Mark Scheme

Q1.

Question number	Answer	Notes	Marks
(a)	B – gravitational; A is incorrect because there are no charges C is incorrect because there are no magnetic fields D is incorrect because nuclear forces are short range		1
(b)	D – universe; A is incorrect because the universe contains billions of galaxies B is incorrect because each solar system contains several planets C is incorrect because galaxies contain billions of stars		1
(c)	A – absolute magnitude; B is incorrect because colour determines the surface temperature of a star C is incorrect because diameter determines the power of a star D is incorrect because temperature determines the power of a star		1

Q2.

Question number	Answer	Mark
(a)	D	1

Question number	Answer	Mark
(b)	B	1

Question number	Answer	Mark
(c)	D	1

Question number	Answer	Mark
(d)	C	1

(Total for question = 4 marks)

Q3.

Question number	Answer	Mark
(a)(i)	Process includes: • rearrangement (1) • substitution (1) • evaluation of orbital radius (1) • answer to 3 s.f. (1) e.g. $r = v \times T/2\pi$ (1) $r = (7.66 \times 92.7 \times 60)2\pi$ (1) $r = 6781$ (km) (1) $r = 6780$ (km) (1)	4

Question number	Answer	Additional guidance	Mark
(a)(ii)	Earth radius = r − 409 = 6370 (km)	Allow ecf Allow 6 371 (km) Allow 6 372 (km)	1

(Total for question = 5 marks)

Q4.

Question number	Answer	Notes	Marks
(a)	An arrow drawn from left to right by eye;		1
(b)	Comparative statements for side containing A: Wavefronts closer together/EQ; (therefore) wavelength smaller; Same speed; (v = f x λ so) frequency larger;	Allow RA for B Allow e.g."waves more compressed together" Condone mention of the Doppler effect for 1 mark if no other mark scored.	4

Q5.

Question number		Answer	Notes	Marks
(a)		(nuclear) <u>fusion</u>;		1
(b)		Sun becomes a red giant; (then) a white dwarf;	allow planetary nebula reject mention of supernova, neutron star or black hole for this mark	2
(c)	(i)	(mass =) 5×10^{29} (kg);	allow 5.3×10^{29}, 5.2×10^{29}, 5.25×10^{29} (kg)	1
	(ii)	evaluation of time; answer to 1 significant figure; e.g. (time = 5.25×10^{29} / 9×10^{19} =) 5.8×10^{9} (years) (time =) 6×10^{9} (years)	allow ecf from (c)(i) allow 5.56×10^{9} (years) allow 6 000 000 000, 6 billion years	2
			Total for question 5 = 6 marks	

Q6.

Question number	Answer	Notes	Marks
(a)	Cosmic Microwave Background Radiation (CMBR) (Cosmological) Red shift of <u>galaxies</u>	Allow one missing word Accept reference to Hubble's Law. Allow higher level idea of ratio of hydrogen to helium as alternative to either marking point.	2
(b)	<u>CMBR</u> MAX TWO from MP1 CMBR appears to be the same in all directions/is everywhere; MP2 Which implies all parts of the Universe were in contact a long time ago; MP3 Wavelength has increased as the universe has expanded; MP4 universe was (significantly) hotter long ago; <u>Red Shift of Galaxies</u> MAX TWO from MP5 The further the galaxy is from Earth, the greater the red-shift; MP6 The greater the red-shift, the faster the galaxy is moving away; MP7 Speed of galaxies increases (is directly proportional to) with increased distance; MP8 Relationship between speed and distance implies expansion from a single point or since the Big Bang;	Allow implication of idea of coming from single point Allow frequency has decreased Allow RA Condone "star" for "galaxy" for MP5 Allow 'red shift' for 'speed of galaxies' Allow 'galaxies moving apart from each other' for 'relationship between speed and distance'	4

Q7.

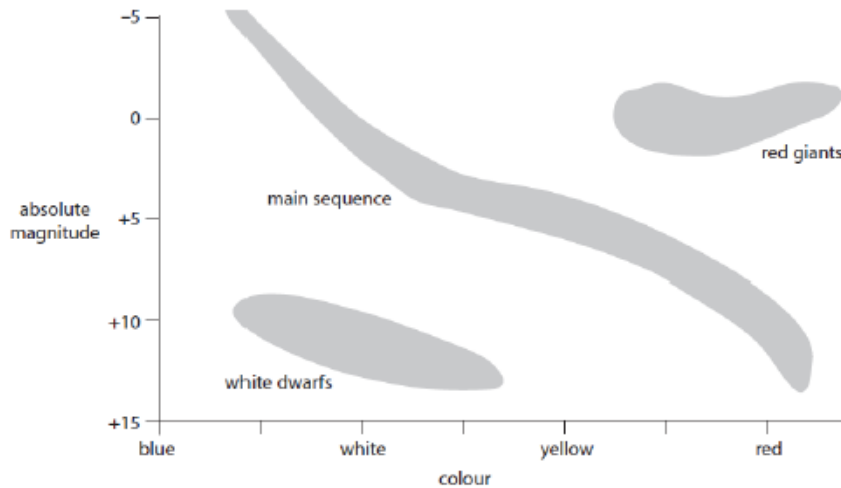| Question number	Answer	Notes	Marks
(a)	comet drawn in orbit around the Sun; orbital path is elliptical;	judge by eye allow partially drawn ellipse Sun need not be at a focus of the ellipse, but should not be at the centre of the ellipse	2
(b)	attempted use of orbital speed formula; valid substitution into orbital speed formula; correct evaluation of time period for either planet; attempt to divide T for Saturn by T for Mars; correct final evaluation of ratio; e.g. $v = 2 \times \pi \times r / T$ $24.1 = 2 \times \pi \times 2.28 \times 10^8 / T$ $T_{Mars} = 5.94 \times 10^7$ (s) OR $T_{Saturn} = 9.26 \times 10^8$ (s) $n = T_{Saturn} / T_{Mars}$ 15.6	allow for either planet seen anywhere in working $9.70 = 2 \times \pi \times 1.43 \times 10^9 / T$ 5.944... 9.2628... allow range of 15-16	5

Q8.

Question number	Answer	Additional guidance	Mark
	A description that makes reference to six of the following points: • **all** main sequence stars fuse H into He (1) • lower mass stars stay on the MS line for longer (1) • lower mass stars become red giants (1) • higher mass stars become red super giants (1) • red giant becomes a white dwarf (1) • supergiant becomes a supernova (1) • supernova becomes a neutron star (1) • supernova becomes a black hole (1)	accept numerical values allow red giant to planetary nebula	
			6

(Total for question = 6 marks)

Q9.

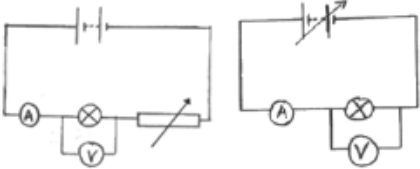| Question number	Answer	Notes	Marks
(a)	(a measurement of) the brightness (of a star);	allow measurement of luminosity/power of a star apparent magnitude	2
	at a standard distance;	allow at 10 pc/32.6 ly. condone incorrect distance.	
(b)	correct absolute magnitude scale; x-axis labelled 'colour'; main sequence top-left to bottom-right with clear flatter region in the middle; white dwarf region in bottom-left corner with part of it in line with 'white' label on x-axis; red giant region in top-right corner with part of it in line with 'red' label on x-axis;	i.e. going from +15 to -5 in regular intervals condone 'temperature'	5

The graph shows absolute magnitude (y-axis, from −5 at top to +15 at bottom) against colour (x-axis, from blue, white, yellow, red). It shows a main sequence band running top-left to bottom-right, a red giants region in the top-right, and a white dwarfs region in the lower-left.

Q10.

Question number		Answer	Notes	Marks
(a)	(i)		ignore starting position of arrows and any horizontal arrows	3
		downward force arrow labelled "weight";	allow "gravitational force", "gravitational pull", "force of gravity" reject "gravity"	
		upward force arrow labelled "drag" / "air resistance"; upward force larger than downward force by eye;	allow "friction" ignore "upthrust"	
	(ii)	any four from:	allow "drag" for air resistance throughout condone "gravity" for weight throughout	4
		MP1. air resistance increases (greatly) when parachute is opened;	allow "upwards force" for air resistance	
		MP2. idea that air resistance is greater than weight;	allow upward force is bigger than downward force	
		MP3. (therefore) resultant force is upwards;	allow deceleration / upwards acceleration ignore "it slows down"	
		MP4. idea that as speed decreases, air resistance decreases;		
		MP5. resultant force (eventually) becomes zero;	allow forces are balanced/equal air resistance = weight	
		MP6. constant speed achieved;	allow idea that there is no acceleration	

(b)	attempted use of $v^2 = u^2 + (2 \times a \times s)$;	accept answers in terms of GPE lost = KE gained, whatever candidate chooses for mass can be implied from calculation reject if contradicted by another irrelevant formula and no further working seen	4
	correct substitution; rearrangement of formula / evaluation of v^2; evaluation of v; e.g. $v^2 = u^2 + (2 \times a \times s)$; $v^2 = 0.45^2 + (2 \times 3.4 \times 2.0)$; $v = \sqrt{(0.45^2 + (2 \times 3.4 \times 2.0))}$ OR $v^2 = 13.8$ (v =) 3.7 (m/s)	allow if 13.8 seen allow 3.72, 3.715...	

(c)	any one from:
	    MP1. Mars has a smaller mass;
	    MP2. Mars has a lower density;
	    MP3. Mars has a smaller (iron rich) core;
		allow RA
		allow Mars is less massive
			1

Q11.

Question number		Answer	Notes	Marks
(a)	(i)	circuit with symbols for ammeter, voltmeter, lamp, any power supply all correct;	variable power supplies or variable number of cells can be shown using labelled standard symbols	4
		voltmeter in parallel with lamp; ammeter in series with lamp;	if no lamp in circuit, allow ammeter drawn in series with power supply	
		correct means of varying voltage of lamp i.e. variable power supply/rheostat/potentiometer;	allow variable resistor in series with lamp	
		e.g.		
	(ii)	any four from: MP1. record ammeter and voltmeter reading;	allow 'measure voltage and current'	4
		MP2. repeat readings (for each voltage) and find average;	allow repeating experiment to find average	
		MP3. idea of changing the voltage / current;	allow described method that would change voltage or current e.g. adding more cells, changing circuit resistance etc.	
		MP4. plot a graph of voltage and current; MP5. switch off current/circuit between readings;	ignore "let lamp cool between readings"	

		Question number	Answer	Notes	Mark
(b)	(i)	ampere / amp / A / mA;	reject I	1
	(ii)	correctly evaluated energy; given to 2 significant figures;	DOP	2
		e.g. 162 (J) gets 1 mark 160 (J) gets 2 marks		
	(iii)	red or orange;		1

Q12.

Question number	Answer	Mark
(a)(i)	B	1

Question number	Answer	Mark
(a)(ii)	A	1

Question number	Answer	Mark
(a)(iii)	A	1

Question number	Answer	Mark
(a)(iv)	A	1

Question number	Answer	Additional guidance	Mark
(b)	Any two suitable reasons: e.g. • stars are made mostly of hydrogen (1) • helium is formed during fusion (1) • carbon is formed during fusion (1) • hydrogen formed after Big Bang (1)	do not allow both helium from fusion and carbon from fusion allow helium formed after Big Bang	2

Question number	Answer	Additional guidance	Mark
(c)(i)	• Determination of λ_0 AND λ (1) • Determination of $\Delta\lambda$ (1) e.g. 760 nm, 655 nm $\Delta\lambda = 105$ (nm)	allow ± 5 nm	2

Question number	Answer	Additional guidance	Mark
(c)(ii)	Rearrangement of equation $v = \frac{\Delta\lambda}{\lambda_0} \times c$ (1) substitution with correct power for c $v = \frac{3 \times 10^5 \times 105}{655}$ (1) evaluation 4.8×10^4 (km/s) (1)	allow ecf from (c)(i) if the answer is given in m/s, check that the power is 10^7 award full marks for correct numerical answer without working	3

Question number	Answer	Additional guidance	Mark
(d)	An explanation that makes reference to the following three points: • RHS shows red shift (1) • LHS shows blue shift (1) • the galaxy is spinning (1)	RHS moving away from the astronomer LHS moving towards the astronomer	3

(Total for question = 14 marks)