

4730 Mechanics 3

<p>1 (i)</p>	<p>For triangle sketched with sides $(0.5)2.5$ and $(0.5)6.3$ and angle θ correctly marked OR Changes of velocity in i and j directions $2.5\cos\theta - 6.3$ and $2.5\sin\theta$, respectively. For sides 0.5×2.5, 0.5×6.3 and 2.6 (or 2.5, 6.3 and 5.2) OR $-2.6\cos\alpha = 0.5(2.5\cos\theta - 6.3)$ and $2.6\sin\alpha = 0.5(2.5\sin\theta)$ $[5.2^2 = 2.5^2 + 6.3^2 - 2 \times 2.5 \times 6.3 \cos\theta$ OR $2.6^2 = 0.5^2\{(2.5\cos\theta - 6.3)^2 + (2.5\sin\theta)^2\}$ $\cos\theta = 0.6$</p>	<p>B1 B1ft M1 A1 AG [4]</p>	<p>May be implied in subsequent working. May be implied in subsequent working. For using cosine rule in triangle or eliminating α. AG</p>
<p>(ii)</p>	<p>$\sin\alpha = 2.5 \times 0.8 / 5.2$ OR $-2.6\cos\alpha = 0.5(2.5 \times 0.6 - 6.3)$ Impulse makes angle of 157° or 2.75° with original direction of motion of P.</p>	<p>M1 A1 M1 A1 [4]</p>	<p>For appropriate use of the sine rule or substituting for θ in one of the above equations in θ and α For evaluating $(180 - \alpha)^\circ$ or $(\pi - \alpha)^\circ$ SR (relating to previous 2 marks; max 1 mark out of 2) $\alpha = 23^\circ$ or 0.395° B1</p>

<p>2 (i)</p>	<p>$[70 \times 2 = 4X - 4Y]$ $X - Y = 35$</p>	<p>M1 A1 [2]</p>	<p>For taking moments about A for AB (3 terms needed)</p>
<p>(ii)</p>	<p>$[110 \times 3 = -4X + 6Y]$ $2X - 3Y + 165 = 0$</p>	<p>M1 A1 [2]</p>	<p>For taking moments about C for BC (3 terms needed) AG</p>
<p>(iii)</p>	<p>$X = 270, Y = 235$ Magnitude is 358N</p>	<p>M1 A1ft M1 A1ft [4]</p>	<p>For attempting to solve for X and Y ft any (X, Y) satisfying the equation given in (ii) For using magnitude = $\sqrt{X^2 + Y^2}$ ft depends on all 4 Ms</p>

<p>5</p>	<p>Initial i components of velocity for A and B are 4ms^{-1} and 3ms^{-1} respectively.</p> <p>$3x4 + 4x3 = 3a + 4b$</p> <p>$0.75(4 - 3) = b - a$</p> <p>$a = 3$</p> <p>Final j component of velocity for A is 3ms^{-1}</p> <p>Angle with l.o.c. is 45° or 135°</p>	<p>B1 M1 A1 M1 A1 M1 A1 B1 M1 A1ft [10]</p>	<p>May be implied. For using p.c.mmtm. parallel to l.o.c. For using NEL For attempting to find a Depends on all three M marks May be implied For using $\tan^{-1}(v_j/v_i)$ for A ft incorrect value of a ($\neq 0$) only</p>
			<p>SR for consistent sin/cos mix (max 8/10) $3x3 + 4x4 = 3a + 4b$ and $b - a = 0.75(3 - 4)$ M1 M1 as scheme and A1 for <i>both</i> equ's $a = 4$ M1 as scheme A1 j component for A is 4ms^{-1} B1 Angle $\tan^{-1}(4/4) = 45^\circ$ M1 as scheme A1</p>

<p>6(i)</p>	<p>Initial speed in medium is $\sqrt{2g \times 10} (= 14)$</p> <p>$[0.125\text{dv}/\text{dt} = 0.125g - 0.025v]$</p> <p>$\int \frac{5dv}{5g - v} = \int dt$</p> <p>$-5 \ln(5g - v) = t (+A)$</p> <p>$[-5 \ln 35 = A]$</p> <p>$t = 5 \ln\{35/(49 - v)\}$</p> <p>$v = 49 - 35e^{-0.2t}$</p>	<p>B1 M1 M1 A1 M1 A1 M1 A1 [8]</p>	<p>For using Newton's second law with $a = \text{dv}/\text{dt}$ (3 terms required) For separating variables and attempt to integrate For using $v(0) = 14$ For method of transposition AG</p>
<p>(ii)</p>	<p>$x = 49t + 175e^{-0.2t} (+B)$</p> <p>$[x(3) = (49x3 + 175e^{-0.6}) - (0 + 175)]$</p> <p>Distance is 68.0m</p>	<p>M1 A1 M1 A1 [4]</p>	<p>For integrating to find $x(t)$ For using limits 0 to 3 or for using $x(0) = 0$ and evaluating $x(3)$</p>

<p>7(i)</p>	<p>Gain in EE = $20x^2/(2x2)$ Loss in GPE = $0.8g(2 + x)$ $[\frac{1}{2} 0.8v^2 = (15.68 + 7.84x) - 5x^2]$ $v^2 = 39.2 + 19.6x - 12.5x^2$</p>	<p>B1 B1 M1 A1 [4]</p>	<p>Accept $0.8gx$ if gain in KE is $\frac{1}{2} 0.8(v^2 - 19.6)$ For using the p.c.energy AG</p>
<p>(ii)</p>	<p>(a) Maximum extension is 2.72m</p> <p>(b) $[19.6 - 25x = 0,$ $v^2 = 46.8832 - 12.5(x - 0.784)^2]$ $x = 0.784$ or $c = 46.9$</p> <p>$[v_{\max}^2 = 39.2 + 15.3664 - 7.6832]$ Maximum speed is 6.85ms^{-1}</p> <p>(c) $\pm (0.8g - 20x/2) = 0.8a$ or $2v \text{ dv/dx} = 19.6 - 25x$ $a = \pm (9.8 - 12.5x)$ or $\ddot{y} = -12.5y$ where $y = x - 0.784$ $[a _{\max} = 9.8 - 12.5 \times 2.72]$ or $\ddot{y}_{\max} = -12.5(2.72 - 0.784)]$ Maximum magnitude is 24.2ms^{-2}</p>	<p>M1 A1 [2]</p> <p>M1 A1</p> <p>M1 A1 [4]</p> <p>M1 A1</p> <p>M1 A1 [5]</p>	<p>For attempting to solve $v^2 = 0$</p> <p>For solving $20x/2 = 0.8g$ or for differentiating and attempting to solve $d(v^2)/dx = 0$ or $dv/dx = 0$ or for expressing v^2 in the form $c - a(x - b)^2$.</p> <p>For substituting $x = 0.784$ in the expression for v^2 or for evaluating \sqrt{c}</p> <p>For using Newton's second law (3 terms required) or $a = v \text{ dv/dx}$</p> <p>For substituting $x = \text{ans(ii)(a)}$ into $a(x)$ or $y = \text{ans(ii)(a)} - 0.784$ into $\ddot{y}(y)$</p>