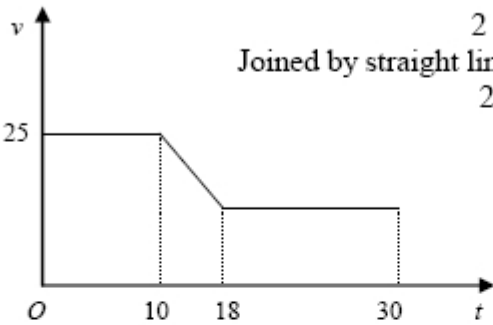
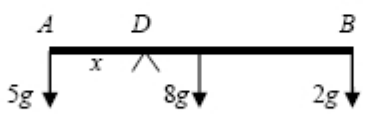


A level Applied Paper 3B Mechanics Practice Paper M7 **MARK SCHEME**

Question 1:

Question Number	Scheme	Marks
	<p>(a)</p>  <p>2 horizontal lines Joined by straight line sloping down 25, 10, 18, 30 oe</p> <p>(b)</p> $25 \times 10 + \frac{1}{2}(25 + V) \times 8 + 12 \times V = 526$ <p>Solving to $V = 11$</p> <p>(c)</p> $v = u + at \Rightarrow 11 = 25 - 8a$ $a = 1.75 \text{ (ms}^{-2}\text{)}$	<p>B1 B1 B1 (3)</p> <p>M1 A1 A1 DM1 A1 (5)</p> <p>M1 A1ft A1 (3)</p> <p>[11]</p>

Question 2:

Question Number	Scheme	Marks
	<p>(a) $M(C) \quad 8g \times (0.9 - 0.75) = mg(1.5 - 0.9)$ Solving to $m = 2$ *</p> <p>(b)</p>  <p>$M(D) \quad 5g \times x = 8g \times (0.75 - x) + 2g(1.5 - x)$ Solving to $x = 0.6$ ($AD = 0.6$ m)</p>	<p>cso</p> <p>M1 A1 DM1 A1 (4)</p> <p>M1 A2(1, 0) DM1 A1 (5) [9]</p>

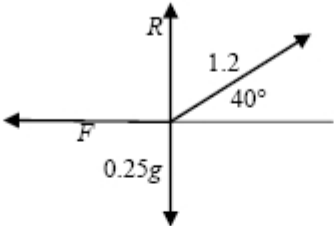
Question 3:

Question Number	Scheme	Marks
	<p>(a) $\mathbf{v} = \frac{8\mathbf{i} + 11\mathbf{j} - (3\mathbf{i} - 4\mathbf{j})}{2.5}$ or any equivalent $\mathbf{v} = 2\mathbf{i} + 6\mathbf{j}$</p> <p>(b) $\mathbf{b} = 3\mathbf{i} - 4\mathbf{j} + vt$ ft their \mathbf{v} $= 3\mathbf{i} - 4\mathbf{j} + (2\mathbf{i} + 6\mathbf{j})t$</p>	<p>M1 A1 A1 (3)</p> <p>M1 A1 ft A1cao (3)</p>

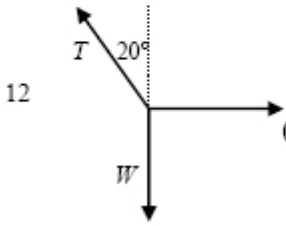
Question 4:

Question Number	Scheme	Marks
(a)	$\mathbf{a} = dv/dt = 6t\mathbf{i} - 4\mathbf{j}$	M1 A1
(b)	<p>Using $\mathbf{F} = \frac{1}{2}\mathbf{a}$, sub $t = 2$, finding modulus</p> <p>e.g. at $t = 2$, $\mathbf{a} = 12\mathbf{i} - 4\mathbf{j}$</p> <p style="text-align: right;">$\mathbf{F} = 6\mathbf{i} - 2\mathbf{j}$</p> <p style="text-align: right;">$\mathbf{F} = \sqrt{(6^2 + 2^2)} \approx \underline{6.32 \text{ N}}$</p>	<p>M1, M1, M1</p> <p>A1(CSO)</p>
	<p>M1 Clear attempt to differentiate. Condone i or j missing. A1 both terms correct (column vectors are OK)</p> <p>The 3 method marks can be tackled in any order, but for consistency on open grid please enter as:</p> <p>M1 $\mathbf{F} = m\mathbf{a}$ (their \mathbf{a}, (correct \mathbf{a} or following from (a)), not \mathbf{v}. $\mathbf{F} = \frac{1}{2}\mathbf{a}$). Condone \mathbf{a} not a vector for this mark.</p> <p>M1 subst $t = 2$ into candidate's vector \mathbf{F} or \mathbf{a} (\mathbf{a} correct or following from (a), not \mathbf{v}) M1 Modulus of candidate's \mathbf{F} or \mathbf{a} (not \mathbf{v}) A1 CSO All correct (beware fortuitous answers e.g. from $6t\mathbf{i} + 4\mathbf{j}$) Accept 6.3, awrt 6.32, any exact equivalent e.g. $2\sqrt{10}$, $\sqrt{40}$, $\frac{\sqrt{160}}{2}$</p>	

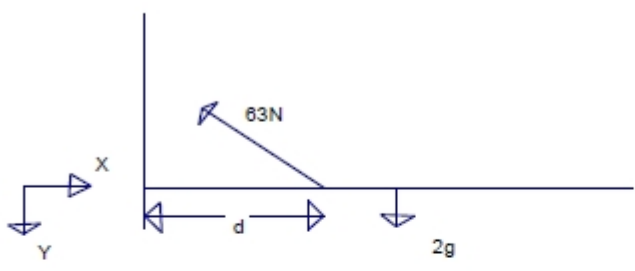
Question 5:

Question Number	Scheme	Marks
	<p>(a)</p>  <p> $\uparrow \pm R + 1.2 \sin 40^\circ = 0.25g$ Solving to $R = 1.7 \text{ (N)}$ </p> <p>(b)</p> <p> $\rightarrow F = 1.2 \cos 40^\circ (\approx 0.919)$ Use of $F = \mu R$ $1.2 \cos 40^\circ = \mu R$ $\mu \approx 0.55$ </p>	<p>M1 A1 DM1 A1 (4)</p> <p>M1 A1 B1 DM1 A1ft A1 cao (6)</p> <p>accept 1.68</p> <p>ft their R</p> <p>accept 0.548</p> <p>[10]</p>

Question 6:

Question Number	Scheme	Marks
	<p>(a)</p> <p> $\rightarrow T \sin 20^\circ = 12$ $T \approx 35.1 \text{ (N)}$ awrt 35 </p> <p>(b)</p> <p> $\uparrow W = T \cos 20^\circ$ $\approx 33.0 \text{ (N)}$ awrt 33 </p> 	<p>M1 A1 A1 (3)</p> <p>M1 A1 DM1 A1 (4)</p> <p>[7]</p>

Question 7:

Question Number	Scheme	Marks
(a)	 <p> $M(A) \quad 63 \sin 30 \cdot 14 = 2g \cdot d$ Solve: $d = 0.225\text{m}$ Hence $AB = \underline{45 \text{ cm}}$ </p>	M1 A1 A1 A1 (4)
(b)	<p> $R(\rightarrow) \quad X = 63 \cos 30 \ (\approx 54.56)$ $R(\uparrow) \quad Y = 63 \sin 30 - 2g \ (\approx 11.9)$ $R = \sqrt{X^2 + Y^2} \approx \underline{55.8, 55.9 \text{ or } 56 \text{ N}}$ </p>	B1 M1 A1 M1 A1 (5)

	<p>M1 Take moments about A. 2 recognisable force x distance terms involving 63 and 2(g).</p> <p>A1 63 N term correct</p> <p>A1 2g term correct.</p> <p>A1 $AB = 0.45(\text{m})$ or $45(\text{cm})$. No more than 2sf due to use of g.</p> <p>B1 Horizontal component (Correct expression – no need to evaluate)</p> <p>M1 Resolve vertically – 3 terms needed. Condone sign errors. Could have cos for sin.</p> <p>Alternatively, take moments about B : $0.225 \times 2g = 0.31 \times 63 \sin 30 + 0.45Y$ or C : $0.14Y = 0.085 \times 2g$</p> <p>A1 Correct expression (not necessarily evaluated) - direction of Y does not matter.</p> <p>M1 Correct use of Pythagoras</p> <p>A1 55.8(N), 55.9(N) or 56 (N)</p> <p>OR For X and Y expressed as $F \cos \theta$ and $F \sin \theta$.</p> <p>M1 Square and add the two equations, or find a value for $\tan \theta$, and substitute for $\sin \theta$ or $\cos \theta$</p> <p>A1 As above .</p> <p>N.B. Part (b) can be done before part (a). In this case, with the extra information about the resultant force at A, part (a) can be solved by taking moments about any one of several points. M1 in (a) is for a complete method - they must be able to substitute values for all their forces and distances apart from the value they are trying to find..</p>	
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Question 8:

Question Number	Scheme	Marks
(a)	$0 \leq t \leq 4: \quad a = 8 - 3t$ $a = 0 \Rightarrow t = 8/3 \text{ s}$ $\rightarrow v = 8 \cdot \frac{8}{3} - \frac{3}{2} \left(\frac{8}{3} \right)^2 = \frac{32}{3} \text{ (m/s)}$ second M1 dependent on the first, and third dependent on the second.	M1 DM1 DM1 A1 (4)
(b)	$s = 4t^2 - t^3/2$ $t = 4: s = 64 - 64/2 = \underline{32 \text{ m}}$	M1 M1 A1 (3)
(c)	$t > 4: \quad v = 0 \Rightarrow t = \underline{8 \text{ s}}$	B1 (1)
(d)	<i>Either</i> $t > 4 \quad s = 16t - t^2 (+ C)$ $t = 4, s = 32 \rightarrow C = -16 \Rightarrow s = 16t - t^2 - 16$ $t = 10 \rightarrow s = 44 \text{ m}$ But direction changed, so: $t = 8, s = 48$ Hence total dist travelled = $48 + 4 = \underline{52 \text{ m}}$ <i>Or (probably accompanied by a sketch?)</i> $t=4 \quad v=8, t=8 \quad v=0$, so area under line = $\frac{1}{2} \times (8-4) \times 8$ $t=8 \quad v=0, t=10 \quad v=-4$, so area above line = $\frac{1}{2} \times (10-8) \times 4$ \therefore total distance = $32(\text{from b}) + 16 + 4 = \underline{52 \text{ m}}$	M1 M1 A1 M1 A1 M1 DM1 A1 (8) M1A1A1 M1A1A1 M1A1 (8)

Or M1, A1 for $t > 4$ $\frac{dv}{dt} = -2$, =constant

$$t=4, v=8; t=8, v=0; t=10, v=-4$$

$$M1, A1 \quad s = \frac{u+v}{2}t = \frac{32}{2}t, =16 \text{ working for } t = 4 \text{ to } t = 8$$

$$M1, A1 \quad s = \frac{u+v}{2}t = \frac{-4}{2}t, =-4 \text{ working for } t = 8 \text{ to } t = 10$$

$$M1, A1 \quad \text{total} = 32+14+4, =52$$

M1 Differentiate to obtain acceleration

DM1 set acceleration. = 0 and solve for t

DM1 use their t to find the value of v

A1 32/3, 10.7oro better

OR using trial an improvement:

M1 Iterative method that goes beyond integer values

M1 Establish maximum occurs for t in an interval no bigger than $2.5 < t < 3.5$

M1 Establish maximum occurs for t in an interval no bigger than $2.6 < t < 2.8$

A1

Or M1 Find/state the coordinates of both points where the curve cuts the x axis.

DM1 Find the midpoint of these two values.

M1A1 as above.

Or M1 Convincing attempt to complete the square:

$$DM1 \text{ substantially correct} \quad 8t - \frac{3t^2}{2} = -\frac{3}{2}\left(t - \frac{8}{3}\right)^2 + \frac{3}{2} \times \frac{64}{9}$$

DM1 Max value = constant term

A1 CSO

M1 Integrate the correct expression

DM1 Substitute $t = 4$ to find distance ($s=0$ when $t=0$ - condone omission / ignoring of constant of integration)

A1 32(m) only

B1 $t = 8$ (s) only

M1 Integrate $16-2t$

M1 Use $t=4$, $s=$ their value from (b) to find the value of the constant of integration.

or $32 +$ integral with a lower limit of 4 (in which case you probably see these two marks

occurring with the next two. First A1 will be for 4 correctly substituted.)

$$A1 \quad s = 16t - t^2 - 16 \text{ or equivalent}$$

M1 substitute $t = 10$

A1 44

M1 Substitute $t = 8$ (their value from (c))

DM1 Calculate total distance (M mark dependent on the previous M mark.)

A1 52 (m)

OR the candidate who recognizes $v = 16 - 2t$ as a straight line can divide the shape into two triangles:

M1 distance for $t = 4$ to $t =$ candidates' $s = \frac{1}{2} \times \text{change in time} \times \text{change in speed}$.

A1 8-4

A1 8-0

M1 distance for $t =$ their 8 to $t = 10 = \frac{1}{2} \times \text{change in time} \times \text{change in speed}$.

A1 10-8

A1 0-(-4)

M1 Total distance = their (b) plus the two triangles ($= 32 + 16 + 4$).

A1 52(m)

NB: This order on open grid (the A's and M's will not match up.)

Question 9:

Question Number	Scheme	Marks
(a)	$0 = (35 \sin \alpha)^2 - 2gh$ $h = \underline{40 \text{ m}}$	M1 A1 A1 (3)
(b)	$x = 168 \Rightarrow 168 = 35 \cos \alpha \cdot t \quad (\Rightarrow t = 8\text{s})$ $\text{At } t = 8, \quad y = 35 \sin \alpha \times t - \frac{1}{2}gt^2 \quad (= 28.8 - \frac{1}{2} \cdot 9.8 \cdot 8^2 = -89.6 \text{ m})$	M1 A1 M1 A1
	<p>M1 Use of $v^2 = u^2 + 2as$, or possibly a 2 stage method using $v = u + at$ and $s = ut + \frac{1}{2}at^2$</p> <p>A1 Correct expression. Alternatives need a complete method leading to an equation in h only.</p> <p>A1 40(m) No more than 2sf due to use of g.</p> <p>M1 Use of $x = u \cos \alpha \cdot t$ to find t.</p> <p>A1 $168 = 35 \times \text{their } \cos \alpha \times t$</p> <p>M1 Use of $s = ut + \frac{1}{2}at^2$ to find vertical distance for their t. (AB or top to B)</p> <p>A1 $y = 35 \sin \alpha \times t - \frac{1}{2}gt^2$ (u,t consistent)</p> <p>DM1 This mark dependent of the previous 2 M marks. Complete method for AB. Eliminate t and solve for s.</p> <p>A1 cso.</p> <p>(NB some candidates will make heavy weather of this, working from A to max height (40m) and then down again to B (129.6m))</p> <p>OR : Using $y = x \tan \alpha - \frac{gx^2 \sec^2 \alpha}{2u^2}$</p> <p>M1 formula used (condone sign error)</p> <p>A1 x,u substituted correctly</p> <p>M1 α terms substituted correctly.</p> <p>A1 fully correct formula</p> <p>M1, A1 as above</p>	

Question 10:

Question Number	Scheme	Marks
	<p>(a) $s = ut + \frac{1}{2}at^2 \Rightarrow 3.15 = \frac{1}{2}a \times \frac{9}{4}$ $a = 2.8 \text{ (ms}^{-2}\text{)} *$</p> <p>(b) N2L for P: $0.5g - T = 0.5 \times 2.8$ $T = 3.5 \text{ (N)}$</p> <p>(c) N2L for Q: $T - mg = 2.8m$ $m = \frac{3.5}{12.6} = \frac{5}{18} *$</p> <p>(d) The acceleration of P is equal to the acceleration of Q.</p> <p>(e) $v = u + at \Rightarrow v = 2.8 \times 1.5$ (or $v^2 = u^2 + 2as \Rightarrow v^2 = 2 \times 2.8 \times 3.15$) $(v^2 = 17.64, v = 4.2)$ $v = u + at \Rightarrow 4.2 = -4.2 + 9.8t$ $t = \frac{6}{9.8}, 0.86, 0.857 \text{ (s)}$</p>	<p>M1 A1 A1 (3)</p> <p>M1 A1 A1 (3)</p> <p>M1 A1 DM1 A1 (4)</p> <p>B1 (1)</p> <p>M1 A1</p> <p>DM1 A1 DM1 A1 (6)</p> <p>[17]</p>

