

## FINAL MARK SCHEME 2821 FORCES AND MOTION

JANUARY 2006

Mark Scheme	Unit Code	Session	Year	Version
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<b>Question 1</b>	Expected Answers			Marks
<b>1</b>				
<b>(a)(i)</b>	speed = $d / t$ $= 24 / 55$ $= 0.436 \text{ (m s}^{-1}\text{)}$ allow 0.44 do not allow one sf			C1  A1
<b>(ii)</b>	kinetic energy = $\frac{1}{2} m v^2$ $= 0.5 \times 20 \times (0.436)^2$ $= 1.9 \text{ (J)}$ note ecf from (a)(i)			C1  A1
<b>(iii)</b>	potential energy = $mg h$ $= 20 \times 9.8 \times 4$ $= 784 \text{ (J)}$ penalise the use of $g = 10$			C1  A1
<b>(b)(i)</b>	power = energy / time or work done / time $= (15 \times 784) / 55$ note ecf from (a)(iii) $= 214 \text{ (W)}$			C1  A1
<b>(ii)</b>	needs to supply children with kinetic energy air resistance friction in the bearings of the rollers / belt total mass of children gives an average mass of greater than 20 kg			B1 B1 B1 B1 Max B2  Total: 10

Question 2	Expected Answers	Marks
2 (a)(i)	velocity = displacement / time or rate of change of displacement	B1
(ii)	acceleration = <u>change in</u> velocity / time or rate of <u>change of</u> velocity	B1
(b)(i) 1.	distance / displacement	B1
2.	acceleration	B1
(ii)	<u>use of</u> area of squares under the line  value for the distance in the range 0.45 to 0.55 (cm) (use of a triangle area scores 1/2 [0.40 cm]) (do not allow 1sf)	C1  A1
(iii)	acceleration is a maximum at A / decreases from A to 0.2 s  acceleration goes to zero at 0.2 s  acceleration is maximum at B / opposite direction at B / decelerates from 0.2 s to B / acceleration increases from 0.2 to B	B1  B1  B1 MAX 2
(v)	acceleration = $[(-)3.8 - (+ 3.6)] / 0.3$  $= 24.7 \text{ (cm s}^{-2}\text{)}$  allow 24 to 25 for 2 marks and 23 to 26 for one mark	C1  A1  Total: 10

Question 3	Expected Answers	Marks
3 (a)(i)	pressure = force / area	B1
(ii)	moment = force multiplied by the <u>perpendicular</u> distance (from the line of action of the force) to the <u>pivot</u>	B1
(b)(i)	force drawn vertically upwards at plunger	B1
	force drawn vertically at H	B1
(ii)	20 x 500 / force on Plunger x 120 (one correct moment stated)	B1
	Plunger force x 120 = (20 x 500)	B1
	Plunger force = 83(.3) (N)	A0
(c)(i)	pressure = force / area = 83 / 4 x 10 <sup>-3</sup>	C1
	= 20800 (Pa)	A1
(ii)	decrease area of plunger / decrease distance H to plunger / increase F / increase length of arm	B2 MAX 2
		Total: 10

Question 4	Expected Answers	Marks
4 (a) (i) 1	mass = $360 / 9.8$ 36.7 (kg) (allow 2sf)	B1
2	density = mass / volume  = $36.7 / 4.7 \times 10^{-3}$  = $7.8 \times 10^3$ unit $\text{kg m}^{-3}$	C1   A1 B1
(a)(ii)	right angled triangle with an additional correct angle marked  set of correct force labels and correct arrows  algebra shown or scale given  tension = 270 (N) or value in the range 255 to 285 (N)	M1  A1  C1  A1
(b)(i)	tension is a vector / has magnitude and direction  direction involved in addition / the tensions or ropes act in different directions	B1  B1
(ii)	sum = $270 \sin 37 + 360 \sin 53$  = $162.5 + 287.5$ (or one mark each for values of 162.5 and 287.5 seen)  = 450 (N)	B1  B1   A0 Total: 12

Question 5	Expected Answers	Marks
5		
(a)(i)	Stress = force / area force = stress x area $= 180 \times 10^6 \times 1.5 \times 10^{-4}$ $= 27000 \text{ (N)}$	C1  A1
(ii)	Y M = stress / strain $= 180 \times 10^6 / 1.2 \times 10^{-3}$ or using the gradient $= 1.5 \times 10^{11} \text{ N m}^{-2}$	C1 C1 A1
(b)	brittle elastic/ graph shown up to elastic limit obeys Hooke's law / force $\propto$ extension / stress $\propto$ strain no plastic region	B3 max 3
		Total: 8

Question 6	Expected Answers	Marks
<p><b>6</b>      <b>(a)</b></p>	<p>road surface / conditions  brake system  tyre surface / tread  speed of car  mass  gradient of road</p> <p>Explanation to include the affect on the acceleration / force  (and hence the braking distance)</p>	<p>MAX B2</p> <p>MAX B2</p>
<p><b>(b)</b></p>	<p>crumple zone</p> <p>seat belts</p> <p>airbag</p> <p>protective cell / side impact protection</p> <p>explanation to include increase in time / distance of stop  decreases force for crumple zone or airbag /  absorbing energy (safely) for crumple zone</p> <p>seat belt restrains /prevents collision with steering wheel /  windscreen</p>	<p>MAX B2</p> <p>MAX B2</p>
<p><b>QWC</b></p>	<p>SPAG (less than four errors)  use of technical language</p>	<p>B1  B1</p> <p>Total: 10</p>