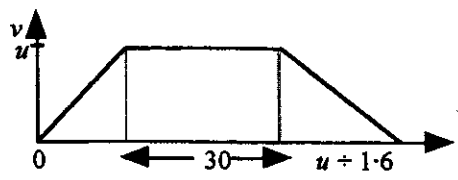


# MECHANICS 1 (A) TEST PAPER 9 : ANSWERS AND MARK SCHEME

1.  $108 \text{ km h}^{-1} = 30 \text{ ms}^{-1}$        $a = 30 \div 7.5 = 4 \text{ ms}^{-2}$       M1 A1 A1      3
2. (a)  $R = W \cos 15^\circ$ ,  $\mu R = W \sin 15^\circ$        $\mu = \tan 15^\circ = 0.268$       M1 A1  
 (b) Acc down plane =  $g \sin 20^\circ - \mu g \cos 20^\circ = 0.0902g = 0.884 \text{ ms}^{-2}$       M1 A1 M1 A1      6
3. (a)  $v_P = 20 - 9.8t$        $v_Q = 30 - 9.8(t - 2)$       B1 M1 A1  
 (b) Equal speeds when  $v_P = v_Q$  (never) or  $v_P = -v_Q$ :  
 $20 - 9.8t = 9.8t - 19.6 - 30$        $19.6t = 69.6$        $t = 3.55$       M1 A1 A1      7
4. (a) Volume per second =  $\pi(0.0275)^2 \times 9 = 0.02138 \text{ m}^3$       M1 A1  
 having mass  $21.38 \text{ kg}$       Mom. =  $mv = 21.38 \times 9 = 192 \text{ Ns}$       A1 M1 A1  
 (b) Change in mom. = impulse = force  $\times$  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  
 $g(m - 1) = a(m + 1)$        $a = \frac{(m-1)g}{m+1}$       A1 A1  
 (b)  $T = a + g = \frac{2mg}{m+1}$       M1 A1  
 (c)  $0.525 = \frac{1}{2} \frac{(m-1)g}{m+1} \left(\frac{1}{2}\right)^2$        $\frac{m-1}{m+1} = \frac{3}{7}$        $7m - 7 = 3m + 3$       M1 A1 A1  
 $4m = 10$        $m = 2.5$       M1 A1  
 (d) Then  $a = \frac{3g}{7} = 4.2$        $v = at = 0.5a = 2.1 \text{ ms}^{-1}$       B1 M1 A1      16
6. (a)  $\underline{r}_P = (\mathbf{i} + 7\mathbf{j}) + t(3\mathbf{i} - 4\mathbf{j}) = (1 + 3t)\mathbf{i} + (7 - 4t)\mathbf{j}$       M1 A1 A1  
 $\underline{r}_Q = (3\mathbf{i} - 8\mathbf{j}) + t(6\mathbf{i} + 5\mathbf{j}) = (3 + 6t)\mathbf{i} + (5t - 8)\mathbf{j}$       M1 A1 A1  
 (b)  $PQ = (2 + 3t)\mathbf{i} + (9t - 15)\mathbf{j}$        $PQ = \sqrt{[(2 + 3t)^2 + (9t - 15)^2]}$       M1 A1 A1  
 $= \sqrt{(90t^2 - 258t + 229)}$       M1 A1  
 (c)  $\frac{d}{dt}(PQ^2) = 180t - 258 = 0$  for min.       $t = 1.43 \text{ hrs} = 86 \text{ mins}$ ,      M1 A1 M1 A1  
 so time is 1:26 p.m.      Then  $PQ = \sqrt{44.1} = 6.64 \text{ km}$       A1 A1      17
7. (a)       B2
- (b) Let three times be  $t_1, t_2, t_3$        $\frac{1}{2} ut_1 = 12$        $t_1 = \frac{24}{u}$       M1 A1  
 $t_2 = 30$        $u \div t_3 = 1.6$        $t_3 = u \div 1.6 = \frac{5u}{8}$       Hence result      M1 A1 A1
- (c) Distance = sum of areas =  $12 + 30u + \frac{1}{2} u \frac{5u}{8} = \frac{5u^2}{16} + 30u + 12$       M1 A1 A1
- (d)  $\frac{5u}{8} + 30 + \frac{24}{u} = 39.5$        $\times 8u: 5u^2 + 240u + 192 = 316u$ , etc.      M1 A1 A1
- (e)  $(5u - 16)(u - 12) = 0$        $u = 3.2$  or  $u = 12$       M1 A1 (both)
- When  $u = 3.2$ , dist. =  $111 \text{ m}$       When  $u = 12$ , dist. =  $417 \text{ m}$       M1 A1 A1      18