

Mechanics - Jan 2010 Miss Watson's solutions

(1) (i) $u = 4.2$ $a = 9.8$ $t = 1.5$ $v = ?$

$$v = u + at$$

$$v = 4.2 + 9.8 \times 1.5$$

$$v = 18.9 \text{ ms}^{-1} \quad \checkmark$$

2

(ii) $s = \frac{1}{2}(u + v)t$

$$s = \frac{1}{2}(4.2 + 18.9) \times 1.5$$

$$s = 17.325 \text{ m} \quad \checkmark$$

2

(iii) $17.325 - 5 = 12.325$

$$s = 12.325 \quad a = 9.8 \quad u = 4.2 \quad v = ?$$

$$v^2 = u^2 + 2as$$

$$v^2 = 4.2^2 + 2 \times 9.8 \times 12.325$$

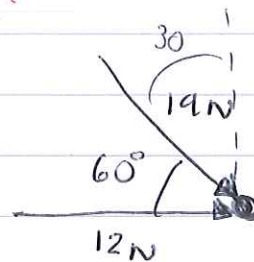
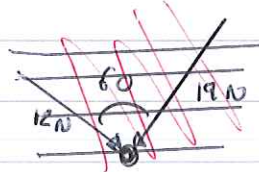
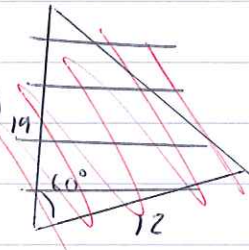
$$v^2 = 259.21$$

$$v = 16.1 \text{ ms}^{-1} \quad \checkmark$$

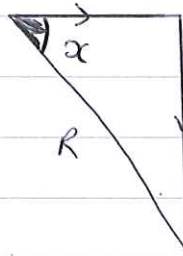
2

(2)

(i)



$$12 + 19 \cos 60 = 21.5$$



$$19 \cos 30 = 16.454$$

$$R = \sqrt{733} = 27.0739$$

$$\underline{27.1 \text{ N}} \quad \checkmark$$

5

(ii) $\alpha = \tan^{-1} \left(\frac{19 \cos 30}{21.5} \right) = 37.4277$
 $37.4^\circ \quad \checkmark$

3

3 (i) (a) $9 \times m + 2 \times 0.8 = -3.5 \times m + 3.5 \times 0.8$
 $9m + 3.5m = 1.2$

$$12.5m = 1.2$$

$$m = 0.096 \text{ kg} \quad \checkmark$$

4

(b) $9 \times 0.096 = 0.864$

$$-3.5 \times 0.096 = -0.336$$

$$0.864 + 0.336 = 1.2 \quad \checkmark$$

2

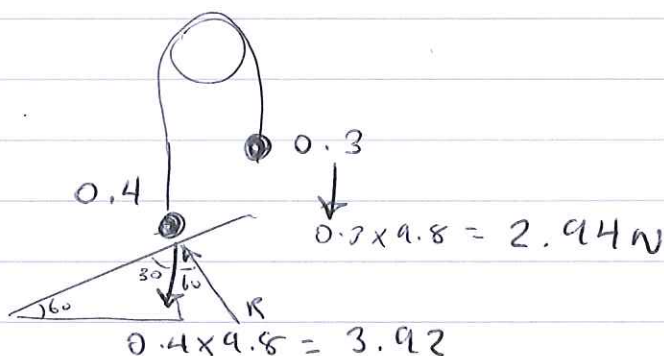
(ii) $3.5 \times 0.8 + 2.75 \times 0.4 = v_x (0.8 + 0.4)$

$$3.9 \text{ ~~xxxx~~ } = 1.2v$$

$$v = \text{~~xxxx~~ } 3.25 \text{ ms}^{-1} \quad \checkmark$$

3

4 (i) (a)



$$3.92 - 2.94 = 0.98$$

$$0.98 \times \cos 60 = 0.49 \text{ N (perp)} \quad \checkmark$$

$$0.98 \times \cos 30 = 0.84870$$

$$= 0.849 \text{ (parallel)} \quad \checkmark$$

4

(b) $F_{\text{lim}} = \mu \times R$

$$0.849 = \mu \times 0.49$$

$$\mu = 1.73 \quad \checkmark$$

2

$$T = 0.4 \times 1.09 + 3.92$$

$$T = 4.36 \text{ N} \quad \checkmark$$

(ii) $0.3 + 0.2 = 0.5$

$$0.5 \times 9.8 = 4.9$$

4

$$4.9 - T = 0.5a$$

$$T - 3.92 = 0.4a$$

$$T = 0.4a + 3.92$$

$$4.9 - (0.4a + 3.92) = 0.5a$$

$$0.98 = 0.9a$$

$$a = 1.09 \text{ ms}^{-2} \quad \checkmark$$

5 (i) $u=3$ $v=11$ $t=20$ $a=?$

$$v = u + at$$

$$11 = 3 + a \times 20$$

$$a = 0.4$$

$u=3$ $a=0.4$ $v=8$ $t=?$

$$v = u + at$$

$$8 = 3 + 0.4t$$

$$t = 12.5 \text{ seconds} \quad \checkmark$$

3

(ii) ~~$u=3$ $v=8$~~

(B) $8 \times 20 = 160$

(A) $\frac{1}{2}(3+11) \times 20 = 140$

$$(t-20) \times 8 = (t-20) \times 11 - 20$$

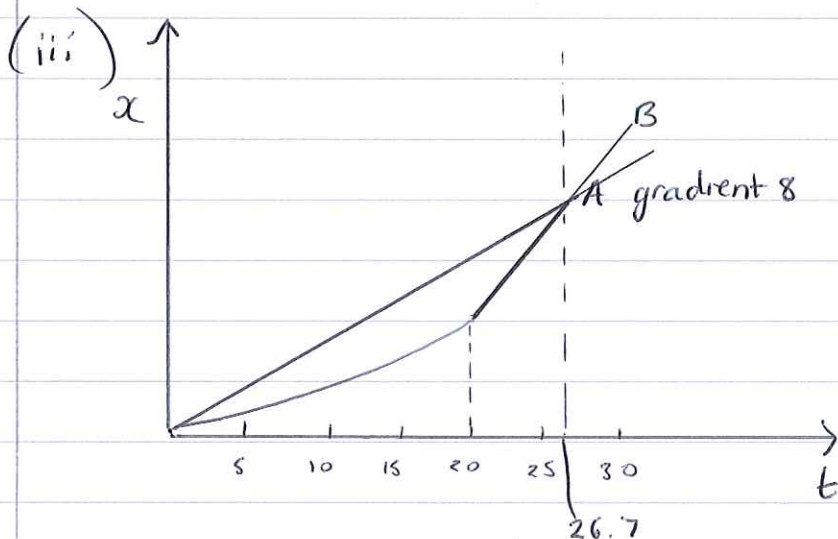
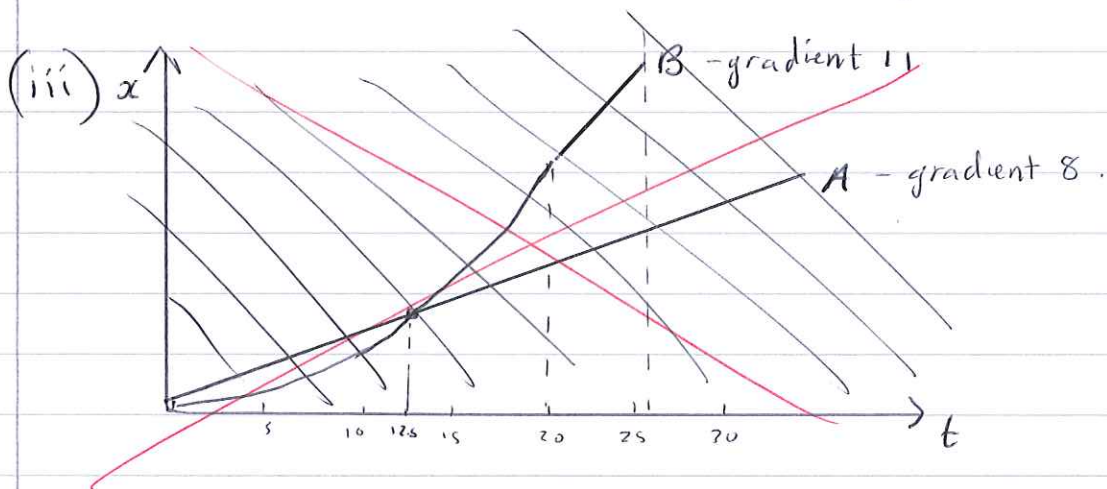
$$8t - 160 = 11t - 220 - 20$$

$$8t - 160 = 11t - 240$$

$$80 = 3t$$

$$t = 26.7 \text{ seconds, or } 26\frac{2}{3} \quad \checkmark$$

5



3

$$6 \text{ (i) } v = 0.006t^2 - 0.18t + K$$

$$\frac{dv}{dt} = a = 0.012t - 0.18 \quad \checkmark$$

2

$$\text{(ii) } 0 = 0.012t - 0.18$$

$$0.012t = 0.18$$

$$t = 15 \quad v = 0.65$$

$$0.65 = 0.006(15)^2 - 0.18(15) + K$$

$$0.65 = -1.35 + K$$

$$K = 2 \quad \checkmark$$

5

$$\text{(iii) } \int v \, dt = x = 0.002t^3 - 0.09t^2 + 2t + c$$

$v=0$ when $t=0$ when $x=0$ so constant = 0

$$t = 28.4$$

$$x = 0.002 \times (28.4)^3 - 0.09 \times (28.4)^2 + 2 \times (28.4)$$

$$x = 30.022208$$

$$x = 30.0 \text{ m} \quad \checkmark$$

5

7

(i)

$$\mu = 0.15 \quad a = 0.11 \quad m = 600$$

$$600 \times 9.8 = 5880$$

$$5880 \times \cos 80 = 1021.05$$

$$5880 \times \cos 10 = 5790.67 = R$$

$$F_{lim} = \mu \times R$$

$$= 0.15 \times 5790.67$$

$$= 868.6 \checkmark$$

$$1021.05 + 868.6 = 1889.65 \text{ N}$$

~~$$1889.65 = T = 600 \times 0.11$$~~

~~$$1889.65 = 66 = T$$~~

~~$$T = 1823.65$$~~

$$T - 1889.65 = 600 \times 0.11$$

$$T = 1955.65$$

$$T = 1960 \text{ N} \checkmark$$

5

(ii)

(b)

$$u = 0 \quad v = ? \quad s = 10 \quad a = 0.11 \quad (a) \quad F = ma$$

$$v^2 = u^2 + 2as$$

$$-1889.65 = 600 \times a$$

$$v^2 = 0^2 + 2 \times 0.11 \times 10$$

$$a = -3.1494$$

$$v^2 = 2.2$$

$$a = -3.15 \checkmark$$

$$v = \sqrt{2.2} = 1.483 \dots \frac{\sqrt{ss}}{s}$$

2

$$u = \frac{\sqrt{ss}}{s} \quad v = 0 \quad a = -3.15 \quad t = ?$$

$$v = u + at$$

$$0 = \sqrt{2.2} + -3.15 \times t$$

$$t = 0.471 \checkmark$$

$$s = \frac{1}{2} (u + v) \times t$$

$$s = \frac{1}{2} (\sqrt{2.2} + 0) \times 0.47$$

$$s = 0.349 \checkmark$$

$$s = 10.349 \quad u = 0 \quad t = ? \quad a = 0.254 \rightarrow F = ma$$

$$s = ut + \frac{1}{2} at^2$$

$$1021.05 - 868.6 = 600a$$

$$10.349 = 0 + \frac{1}{2} \times 0.254 \times t^2$$

$$a = 0.254 \checkmark$$

$$t^2 = 81.488$$

$$t = 9.027 \checkmark$$

$$\text{total time} = 9.027 + 0.47 = 9.49708$$

9

$$= 9.50 \checkmark$$