	**B1**
(c)(ii)	Universe has expanded	**B1**
	(radiation) has been redshifted (to the microwave region of the electromagnetic spectrum)	**B1**

Q6.

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)	change 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

Q7.

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**

Q8.

Question	Answer	Marks
(a)	$v = 2\pi r / T$	**B1**
	r = (average) radius of the orbit **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**
	(3rd and 4th spaces:) neutron star	**B1**
	black hole	**B1**
(d)	1.6×10^{9} (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

Q9.

Question	Answer	Marks
(a)	group / collection of (billions of) stars	**B1**
(b)	9.5×10^{17} (km)	**A2**
	(1 light-year =) 9.5×10^{15} (m) **OR** (1 light-year =) $3 \times 10^{8} \times 365 \times 24 \times 3600$	C1
(c)(i)	increase in wavelength (of light from far galaxy) **OR** (amount of) redshift	**B1**
(c)(ii)	brightness of a supernova	**B1**
(c)(iii)	(their) speeds are (directly) proportional to distances (from Earth) **OR** $H_0 = v / d$	**B1**
(c)(iv)	4.5×10^{17} (s)	**A2**
	(age of Universe =) $1 / H_0$ **OR** $1 / (2.2 \times 10^{-18})$	C1