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# Mark Scheme
# Summer 2007

GCE

## GCE Physics (6734/01)

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## 6734 Unit Test PHY4 June 2007 Mark scheme Standardisation

**1.** Word equations

[Spelling must be correct, but ignore missing apostrophes.
Accept upper case or lower case throughout.]

| | | |
|---|---|---|
| Wavelength / wave length | 1 | |
| Area / surface area<br>[Don't accept "unit area"] | 1 | |
| Hubble constant / Hubble's constant | 1 | |
| Charge of electron / charge on electron / electron charge / electron's charge / electronic charge<br>[Accept "proton" for "electron" in any of the above] | 1 | 4 |
| | **Total** | **4** |

**2 a** Experiment

[Marks may be earned on diagram or in text]

| | | |
|---|---|---|
| Named light source plus polaroid (OR polariser OR polarising filter) / Laser / Named light source and suitable reflector (e.g. bench) | 1 | |
| 2nd Polaroid plus means to detect the transmitted light (i.e. eye OR screen OR LDR OR light detector OR instruction to e.g. look through polaroids) | 1 | |
| Rotate one Polaroid [Only award if expt would work] | 1 | |
| Detected intensity varies / No light when polaroids are at $90^0$ | 1 | |
| Maxima and minima $90^0$ apart / changes from dark to light every $90^0$<br>[Use of microwaves, slits or "blockers": 0/5<br>Use of filters or diffraction gratings: lose first two marks<br>Use of "sunglasses" to observe: lose mark 2] | 1 | 5 |

**b** Why sound can't be polarised

| | | |
|---|---|---|
| They are longitudinal / They are not transverse / Only transverse waves can be polarised / Longitudinal waves cannot be polarised / Because the * is parallel to the ** | 1 | 1 |
| * = vibration OR displacement OR oscillation OR motion of particles | | |
| ** = direction of travel OR direction of propagation OR motion of the wave OR direction of energy transfer | | |
| | **Total** | **6** |

| | | | | | |
|---|---|---|---|---|---|
| 3 | a | Table | | | |
| | | [Ignore crosses. If more than one tick in a line, no mark.] | | | |
| | | Top line: To the left | | 1 | |
| | | Bottom line: Downwards | | 1 | 2 |
| | b | Calculation of rotation period | | | |
| | | Use of $T = 2\pi r/v$ or $T = 2\pi/\omega$ and $\omega = v/r$ | | 1 | |
| | | Correct answer [0.084 s] | | 1 | 2 |
| | | e.g. | | | |
| | | $2\pi$ (0.28 m)/(21 m $s^{-1}$)<br>= 0.084 s | | | |
| | c i | How the angular speed is affected | | | |
| | | $\omega$ is increased, plus correct supporting argument in formula or words<br>i.e. Since $v = r\omega$ / $T$ decreases / $f$ increases / wheel must turn faster | | 1 | 1 |
| | c ii | Speedometer reading | | | |
| | | Speedometer reading is too high because frequency (OR $\omega$ OR revs per second OR rate of rotation of wheel) is increased<br>[Allow ecf from "$\omega$ decreased" in c (i)] | | 1 | 1 |
| | | | | **Total** | **6** |
| 4 | a i | Table | | | |
| | | $\lambda$ $f$<br>2.4 (110)<br>1.2 220<br>0.8 330 | | | |
| | | All wavelengths correct | | 2 | |
| | | [One or two wavelengths correct gets 1] | | | |
| | | Both frequencies correct | | 1 | 3 |
| | | [Accept extra zero following wavelength figure, e.g. 2.40. Accept units written into table, e.g. "2.4 m", "220 Hz"] | | | |
| | a ii | Why nodes | | | |
| | | String cannot move / no displacement / zero amplitude / no oscillation / phase change of $\pi$ on reflection / two waves cancel out / two waves are exactly out of phase (OR have phase difference of $\pi$ OR half a cycle) / destructive interference | | 1 | 1 |
| | b i | Momentum of electron | | | |
| | | Use of $\lambda = h/p$ or $\lambda = h/mv$ | | 1 | |
| | | Correct answer [6.63 x $10^{-24}$ kg m $s^{-1}$] | | 1 | 2 |

e.g.

$(6.63 \times 10^{-34}\ J\ s)/(1.0 \times 10^{-10}\ m)$
$= 6.63 \times 10^{-24}\ kg\ m\ s^{-1}$
[Accept any correct unit e.g. N s , J s $m^{-1}$]

b ii Why waves with more nodes represent higher energies

| | | |
|---|---|---|
| More nodes means shorter wavelength | 1 | |
| Momentum will be larger | 1 | 2 |
| [ OR Allow 1 mark for "More nodes means higher frequency and $E = hf$ "] | | |

**Total 8**

5 a Diagram

| | | |
|---|---|---|
| At least 3 crests drawn, with correct even spacing [Judge by eye. Allow +/- 20 %. Check in centre of pattern.] | 1 | |
| Crests approximately straight opposite harbour entrance and curved in the "shadow" region | 1 | |
| Wavefronts get longer, but diffraction at the edges through no more than $45^0$ | 1 | 3 |

b i Values from graph

| | | |
|---|---|---|
| Period: 3.0 [Accept 3] | 1 | 1 |
| Maximum acceleration: 1.2 [Accept 1.17, 1.18, 1.19, 1.20] | | |
| [Both values are needed for the mark. Ignore written units, e.g. "3.0 s", "1.2 m $s^{-2}$".] | | |

b ii Calculation of amplitude

| | | |
|---|---|---|
| Use of acceleration = $(-)(2\pi f)^2 x$ | 1 | |
| Use of $f = 1/T$ | 1 | |
| Correct answer [0.27 m] | 1 | 3 |
| [Negative amplitude loses third mark] | | |

e.g.

$\omega = 2\pi / (3.0\ s)$
$= 2.09\ rad\ s^{-1}$
$A = (1.2\ m\ s^{-2}) / (2.09\ rad\ s^{-1})^2$
$= 0.27\ m$

b iii Displacement graph

| | | |
|---|---|---|
| Cosine curve [Correct way up] | 1 | |
| Axis labelled ( i.e. displacement / $x$ / $y$ / $z$) plus all amplitudes consistent with previous answer ( i.e. | 1 | |

| | | | | |
|---|---|---|---|---|
| | | within 1 square) plus unit<br>2 cycles shown with $T$ = 3 s<br>[All zero crossings correct within 1 square] | 1 | 3 |
| | | | **Total** | **10** |
| 6 | a i | Fringe width | | |
| | | 1.24 mm<br>[Accept 49.6 mm / 39 giving 1.27 mm] | 1 | 1 |
| | a ii | Wavelength calculation | | |
| | | Use of $\lambda = xs/D$<br>Correct answer [520 nm]<br>[Accept 530 nm if 39 fringes used] | 1<br>1 | 2 |
| | | e.g.<br><br>$(1.24 \times 10^{-3}\ m)(0.50 \times 10^{-3}\ m)/(1.2\ m)$<br>$= 5.2 \times 10^{-7}\ m$ | | |
| | b | Effect on gradient | | |
| | | [Ignore crosses. If more than one tick in a line, no mark for that line.]<br>Top line: Decreases<br>Bottom line: Decreases | 1<br>1 | 2 |
| | c i | Meaning of coherence | | |
| | | Constant (OR fixed) phase relationship (OR phase difference) / Remain in phase<br>[Don't accept just "phase locked"] | 1 | 1 |
| | c ii | Why no interference with incoherent sources | | |
| | | Phase difference is changing<br>Type of interference at a point changes / Interference pattern moves (OR is unstable)<br>Change (OR motion) is too fast for us to observe | 1<br>1<br>1 | Max 2 |
| | | | **Total** | **8** |
| 7 | a | Why statement correct | | |
| | | Blue photon has more energy than red photon | 1 | |
| | | Why statement incorrect | | |
| | | Blue beam carries less energy per unit area per second / Blue beam carries less energy per second / Blue beam carries less energy per unit area / Blue beam has lower intensity and intensity = energy per unit area per second | 1 | |

| | | | | |
|---|---|---|---|---|
| | | Additional explanation | | |
| | | [Under "correct"] Blue has a higher frequency (OR shorter wavelength) /<br>[Under "incorrect"] Blue beam has fewer photons | 1 | 3 |
| | | [Allow reverse statements about Red throughout part a] | | |
| | b i | Meaning of work function | | |
| | | Energy to remove an electron from the surface (OR metal OR substance)<br>[Don't accept "from the atom". Don't accept "electrons".] | 1 | |
| | | Minimum energy... / Least energy... / Energy to just ... / ...without giving the electron any kinetic energy | 1 | 2 |
| | b ii | Calculation of threshold frequency | | |
| | | Use of $\varphi = hf_0$ | 1 | |
| | | Correct answer [$6.00 \times 10^{14}$ Hz] | 1 | 2 |
| | | e.g. | | |
| | | $(3.98 \times 10^{-19}$ J$)/(6.63 \times 10^{-34}$ J s)<br>$= 6.00 \times 10^{14}$ Hz | | |
| | | | **Total** | 7 |
| **8** | a | Which transition | | |
| | | Use of $(\Delta)E = hc/\lambda$ OR $(\Delta)E = hf$ and $f = c/\lambda$ | 1 | |
| | | Use of $1.6 \times 10^{-19}$ | 1 | |
| | | Correct answer [1.9 eV] | 1 | |
| | | C to B / -1.5 to - 3.4 | 1 | 4 |
| | | [Accept reverse calculations to find wavelengths] | | |
| | | e.g. | | |
| | | $(6.63 \times 10^{-34}$ J s$)(3.00 \times 10^{8}$ m s$^{-1})/$<br>$(656 \times 10^{-9}$ m$)(1.6 \times 10^{-19}$ J eV$^{-1})$<br>$= 1.9$ eV | | |
| | b | Explanation of absorption line | | |
| | | QOWC | 1 | |
| | | Light of this wavelength is absorbed by hydrogen | 1 | |
| | | In the outer part of the Sun (OR Sun's atmosphere) | 1 | |

| | | | |
|---|---|---|---|
| | Absorbed radiation is reemitted in all directions | 1 | |
| | Transition from B to C (OR -3.4 to -1.5) | 1 | Max 4 |
| c i | Why galaxy receding | | |
| | Wavelength increased (OR stretched) / red shift / frequency decreased | 1 | |
| c ii | Calculation of speed | | |
| | Use of $v/c = \Delta\lambda/\lambda$ | 1 | |
| | Correct answer [$1.78 \times 10^7$ m s$^{-1}$] | 1 | 3 |
| | e.g. | | |
| | $(3.00 \times 10^8$ m s$^{-1})(695 \times 10^{-9}$ m - $656 \times 10^{-9}$ m)/ $(656 \times 10^{-9}$ m) = $1.78 \times 10^7$ m s$^{-1}$ [N.B. Use of wrong wavelength in denominator gives $1.68 \times 10^7$] | | |
| | OR | | |
| | Use of $v = f\lambda$ and $v/c = \Delta f/f$ | 1 | |
| | Correct answer [$1.67 \times 10^7$ m s$^{-1}$] | 1 | |
| | [Look for $(4.573 \times 10^{14}$ Hz - $4.317 \times 10^{14}$ Hz) / $(4.537 \times 10^{14}$ Hz) N.B. Use of wrong frequency in denominator gives $1.78 \times 10^7$] | | |
| | | **Total** | **11** |