OCR
RECOGNISING ACHIEVEMENT

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education

MATHEMATICS 4728

Mechanics 1

MARK SCHEME

Specimen Paper

MAXIMUM MARK	72

This mark scheme consists of 4 printed pages.

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1	$E - 400 = 6000 \times 2$	B1		For resultant force $E - 400$ stated or implied
		M1		For use of Newton II for the truck
		A1√		For the correct equation
	Hence $E = 1600$	A1	**4**	For correct answer 1600
			4	
2	*EITHER*: $R\cos\theta = 8 + 5\cos 30°$	M1		For attempt at resolving ‖ or ⊥ to 8 N force
		A1		For one completely correct equation
	$R\sin\theta = 5\sin 30°$	A1		For a second correct equation
	Hence $R^2 = (12.33...)^2 + 2.5^2$	M1		For correct method for either unknown
	$R = 12.6$	A1√		For correct value
	$\tan\theta = \dfrac{2.5}{12.33...}$	M1		For correct method for second unknown
	$\theta = 11.5$	A1√		For correct value
	OR: Triangle of forces has 5, 8, R and 150°	M1		For considering any triangle with 5, 8, R
		A1		For correct triangle drawn or used
	$R^2 = 8^2 + 5^2 - 2\times5\times8\times\cos 150°$	M1		For use of cosine formula attempted
		A1		For correct expression for R^2
	Hence $R = 12.6$	A1√		For correct value
	$\sin\theta = \dfrac{5\sin 150°}{12.58...} = 0.1987...$	M1		For use of sine formula with numerical R
	Hence $\theta = 11.5$	A1√	**7**	For correct value
			7	
3	**(i)** $0 = 28^2 - 2\times9.8\times h$	M1		For use of const acc formula(s) to find h
	Hence maximum height is 40 m	A1	**2**	For correct value 40
	(ii) $v^2 = 28^2 - 2\times9.8\times30$	M1		For use of const acc formula(s) to find v
		A1		For correct equation in v
	Hence speed is 14 m s^{-1}	A1	**3**	For correct value 14
	(iii) $10 = \frac{1}{2}\times9.8t^2$	M1		For use of const acc formula(s) to find t
		A1√		For correct equation in t
	Hence time is $\frac{10}{7} \approx 1.43$ s	A1	**3**	For correct value $\frac{10}{7}$ or equivalent
	(iv) Length of time is $2\times\frac{10}{7} = \frac{20}{7}$ s	M1		For doubling, or equiv longer method
		A1√	**2**	For correct value, i.e. double their **(iii)**
			10	
4	**(i)** Total distance is $3\times30 + 3\times30 + 3\times30 = 270$ m	M1		For any calculation of a rectangular area
		M1		For addition of three positive areas
		A1	**3**	For correct value 270
	(ii) Distance at $t = 50$ is $90 - 60 = 30$ m	M1		For correct use of signed areas
		A1		For correct value 30
	Distance at $t = 80$ is 60 m	A1	**3**	For correct value 60
	(iii) Child's speed is $\dfrac{30}{50} = 0.6$ m s^{-1}	B1√		For distance 30 m
		M1		For dividing by 50
		A1	**3**	For correct value 0.6
	(iv) Child walks $60 - 30 = 30$ m in next 30 s	B1√		For child's distance gone from $t = 50$ to 80
	Hence $30 = \frac{1}{2}(0.6 + v)\times30$	M1		For suitable use of $s = \frac{1}{2}(u+v)t$ or equiv
	i.e. child's speed is 1.4 m s^{-1}	A1	**3**	For correct value 1.4
			12	

5	**(i)**	$v = \int -\frac{1}{10}t \, \mathrm{d}t = -\frac{1}{20}t^2 + c$	M1	For integrating the acceleration formula
			A1	For $v = -\frac{1}{20}t^2$, with or without c
		$V = 0 + c$	M1	For using $v = V$ when $t = 0$ to find c
		Hence $v = V - \frac{1}{20}t^2$	A1 **4**	For correct equation for v in terms of t and V
	(ii)	$0 = V - \frac{10^2}{20} \Rightarrow V = 5$	M1	For use of given values to find V
			A1 **2**	For correct value 5
	(iii)	$s = \int (5 - \frac{1}{20}t^2) \, \mathrm{d}t = 5t - \frac{1}{60}t^3 + k$	M1	For any attempt to integrate velocity
			A1√	For correct integration (ignoring k)
		Hence displacement is $50 - \frac{1000}{60} = 33\frac{1}{3}$ m	M1	For evaluation of s when $t = 10$
			A1√ **4**	For correct value $33\frac{1}{3}$; allow omission of k
	(iv)	Returns to O when $0 = -\frac{1}{60}t^3 + 5t \Rightarrow t^2 = 300$	M1	For attempting non-zero root of $s = 0$
		When $t^2 = 300$, $v = -\frac{1}{20} \times 300 + 5$	M1	For consequent evaluation of v
		i.e. speed is 10 m s^{-1}	A1 **3**	For correct value 3 (allow negative here)
			13	
6	**(i)**	$0.3 \times 3.2 = 0.3 \times 0.8 + 0.4 \times b$	M1	For using conservation of momentum
			A1	For correct LHS
			A1	For correct RHS
		Hence $b = 1.8$ so B's speed is 1.8 m s^{-1}	A1 **4**	For correct value 1.8 correctly obtained
	(ii)	$0.4 \times 1.8 - 3.2m = -0.4 \times 3.1 - 0.4m$	M1	For momentum equn with at least one relevant negative sign
			A1	For correct LHS
			A1	For correct RHS
		Hence $m = 0.7$	A1 **4**	For correct value 0.4 correctly obtained
	(iii)	$0.4 \times 3.1 > 0.3 \times 0.8$, so net momentum of A and B is towards the left and therefore they can't both move towards the right after the impact	B1 **1**	For correctly explained application of momentum conservation.
	(iv)	Total momentum of all three particles is leftwards	M1	For reasoning based on the total momentum
		Hence A ends up moving left, as if it moves right after all collisions so do B and C	A1	For correct conclusion regarding direction
		Total momentum left is at most $1.4a$	M1	For use of the idea that $a \geqslant b \geqslant c$
		Hence $1.4a \geqslant 0.7 \times 3.2 - 0.3 \times 3.2$, so the speed of A is at least 0.914 m s^{-1}	A1 **4**	For correct conclusion
			13	

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7	**(i)**	Acceleration is $\frac{0.8}{10} = 0.08$ m s^{-2}	B1		For $0.8 \div 10$ stated or implied
		$R = 25g\cos 30°$	B1		For correct resolving $\perp$ plane
		$T - 25g\sin 30° - 0.2 \times 25g\cos 30° = 25 \times 0.08$	M1		For attempting Newton II $\parallel$ plane
			B1		For upwards force $T - 25g\sin 30° - F$
			B1√		For $F = 0.2 \times 25g\cos 30°$
		Hence the tension is 167 N	A1	**6**	For correct value 167
	(ii)	$R' = P\sin 30° + 175g\cos 30°$	M1		For resolving $\perp$ plane, with 3 forces
			A1		For correct equation
		$P\cos 30° + 0.2R' = 175g\sin 30°$	M1		For resolving $\parallel$ plane, with 3 forces
			A1		For correct equation
		$P(\cos 30° + 0.2\sin 30°) = 175g(\sin 30° - 0.2\cos 30°)$	M1		For attempting elimination of R'
		Hence $P = \frac{175g(\sin 30° - 0.2\cos 30°)}{\cos 30° + 0.2\sin 30°} = 580$	M1		For solving a relevant equation for P
			A1	**7**	For correct value 580
				13	