

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
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This mark scheme consists of 4 printed pages.

<p>1 $E - 400 = 6000 \times 2$</p> <p>Hence $E = 1600$</p>	<p>B1 M1 A1✓ A1</p> <p style="text-align: right;">4 4</p>	<p>For resultant force $E - 400$ stated or implied For use of Newton II for the truck For the correct equation For correct answer 1600</p>
<p>2 EITHER: $R \cos \theta = 8 + 5 \cos 30^\circ$</p> <p>$R \sin \theta = 5 \sin 30^\circ$ Hence $R^2 = (12.33\dots)^2 + 2.5^2$ $R = 12.6$ $\tan \theta = \frac{2.5}{12.33\dots}$ $\theta = 11.5$</p> <p>OR: Triangle of forces has 5, 8, R and 150°</p> <p>$R^2 = 8^2 + 5^2 - 2 \times 5 \times 8 \times \cos 150^\circ$</p> <p>Hence $R = 12.6$ $\sin \theta = \frac{5 \sin 150^\circ}{12.58\dots} = 0.1987\dots$ Hence $\theta = 11.5$</p>	<p>M1 A1 A1 M1 A1✓ M1 A1✓ M1 A1 A1 M1 A1✓ M1 A1✓</p> <p style="text-align: right;">7 7</p>	<p>For attempt at resolving \parallel or \perp to 8 N force For one completely correct equation For a second correct equation For correct method for either unknown For correct value For correct method for second unknown For correct value For considering any triangle with 5, 8, R For correct triangle drawn or used For use of cosine formula attempted For correct expression for R^2 For correct value For use of sine formula with numerical R For correct value</p>
<p>3 (i) $0 = 28^2 - 2 \times 9.8 \times h$ Hence maximum height is 40 m</p> <hr/> <p>(ii) $v^2 = 28^2 - 2 \times 9.8 \times 30$ Hence speed is 14 m s^{-1}</p> <hr/> <p>(iii) $10 = \frac{1}{2} \times 9.8 t^2$ Hence time is $\frac{10}{7} \approx 1.43 \text{ s}$</p> <hr/> <p>(iv) Length of time is $2 \times \frac{10}{7} = \frac{20}{7} \text{ s}$</p>	<p>M1 A1</p> <p style="text-align: right;">2</p> <p>M1 A1 A1</p> <p style="text-align: right;">3</p> <p>M1 A1✓ A1</p> <p style="text-align: right;">3</p> <p>M1 A1✓</p> <p style="text-align: right;">2 10</p>	<p>For use of const acc formula(s) to find h For correct value 40</p> <p>For use of const acc formula(s) to find v For correct equation in v For correct value 14</p> <p>For use of const acc formula(s) to find t For correct equation in t For correct value $\frac{10}{7}$ or equivalent</p> <p>For doubling, or equiv longer method For correct value, i.e. double their (iii)</p>
<p>4 (i) Total distance is $3 \times 30 + 3 \times 30 + 3 \times 30 = 270 \text{ m}$</p> <hr/> <p>(ii) Distance at $t = 50$ is $90 - 60 = 30 \text{ m}$ Distance at $t = 80$ is 60 m</p> <hr/> <p>(iii) Child's speed is $\frac{30}{50} = 0.6 \text{ m s}^{-1}$</p> <hr/> <p>(iv) Child walks $60 - 30 = 30 \text{ m}$ in next 30 s Hence $30 = \frac{1}{2}(0.6 + v) \times 30$ i.e. child's speed is 1.4 m s^{-1}</p>	<p>M1 M1 A1</p> <p style="text-align: right;">3</p> <p>M1 A1 A1</p> <p style="text-align: right;">3</p> <p>B1✓ M1 A1</p> <p style="text-align: right;">3</p> <p>B1✓ M1 A1</p> <p style="text-align: right;">3 12</p>	<p>For any calculation of a rectangular area For addition of three positive areas For correct value 270</p> <p>For correct use of signed areas For correct value 30 For correct value 60</p> <p>For distance 30 m For dividing by 50 For correct value 0.6</p> <p>For child's distance gone from $t = 50$ to 80 For suitable use of $s = \frac{1}{2}(u + v)t$ or equiv For correct value 1.4</p>

<p>5 (i) $v = \int -\frac{1}{10}t \, dt = -\frac{1}{20}t^2 + c$</p> <p>$V = 0 + c$ Hence $v = V - \frac{1}{20}t^2$</p>	<p>M1 A1 M1 A1</p>	<p>For integrating the acceleration formula For $v = -\frac{1}{20}t^2$, with or without c For using $v = V$ when $t = 0$ to find c 4 For correct equation for v in terms of t and V</p>
<p>(ii) $0 = V - \frac{10^2}{20} \Rightarrow V = 5$</p>	<p>M1 A1</p>	<p>For use of given values to find V 2 For correct value 5</p>
<p>(iii) $s = \int (5 - \frac{1}{20}t^2) \, dt = 5t - \frac{1}{60}t^3 + k$</p> <p>Hence displacement is $50 - \frac{1000}{60} = 33\frac{1}{3}$ m</p>	<p>M1 A1✓ M1 A1✓</p>	<p>For any attempt to integrate velocity For correct integration (ignoring k) For evaluation of s when $t = 10$ 4 For correct value $33\frac{1}{3}$; allow omission of k</p>
<p>(iv) Returns to O when $0 = -\frac{1}{60}t^3 + 5t \Rightarrow t^2 = 300$ When $t^2 = 300$, $v = -\frac{1}{20} \times 300 + 5$ i.e. speed is 10 m s^{-1}</p>	<p>M1 M1 A1</p>	<p>For attempting non-zero root of $s = 0$ For consequent evaluation of v 3 For correct value 3 (allow negative here)</p>
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<p>6 (i) $0.3 \times 3.2 = 0.3 \times 0.8 + 0.4 \times b$</p> <p>Hence $b = 1.8$ so B's speed is 1.8 m s^{-1}</p>	<p>M1 A1 A1 A1</p>	<p>For using conservation of momentum For correct LHS For correct RHS 4 For correct value 1.8 correctly obtained</p>
<p>(ii) $0.4 \times 1.8 - 3.2m = -0.4 \times 3.1 - 0.4m$</p> <p>Hence $m = 0.7$</p>	<p>M1 A1 A1 A1</p>	<p>For momentum equn with at least one relevant negative sign For correct LHS For correct RHS 4 For correct value 0.4 correctly obtained</p>
<p>(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</p>	<p>B1</p>	<p>1 For correctly explained application of momentum conservation.</p>
<p>(iv) Total momentum of all three particles is leftwards Hence A ends up moving left, as if it moves right after all collisions so do B and C Total momentum left is at most $1.4a$ Hence $1.4a \geq 0.7 \times 3.2 - 0.3 \times 3.2$, so the speed of A is at least 0.914 m s^{-1}</p>	<p>M1 A1 M1 A1</p>	<p>For reasoning based on the total momentum For correct conclusion regarding direction For use of the idea that $a \geq b \geq c$ 4 For correct conclusion</p>
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<p>7 (i) Acceleration is $\frac{0.8}{10} = 0.08 \text{ m s}^{-2}$ $R = 25g \cos 30^\circ$ $T - 25g \sin 30^\circ - 0.2 \times 25g \cos 30^\circ = 25 \times 0.08$</p> <hr/> <p>Hence the tension is 167 N</p>	<p>B1 B1 M1 B1 B1✓ A1</p>	<p>For $0.8 \div 10$ stated or implied For correct resolving \perp plane For attempting Newton II \parallel plane For upwards force $T - 25g \sin 30^\circ - F$ For $F = 0.2 \times 25g \cos 30^\circ$ 6 For correct value 167</p>
<p>(ii) $R' = P \sin 30^\circ + 175g \cos 30^\circ$</p> <p>$P \cos 30^\circ + 0.2R' = 175g \sin 30^\circ$</p> <p>$P(\cos 30^\circ + 0.2 \sin 30^\circ) = 175g(\sin 30^\circ - 0.2 \cos 30^\circ)$</p> <p>Hence $P = \frac{175g(\sin 30^\circ - 0.2 \cos 30^\circ)}{\cos 30^\circ + 0.2 \sin 30^\circ} = 580$</p>	<p>M1 A1 M1 A1 M1 M1 A1</p>	<p>For resolving \perp plane, with 3 forces For correct equation For resolving \parallel plane, with 3 forces For correct equation For attempting elimination of R' For solving a relevant equation for P 7 For correct value 580</p>
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