

GCE

Physics A

Advanced GCE **2825/01**

Cosmology

Mark Scheme for June 2010

OCR (Oxford Cambridge and RSA) is a leading UK awarding body, providing a wide range of qualifications to meet the needs of pupils of all ages and abilities. OCR qualifications include AS/A Levels, Diplomas, GCSEs, OCR Nationals, Functional Skills, Key Skills, Entry Level qualifications, NVQs and vocational qualifications in areas such as IT, business, languages, teaching/training, administration and secretarial skills.

It is also responsible for developing new specifications to meet national requirements and the needs of students and teachers. OCR is a not-for-profit organisation; any surplus made is invested back into the establishment to help towards the development of qualifications and support which keep pace with the changing needs of today's society.

This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by Examiners. It does not indicate the details of the discussions which took place at an Examiners' meeting before marking commenced.

All Examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the Report on the Examination.

OCR will not enter into any discussion or correspondence in connection with this mark scheme.

© OCR 2010

Any enquiries about publications should be addressed to:

OCR Publications
PO Box 5050
Annesley
NOTTINGHAM
NG15 0DL

Telephone: 0870 770 6622
Facsimile: 01223 552610
E-mail: publications@ocr.org.uk

1.	a.i	1. Moons <u>orbiting</u> Jupiter	1
		2. Craters/mountains on (Earth's) moon	1
	a.ii	Moon not perfect sphere/imperfections/ mountains observed (do not award mark for mountains twice)	1
		Earth not centre of all orbits/ confirmed heliocentric theory	1
	b	Position/ velocity (of Uranus) not that predicted/ perturbations	1
		Another force acting (on Uranus) owtte	1
		Existence of another planet/ Neptune predicted	1
	c	$10^9 - 10^{10}$	1
		$10^{-6} - 10^{-5}$	1
		$10^{-9} - 10^{-8}$	1
Total			10

2.	a.i	$F = GMm/r^2$ <u>with labels</u> , or correct statement in words	1
	a.ii	finite universe contracts/ resultant force on stars	1
	b.i	$r_1^3 / T_1^2 = r_2^3 / T_2^2 \quad / \quad T^2 \propto r^3$	1
		$T_1^2 = T_2^2 \times (r_1^3 / r_2^3)$	1
		Size of period increases more in proportion to radius	1
	b.ii	accept calculation for either satellite.	
		<div style="display: flex; justify-content: space-between;"> <div> Satellite X $r_2^3 = 8430^3 \times 48.1^2 / 2.15^2$ $r_2 = 66900 \text{ km}$ </div> <div> satellite Y $r_2^3 = 21900^3 \times 48.1^2 / 2.15^2$ $r_2 = 66900 \text{ km}$ </div> </div>	1
			1

Total: 7

- | | | | |
|----|----|--|---|
| 3. | a. | uniform intensity detected in all directions/ isotropic/
black body spectrum at 2.7K (3K) | 1 |
| | b. | Hydrogen and helium in early stars and Sun | 1 |
| | | Sun has greater proportion of helium than early stars/
H changed to He by fusion in Sun | 1 |
| | | Virtually no higher elements in first stars ora (accept
specific examples up to iron) | 1 |
| | c. | Combination of (spectral) lines unique to element | 1 |
| | | Any 3 from: | |
| | | <u>Dark</u> lines | 1 |
| | | (Crossing) continuous spectrum | 1 |
| | | Absorption occurs in stellar atmosphere | 1 |
| | | Only get information about atmosphere | 1 |
| | | Measurement of wavelength | 1 |
| | | Identification by comparison with known spectra | 1 |
| | | | 3 |

Total: 8

4. a. $v \propto r$ / $v = H_0 \times r$ 1

Any 4 from

- b.i infinite universe 1
 static universe 1
 uniformly populated with stars/ cosmological principle 1
 all lines of sight end on a star 1
 night sky should be bright / not dark 1
4

- b.ii **either**
 Hubble's law implies universe is expanding 1
 Wavelength of light stretched by expansion/ red shift 1
 light from distant galaxies red-shifted from visible to IR 1

or
 Hubble implies universe started at particular time 1

 finite age of universe/ $\text{age} = 1/H_0$ 1
 light from distant stars not had time to reach Earth/ finite number of stars 1
3

Total: 8

5.	a.	brightness of object <u>seen from Earth</u>	1
		brightness of object <u>seen from 10pc</u>	1
	b.i	1 st column correct 3530; 60500	1
		2 nd column correct 1.02; 2.51; 3.55; 4.78	1
	b.ii	plot points correctly	2
	b.iii	best straight line	1
	b.iv	b = 4.8 from intercept on M axis	1
		correct calculation of gradient	1
		a = - 2.5	1
	c.	Any 3 from	
		Sun becomes <u>red giant</u>	1
		<u>Surface</u> area increases	1
		Temperature decreases	1
		Absolute magnitude increases negatively	1
			3

Total: 13

- | | | | |
|----|------|---|----------|
| 6. | a. | Any 5 from | |
| | | <u>very</u> high temperature | 1 |
| | | leptons/quarks/electrons/positrons/neutrinos formed | 1 |
| | | temperature decreases/ inflation | 1 |
| | | strong nuclear force takes effect/ forces freeze out | 1 |
| | | protons/neutrons/pions formed | 1 |
| | | matter and antimatter formed/annihilation/ excess matter over antimatter | 1 |
| | | synthesis of helium <u>nuclei</u> | 1 |
| | | <u>hydrogen</u> atoms form | 1 |
| | | 25% mass is helium | 1 |
| | | gamma radiation/ recombination/ universe becomes transparent | 1 |
| | | | 5 |
| | b. | isotropic: appears the same in every direction | 1 |
| | | homogeneous: (on a large scale) the same number of galaxies in any given volume | 1 |
| | c.i | volume = mass/ density = $2 \times 10^{30} / 3.8 \times 10^{23}$ | 1 |
| | | volume = $5.3 \times 10^6 \text{ pc}^3$ | 1 |
| | c.ii | density less than critical density | 1 |
| | | open universe/ universe expands forever | 1 |
| | | density greater than critical density | 1 |
| | | universe collapses back/ closed universe | 1 |
| | | universe expands to limit/ flat universe if density = critical density | 1 |

Total: 14

7.	a.	acceleration and gravitational fields are indistinguishable	1 1
	b.	Any 5 from	
		Rocket, light and observer	1
		Rocket <u>accelerates</u>	1
		Time between flashes measured	1
		Frequency decreases for rear lamp	1
		Principle of equivalence	1
		Rate of clocks is less in gravitational fields	1
			5
	c.i	orbit rotates	1
		Sun remains at focus	1
	c.ii	gravitational field from Sun is greatest for Mercury	1
			Total: 10

8

- (a) $mg\Delta h$ / gravitational potential energy / of upper carriage decreases / is converted
 into.....B1
 gravitational energy of lower carriage.....B1
 and E_k of carriage(s).....B1
 allow for the third mark ref. to heat in brakes / work done against friction
- (b) $T_1 = mg \sin\theta$
 $T_1 = 10000 \times 9.81 \times 150 / 260$ or $10000 \times 9.81 \times \sin 35$B1
 $T_1 = 5.7 \times 10^4 \text{ N}$ or 5.66, 5.63, $5.62 \times 10^4 \text{ N}$ B1
- (c)(i) $m = F/a$, $8.7 \times 10^3 / 1.5$ C1
 $= 5.8 \times 10^3 \text{ kg}$C1
 $m = 10000 - 5800 = 4200 \text{ kg}$ C1
 $V = m / \rho$
 $V = 4.2 \times 10^3 / 1000 = 4.2 \text{ m}^3$ A1
- (ii) $t = (v-u) / a$
 $t = 6.6 / 1.5$ C1
 $t = 4.4 \text{ s}$ A1
- (iii) $s = ut + 0.5 \times a \times t^2$
 $= 0 + 0.5 \times 1.5 \times 4.4^2$ C1
 $= 14.5 \text{ m}$ or 15 mA1
- (d) (i) $3800 \times 9.81 \times 150 = \text{change in gpe}$B1
 $= 5.6$ or 5.59 MJ B1
- (ii) $E = m c \Delta T$C1
 $5.5 \times 10^6 = 6 \times 25 \times 470 \times \Delta T$ C1
 $\Delta T = 78 \text{ K}$ allow 79 K if 5.6 MJ usedA1
- (iii) some thermal energy is lost to the surroundings / brakes lose heat.....B1
 sensible explanation,B1
 e.g. mechanism e.g. radiation, by which energy is transferred or
 to where the thermal energy might also be transferred e.g. cable or pulley

Total: 20

OCR (Oxford Cambridge and RSA Examinations)
1 Hills Road
Cambridge
CB1 2EU

OCR Customer Contact Centre

14 – 19 Qualifications (General)

Telephone: 01223 553998

Facsimile: 01223 552627

Email: general.qualifications@ocr.org.uk

www.ocr.org.uk

For staff training purposes and as part of our quality assurance programme your call may be recorded or monitored

Oxford Cambridge and RSA Examinations
is a Company Limited by Guarantee
Registered in England
Registered Office; 1 Hills Road, Cambridge, CB1 2EU
Registered Company Number: 3484466
OCR is an exempt Charity

OCR (Oxford Cambridge and RSA Examinations)
Head office
Telephone: 01223 552552
Facsimile: 01223 552553

© OCR 2010

