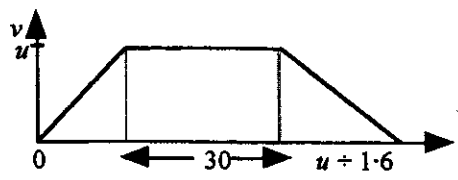# MECHANICS 1 (A) TEST PAPER 9 : ANSWERS AND MARK SCHEME

1. $108 \text{ km h}^{-1} = 30 \text{ ms}^{-1}$ $a = 30 \div 7 \cdot 5 = 4 \text{ ms}^{-2}$ M1 A1 A1   3

2. (a) $R = W \cos 15°$, $\mu R = W \sin 15°$ $\mu = \tan 15° = 0 \cdot 268$ M1 A1

    (b) Acc down plane $= g \sin 20° - \mu g \cos 20° = 0 \cdot 0902 g = 0 \cdot 884 \text{ ms}^{-2}$ M1 A1 M1 A1   6

3. (a) $v_P = 20 - 9 \cdot 8t$ $v_Q = 30 - 9 \cdot 8(t - 2)$ B1 M1 A1

    (b) Equal speeds when $v_P = v_Q$ (never) or $v_P = -v_Q$:   M1

    $20 - 9 \cdot 8t = 9 \cdot 8t - 19 \cdot 6 - 30$ $19 \cdot 6t = 69 \cdot 6$ $t = 3 \cdot 55$ M1 A1 A1   7

4. (a) Volume per second $= \pi (0 \cdot 0275)^2 \times 9 = 0 \cdot 02138 \text{ m}^3$ M1 A1

    having mass $21 \cdot 38 \text{ kg}$ Mom. $= mv = 21 \cdot 38 \times 9 = 192 \text{ Ns}$ A1 M1 A1

    (b) Change in mom. $=$ impulse $=$ force x time, so force $= 192 \text{ N}$ M1 A1

    (c) Assumed water moves horizontally, does not rebound, etc.   B1   8

5. (a) $mg - T = ma$, $T - g = a$ Add : $mg - g = ma + a$ M1 A1 A1 M1

    $g(m - 1) = a(m + 1)$ $a = \dfrac{(m - 1)g}{m + 1}$ A1 A1

    (b) $T = a + g = \dfrac{2mg}{m + 1}$ M1 A1

    (c) $0 \cdot 525 = \dfrac{1}{2} \dfrac{(m - 1)g}{m + 1} (\dfrac{1}{2})^2$ $\dfrac{m - 1}{m + 1} = \dfrac{3}{7}$ $7m - 7 = 3m + 3$ M1 A1 A1

    $4m = 10$ $m = 2 \cdot 5$ M1 A1

    (d) Then $a = \dfrac{3g}{7} = 4 \cdot 2$ $v = at = 0 \cdot 5a = 2 \cdot 1 \text{ ms}^{-1}$ B1 M1 A1   16

6. (a) $r_P = (i + 7j) + t(3i - 4j) = (1 + 3t)i + (7 - 4t)j$ M1 A1 A1

    $\underrightarrow{r_Q} = (3i - 8j) + t(6i + 5j) = (3 + 6t)i + (5t - 8)j$ M1 A1 A1

    (b) $PQ = (2 + 3t)i + (9t - 15)j$ $PQ = \sqrt{[(2 + 3t)^2 + (9t - 15)^2]}$ M1 A1 A1

    $= \sqrt{(90t^2 - 258t + 229)}$ M1 A1

    (c) $\dfrac{d}{dt}(PQ^2) = 180t - 258 = 0$ for min. $t = 1 \cdot 43 \text{ hrs} = 86 \text{ mins}$,   M1 A1 M1 A1

    so time is 1:26 p.m.   Then $PQ = \sqrt{44 \cdot 1} = 6 \cdot 64 \text{ km}$ A1 A1   17

7. (a)

B2

    (b) Let three times be t_1, t_2, t_3 $\dfrac{1}{2} ut_1 = 12$ $t_1 = \dfrac{24}{u}$ M1 A1

    $t_2 = 30$ $u \div t_3 = 1 \cdot 6$ $t_3 = u \div 1 \cdot 6 = \dfrac{5u}{8}$ Hence result   M1 A1 A1

    (c) Distance $=$ sum of areas $= 12 + 30u + \dfrac{1}{2} u \dfrac{5u}{8} = \dfrac{5u^2}{16} + 30u + 12$ M1 A1 A1

    (d) $\dfrac{5u}{8} + 30 + \dfrac{24}{u} = 39 \cdot 5$ x $8u$: $5u^2 + 240u + 192 = 316u$, etc.   M1 A1 A1

    (e) $(5u - 16)(u - 12) = 0$ $u = 3 \cdot 2$ or $u = 12$ M1 A1 (both)

    When $u = 3 \cdot 2$, dist. $= 111 \text{ m}$ When $u = 12$, dist. $= 417 \text{ m}$ M1 A1 A1   18

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