Mark Scheme Paper 1 September/October 2008

1. (a) Same change of gravitational pe to ke on each track ✓
   So same speeds ✓

   (b) Track (i) has more time at a slow speed initially yet the same final speed, so average speed is less (owtte) ✓
   So (i) is longer time or (ii) is shorter time ✓

   (c) Speed would be the same as in (a) or mass makes no difference (ottwe) ✓
   So (i) is longer time / (ii) is shorter time (same as (b)) ✓

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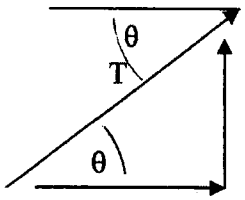
2. (a) $T_V = 2.00 \times 9.81 = 19.6$ N ✓

   $19.6 = T_{60} \times \sin(60^o)$
   $T_{60} = 22.6$ N ✓

   $mg = T_H \times \tan(60^o)$
   $T_H = 19.6 / \tan(60^o)$
   $= 11.3$ N ✓

   (b) Forces are vectors ✓
   and so must be added taking into account the directions / the forces are represented by arrows whose lengths are proportional to the magnitudes and the directions of the forces form
   a right angle triangle ✓

   (c)



$$T \sin\vartheta = \frac{1}{2} mass \times g$$

Factor half ✓
Eliminate T ✓

$$\frac{1}{2} m_{wire} g = T \sin\vartheta_{wire}$$

$$\frac{1}{2}(m_{wire} + m_{bird}) = T \sin\vartheta_{wire\ \&\ bird}$$

$$\frac{(m_{wire} + m_{bird})}{m_{wire}} = \frac{\sin\vartheta_{wire\ \&\ bird}}{\sin\vartheta_{wire}}$$

$m_{bird} = 0.8\ kg$ ✓

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3. (a) $Stress = \frac{Force}{Area} = \frac{0.5 \times 70 \times 9.81}{5.0 \times 10^{-4}}$ ✓

$= 7 \times 10^5 \text{ Nm}^{-2}$ ✓

(b) *ratio = 0.07* ecf ✓

(c) *mass of giant* $= 9^3$ ✓ x 70 (✓)

$= 5.1 \times 10^4$ kg ✓

(d) $stress = \frac{0.5 \times 5.1 \times 10^4 \times 9.81}{9^2 \times 5.0 \times 10^4}$ ecf

$= 6.2 \times 10^6 \text{ Nm}^{-2}$ ✓

ratio = 0.6 ecf ✓

(e) The ratio will be 1.2 and he will break his leg. owtte ✓

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4. (a) Simple sketch with peaks at bows of boat and one trough in the middle

Or peak in the middle and troughs at ends ✓

18 m ✓

(b) $c = 4.8 \text{ ms}^{-1}$ ✓

$f = c/\lambda$ ✓

$= 4.8(5)/18 = 0.27$ Hz ✓

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5. (a) $p = \frac{h}{\lambda} = \frac{6.6 \times 10^{-34}}{2 \times 10^{-15}}$ ✓

$= 3.3 \times 10^{19} \text{ kg ms}^{-1}$ (1 mark if no factor half) ✓

(b) $E = mc^2$

$= pc$

$E = 3.3 \times 10^{-19} \times 3 \times 10^8$

$= 9.9 \times 10^{-11}$ J ecf ✓

$E = \frac{9.9 \times 10^{-11}}{1.6 \times 10^{-19}} eV$ ecf ✓

$= 6.2 \times 10^8 \, eV$

(c) $I = 10^{-8}$ C/s

$N = 10^{-8} / 1.6 \times 10^{-19}$ ecf ✓

$= 6.3 \times 10^{10}$ electrons / second ✓

(d) Volume = $9 \times 10^{-6} \times 0.1 \times 10^{-2} = 9 \times 10^{-9}\ m^3$ ✓

Number of atoms or nuclei =

$$= 9\times10^{-9} \times 8900 \frac{kg}{m^3} \times 10^3 \frac{g}{kg} \times \frac{1}{63.5} \frac{mol}{g} \times 6.0\times10^{23} \frac{atoms}{mol}$$ ✓ allowed if only one mistake

$= 7.5 \times 10^{20}$ nuclei ecf ✓

(e) Area of nuclei = $7.5 \times 10^{20} \times \pi \times (10^{-15})^2$
$= 2.4 \times 10^{-9}\ m^2$ ecf ✓

ratio of nuclei area/beam area = $2.4 \times 10^{-9} / 9 \times 10^{6}$
$= 2.6 \times 10^{-4}$ ✓

(f) No of collisions / second = $2.6 \times 10^{-4} \times 6.3 \times 10^{10}$ ecf ✓
$= 1.7 \times 10^{7}$ ✓

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6. (a) $2\theta = 2 \times 1.2 \times 530 \times 10^{-9} / 10^{-2}$ ✓
$= 1.3 \times 10^{-4}$ radians

Diameter of circle on moon = 2θ x distance to moon
$= 1.3 \times 10^{-4} \times 4.0 \times 10^{8}$
$= 51$ km eccf ✓

Area of circle on the moon = πr^2
$= 2.0 \times 10^{9}\ m^2$ ecf ✓

(b) width = 2θ x *focal length* = $(2 \times 1.2\ \lambda/d)$ x *focal length*
$= 2 \times 1.2 \times 530 \times 10^{-9} \times 0.15/10^{-2}$
$= 1.9 \times 10^{-5}$ m ✓

Radius of spot = 0.85×10^{-5} m ecf ✓

Intensity = power/area of spot
$= 10/\pi \times (0.85 \times 10^{-5})^2$
$= 3.5 \times 10^{10}\ Wm^{-2}$ ecf ✓

(c) $\lambda = 3 \times 10^{9} / 1.5 \times 10^{9} = 0.2$ m ✓

$2\theta = 2 \times 1.2 \times 0.2 / 10$
$= 0.048$ radians ecf ✓

Radius of circle on earth = $0.5 \times 0.048 \times 44 \times 10^{6}$
$= 1.06 \times 10^{5}$ m ecf ✓

Area = $\pi r^2 = 3.5 \times 10^{12}\ m^2$ ecf ✓

[10]