Mark Scheme for June 2010
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### Question 1

**Part i**

\[ t = \frac{5}{1.2} \]

\[ t = 4.17 \text{ s} \]

M1

A1

\( 4 \frac{1}{6} \text{ s}, 4.166 \text{ or better, 4.16 recurring.} \)

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<thead>
<tr>
<th>M1</th>
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**Part ii**

\[ s = (-5)^2 \times 1.2 \]

\[ s = 10.4 \text{ m} \]

\( OR (using \text{(ii)}) \)

\[ s = 5 \times 4.17 - 1.2 \times 4.17^2 \]

\[ s = 10.4 \text{ m} \]

\( OR (using \text{(ii)}) \)

\[ s = (5 \times (0))/2 \times 4.17 \]

\[ s = 10.4 \text{ m} \]

M1

A1

\( s = 5 = 1.2t \text{ or } 0 = 5 - 1.2t \)

\( 5 \times 4.17 \text{ or } 0 = 5 - 1.2 \times 4.17 \)

Time must be > 0. Accept \( |t| \) from (i)

Award if \( |-4.17| \) used.

\( M1 \)

A1

\( s = 10.4 \text{ m} \)

\( OR (using \text{(i)}) \)

\( s = (5 + 0)/2 \times 4.17 \)

\( s = 10.4 \text{ m} \)

\( M1 \)

A1

\( M1 \)

A1

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**Part iii**

\[ \text{Fr} = 3 \times 1.2 \]

\[ R = 3 \times 9.8 \]

\( \mu = (3x)1.2/(3x)9.8 \)

\( \mu = 0.122 \)

\( OR \)

\( R = 3 \times 9.8 \)

Mass \times acceleration = +/- 3 \times 1.2

\( +/- \mu \times 29.4 = +/- 3 \times 1.2 \)

\( \mu = 0.122 \)

M1

A1

Accept 3 \times 0.6, +/-

Accept 3g, +/-

B1

B1

M1

A1

M1

A1

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<th>M1</th>
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### Question 2

**Part i**

\( +/- (0.4x3 - 0.6x1.5) \)

\( +/- (0.4x0.1 - 0.6v) \)

\( 0.4x3 - 0.6x1.5 = +/- (0.4x0.1 + 0.6v) \)

speed \( |v| = 0.433 \text{ ms}^{-1} \)

\( OR \)

\( +/- (0.4x3 - 0.4x0.1) = +/- 1.16 \)

\( 0.6v + 0.6x1.5 = 0.6v + 0.9 \)

\( 1.16 = +/- (0.6v + 0.9) \)

speed \( |v| = 0.433 \text{ ms}^{-1} \)

B1

B1

M1

A1

Accept 13/30 or 0.43 recurring, but not 0.43

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**Part ii**

\( +/- (0.4x0.1 - 0.6v) \)

\( 0.4x3 - 0.6x1.5 = +/- (0.6v - 0.4x0.1) \)

\( v = 0.567 \)

\( \text{PQ} = 0.1x3 + 0.567x3 \)

\( \text{PQ} = 2 \text{ m} \)

\( OR \)

\( +/- 0.4x3 + 0.4x0.1 \text{ and } +/- 0.6v + 0.6x1.5 \)

\( 1.24 = +/- 0.6v + 0.9 \)

\( v = 0.567 \)

etc

B1

M1

A1

Accept 2.00(1), 2.0, 2.00

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<th>M1</th>
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### Question 3

**Part i**

\( H = +/- (9 - 5 \cos 60) \)

\( H = 6.5 \text{ N} \)

AG

M1

A1

\( +/- (9 + 5 \cos 120) \)

\( +/- 9 \text{ or } -9 \)

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**Part ii**

\( V = +/- (12 - 5 \sin 60) \)

\( V = 7.67 \text{ N} \)

M1

A1

\( +/- (12 + 5 \cos 150) \)

Accept 7.666 or better, or 7.6 recurring

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**Part iii**

\( R^2 = 6.5^2 + 7.67^2 \)

\( R = 10.1 \text{ N} \)

\( \tan A = 6.5/7.67 \text{ or } 7.67/6.5 \)

\( A = 40(\cdot)3 \text{ or } 49.7 \)

Bearing = 320°

M1

A1

Uses Pythagoras on forces \( V(ii) \) and 6.5

\( 10.053 \cdot \)

Uses trigonometry in relevant triangle

M1

A1

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May be implied by final answer

As this is not a final answer, exact accuracy is not an issue

Or better
### Question 4

<table>
<thead>
<tr>
<th>Part</th>
<th>Expression</th>
<th>Mark Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>$3.2 - 0.2t^2 = 0$</td>
<td>M1 A1 [2] Puts 0 for $v$ and attempts to solve QE Accept dual solution $+/-4$</td>
</tr>
</tbody>
</table>
| ii   | $a = -2x0.2t$  
$a = -0.4x4$  
$a = -1.6 \text{ ms}^2$ | M1* D*M1 A1 [3] Differentiates $v$ Substitutes $+ve \ t(i)$ in derivative of $v$ Negative only |
| iii  | $s= 3.2t - 0.2t^3/3 \ (+c)$  
$t = 0, s = 0 \ \text{so} \ c = 0$  
$s(4) = 3.2x4 -0.2x4^3/3$  
$s = 8.53 \text{ m}$ | M1* A1 B1 D*M1 A1 [5] Integrates $v$, not multiplication by $t$ Or correct use of limits 0 and 4 Accept without/loss of $c$ 8 8/15 Accept with/without $c$ |

### Question 5

<table>
<thead>
<tr>
<th>Part</th>
<th>Expression</th>
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</tr>
</thead>
<tbody>
<tr>
<td>i</td>
<td>$+/-3x20/2$</td>
<td>M1 A1 [2] Use area of scalene triangle(s). Not suvat. Accept -30</td>
</tr>
</tbody>
</table>
| ii   | $(t+4)x3/2 = 30$ or $3t/2 = 30 - 4x3$  
$t = 16$ or $t = 12$  
$T = 76$ | M1 A1 A1 A1 [4] Equates scalene trapezium area to distance (i) $(T-60)+4)x3/2 =30$, award A2 |
| iii  | $T(\text{accn}) = 3/0.4 \ (-7.5 \text{ s})$  
$\text{decn} = 3/[76-60 - 7.5]$  
$\text{decn} = (+/-) 2/3 \text{ ms}^2$  
$\text{OR}$  
$S(\text{accn}) = 3^2/(2x0.4) \ (= 11.25 \text{ m})$  
$\text{decn} = 3^2 / [2x(30 - 3x4 - 11.25)]$  
$\text{decn} = (+/-) 2/3 \text{ ms}^2$ | B1 M1 A1 A1 [3] Or $3 = \text{decn} \times [(76-60) - 4 - 7.5]$ $(+/-) 0.667$ or better - accept 0.6 recurring |

### Question 6

<table>
<thead>
<tr>
<th>Part</th>
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</table>
| i    | $T - 0.85g \sin30 = 0.85a$  
$0.55g - T = 0.55a$  
$a = 1.225/1.4$  
$a = 0.875$  
$T = 4.91$ | B1 B1 M1 A1 A1 [5] Either equation correct Both eqns correct and consistent ‘a’ direction Solves 2 sim eqn 4.908 or better – has to be positive |
| b    | $F = 2T\cos30$  
$F = 8.5(02\ldots)$ | M1 A1ft [2] Or Pythagoras or cosine rule $\text{cv}(4.91)x\sqrt{3}$ |
| ii   | $v^2 = 1.3^2 + 2x0.875x1.5 \ (=4.315)$  
$a = +/\,-\sin30$  
$0 = 4.315 -2x4.9s$  
$(s = 0.44\ldots)$  
$S = 1.94$ | M1 A1ft B1 M1 A1 A1 [6] Uses $v^2 = u^2 + 2a(1.5)$, $u$ non-zero, $a$ from (i) $v = 2.077(\ldots)(v^2 =1.69+3xcv(0.875))$ $a = +/-4.9$ Uses $0^2 = u^2+/-2as$, with a not g or (i), u not1.3 May be implied – need not be 3sf |
### 7

#### i
- $F_r = 4 + 5\sin 60$
- $R = 12 - 5\cos 60$
- $\mu = \frac{(4 + 5\sin 60)}{(12 - 5\cos 60)}$
- $\mu = 0.877$

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<tr>
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<tr>
<td>All 4 + component 5 ($4 + 4.333(01)$)</td>
<td>May be implied</td>
</tr>
<tr>
<td>May be implied</td>
<td>+ve from correct work</td>
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<td></td>
<td>Friction/Reaction, $F_r &gt; 4$, $R &lt; 12$, both positive</td>
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#### ii
- Upper block
  - $\mu = \frac{5\sin 60}{(9-5\cos 60)}$ ($= 4.3/6.5$)
  - $\mu = 0.666$

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<td>(Component 5)/(9-component 5)</td>
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#### iii
- Upper mass = $\frac{9}{g}$
  - $(\frac{9}{g})a = 5\sin 60 - 0.1(9 - 5\cos 60)$
  - $a = 4.01$
  - Lower mass
  - Tractive force = $4 + 0.1(9-5\cos 60)$ (= 4.65)
  - Max Friction = $0.877(3 +(9-5\cos 60)$ (= 8.33)
  - Tractive force $< \text{Max Friction}$
  - $a = 0$

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| $0.918(36..)$ | $N2L$ $0.918(36..)a = 4.33(01..) - 0.1x6.5$ | where friction $= 0.1x(9\text{- component 5})$

**OR for Lower Mass**
- ma = $4+0.1(9-5\cos 60)-0.877(3+9-5\cos 60)$
- -ve a caused by friction impossible, hence $a = 0$

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<td>N2L with 3 force terms:</td>
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