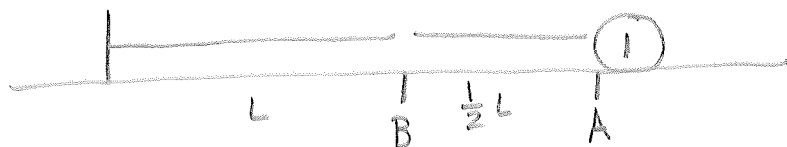


3D
1)



$\lambda = mg$
 $L = L$
 $x = 0.5$

		A	B
$\frac{\lambda x^2}{2L}$	EPE	$\frac{(1)g(\frac{1}{2}L)^2}{2L}$	0
$\frac{1}{2}mv^2$	KE	0	$\frac{1}{2}(1)(v)^2$

Energy @ A = Energy @ B

$$\frac{(1)g(0.5L)^2}{2L} = \frac{v^2}{2}$$

$$\frac{gL^2}{2L} = \frac{v^2}{2}$$

$$\frac{gL^2}{2L} = \frac{v^2}{2}$$

$$v^2 = \frac{gL}{4}$$

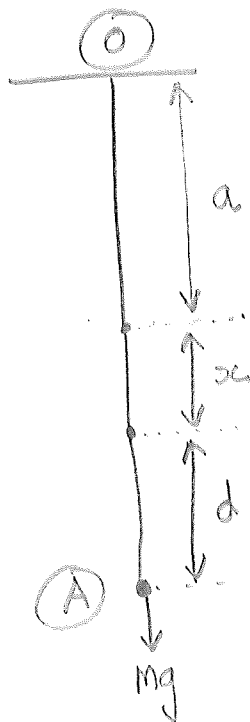
$$v = \sqrt{\frac{1}{4}} \sqrt{gL}$$

$$v = \frac{1}{2} \sqrt{gL}$$

3D

2)

$0 \text{ ms}^{-1} \uparrow$



$$\lambda = 4mg$$

$$l = a$$

$$x =$$

$$T = mg$$

$$T = \frac{\lambda x}{L}$$

$$mg = \frac{4mgx}{a}$$

$$a = 4x$$

$$x = \frac{a}{4}$$

$0 \text{ ms}^{-1} \uparrow$

	A	O
KE	0	0
mgh GPE	0	$mg\left(\frac{5}{4}a + d\right)$
$\frac{\lambda x^2}{2L}$ EPE	$\frac{4mg\left(\frac{a}{4} + d\right)^2}{2a}$	It is a spring 0

$$\frac{4mg\left(\frac{a}{4} + d\right)^2}{2a} = mg\left(\frac{5}{4}a + d\right)$$

$$2\left(\frac{a}{4} + d\right)^2 = a\left(\frac{5}{4}a + d\right)$$

$$2\left(\frac{a^2}{16} + \frac{ad}{2} + d^2\right) = \frac{5a^2}{4} + ad$$

$$\frac{a^2}{8} + ad + 2d^2 = \frac{5a^2}{4} + ad$$

$$\frac{a^2}{8} + 2d^2 = \frac{5a^2}{4}$$

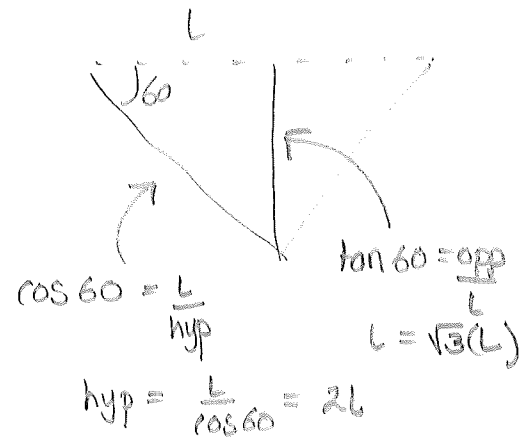
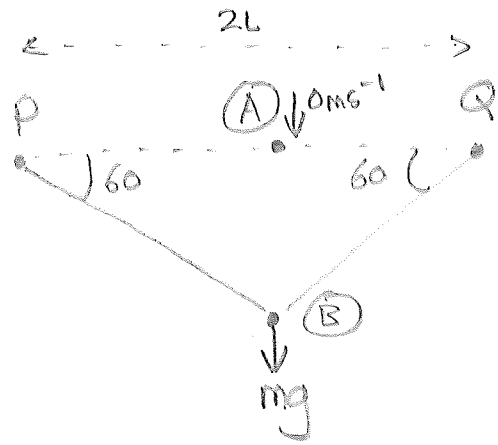
$$2d^2 = \frac{9a^2}{8}$$

$$d^2 = \frac{9a^2}{16}$$

$$d = \frac{3a}{4}$$

(3D)

3)



		(A)	(B)
$\frac{1}{2}mv^2$	KE	0	0
mgh	GPE	$mg\sqrt{3}L$	0
$\frac{\lambda x^2}{2L}$	EPE	0	$\frac{\lambda(4L-2L)^2}{2(2L)}$

$$mg\sqrt{3}L = \frac{\lambda(2L)^2}{4L}$$

$$mg\sqrt{3}L = \frac{\lambda 4L^2}{4L}$$

$$mgL\sqrt{3} = \lambda L$$

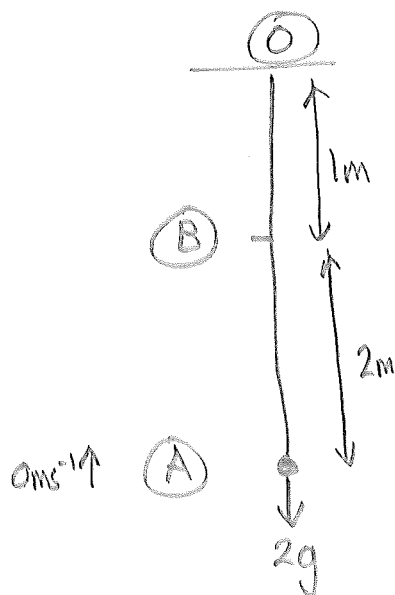
$$\lambda = \underline{\underline{mg\sqrt{3}}}$$

c) Take into account the mass of the spring

3D

4)

a)



$$\lambda = 21.6$$

$$L = 1$$

$$x = 2$$

$$T = 2g$$

		A	B
$\frac{1}{2}mv^2$	KE	0	$\frac{1}{2}(2)v^2$
mgh	GPE	0	$(2)(g)(2)$
$\frac{\lambda x^2}{2L}$	EPE	$\frac{21.6(2)^2}{2(1)}$	0

$$\frac{21.6(2)^2}{2} = v^2 + 4g$$

$$43.2 = v^2 + 39.2$$

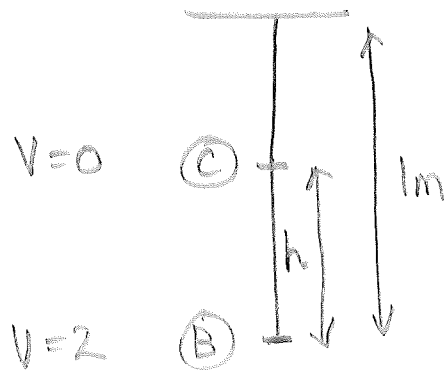
$$v^2 = 4$$

$$v = \underline{\underline{2 \text{ ms}^{-1}}}$$

3D

4)

b)



		B	C
$\frac{1}{2}mv^2$	KE	$\frac{1}{2}(2)(2)^2$	0
mgh	GPE	0	$(2)(9.8)(h)$
$\frac{\lambda x^2}{2L}$	EPE	0	0

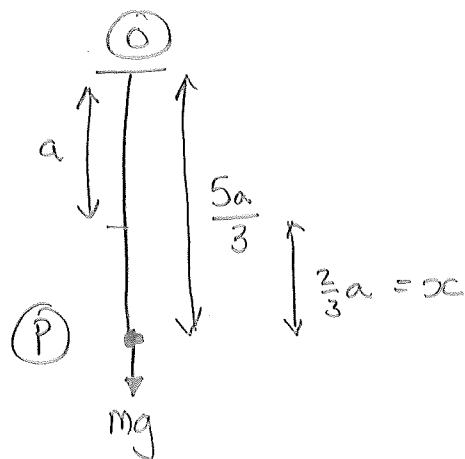
$$4 = 19.6h$$

$$h = \frac{10}{49}$$

$$\text{Distance from O} = 1 - \frac{10}{49}$$

$$= \frac{39}{49} \text{ m}$$

3D
5)



$$T = mg$$

$$\lambda =$$

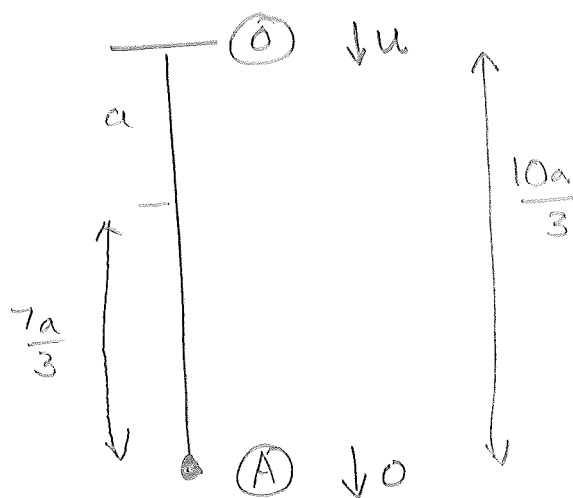
$$x = \frac{2}{3}a$$

$$L = a$$

$$T = \frac{\lambda x}{L}$$

$$mg = \frac{\lambda (\frac{2}{3}a)}{a}$$

$$\frac{3mg}{2} = \lambda$$



		O	A
$\frac{1}{2}mv^2$	KE	$\frac{1}{2}mu^2$	0
mgh	GPE	$mg(\frac{10a}{3})$	0
$\frac{\lambda x^2}{2L}$	EPE	0	$\frac{3mg(\frac{7a}{3})^2}{2a}$

(3D)

5) conti

$$\frac{1}{2}mu^2 + mg\left(\frac{10a}{3}\right) = \frac{\frac{3mg}{2}\left(\frac{7a}{3}\right)^2}{2a}$$

$$\frac{1}{2}mu^2 + \frac{10mga}{3} = \frac{49amg}{12}$$

$$\frac{1}{2}u^2 = \frac{49ag}{12} - \frac{10ag}{3}$$

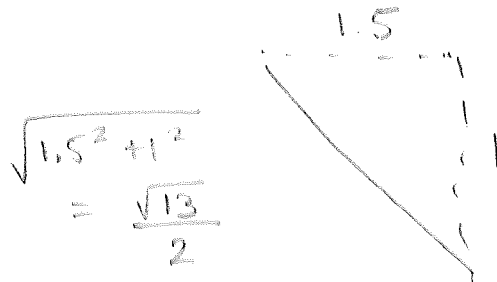
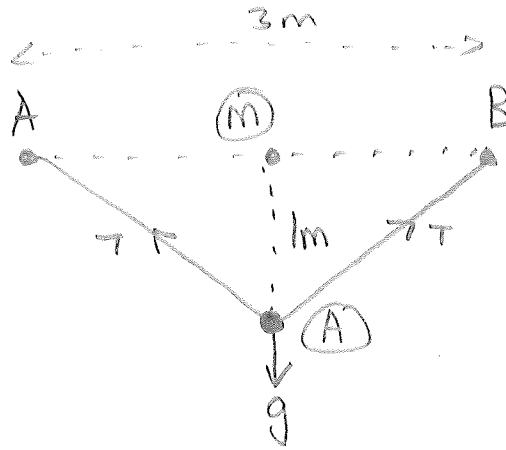
$$\frac{1}{2}u^2 = \frac{49ag}{12} - \frac{40ag}{12}$$

$$\frac{1}{2}u^2 = \frac{9ag}{12}$$

$$u^2 = \frac{9ag}{6}$$

$$u = \sqrt{\frac{3ag}{2}}$$

3D
6)
a)



$$x = \frac{2\sqrt{13}}{2} - 3$$

$$x = \sqrt{13} - 3$$

	m	A
$\frac{1}{2}mv^2$ KE	0	0
mgh GPE	$(1)(9.8)(1)$	0
$\frac{\lambda x^2}{2L}$ EPE	0	$\frac{\lambda (\sqrt{13}-3)^2}{2(3)}$

$$9.8 = \frac{\lambda (22 - 6\sqrt{13})}{6}$$

$$\frac{58.8}{(22 - 6\sqrt{13})} = \lambda$$

$$\lambda = \underline{\underline{160 \text{ (3sf)}}}$$

$$(\sqrt{13}-3)(\sqrt{13}-3)$$

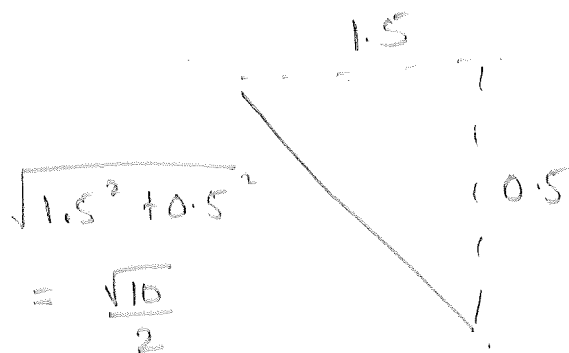
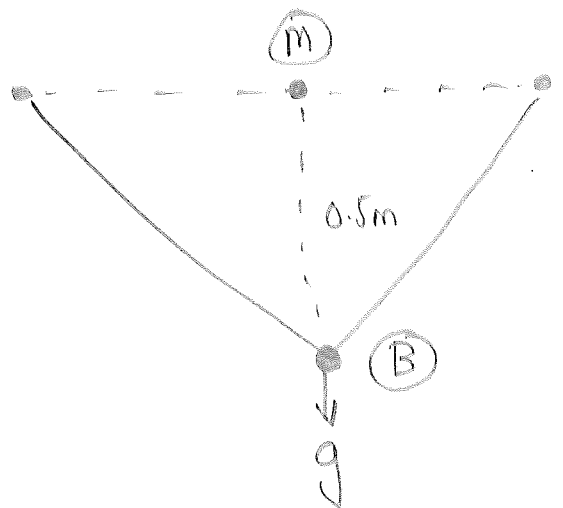
$$= 13 - 3\sqrt{13} - 3\sqrt{13} + 9$$

$$= 22 - 6\sqrt{13}$$

3D

6)

b)



$$x = \frac{2\sqrt{10}}{2} - 3$$

$$x = \sqrt{10} - 3$$

		m	B
$\frac{1}{2}mv^2$	KE	0	$\frac{1}{2}(1)v^2$
mgh	GPE	$(1)(9.8)(0.5)$	0
$\frac{\lambda x^2}{2L}$	FPE	0	$\frac{160(\sqrt{10}-3)^2}{2\sqrt{3}}$

$$4.9 = \frac{v^2}{2} + \frac{160(\sqrt{10}-3)^2}{6}$$

$$4.9 - \frac{160(19-6\sqrt{10})}{6} = \frac{v^2}{2}$$

$$v = \underline{\underline{2.90}} \text{ (3sf)}$$

$$\begin{aligned} &(\sqrt{10}-3)(\sqrt{10}-3) \\ &= 10 - 3\sqrt{10} - 3\sqrt{10} + 9 \\ &= 19 - 6\sqrt{10} \end{aligned}$$

(3D)
7)
a)



	O	A
KE	0	0
GPE	$(3)(9)(2+x)$	0
EPE	0	$\frac{117.6(x)^2}{2(2)}$

$$3g(2+3) = \frac{117.6x^2}{4}$$

$$6g + 3gx = \frac{117.6x^2}{4}$$

$$0 = 117.6x^2 - 12gx - 24g$$

$$0 = 117.6x^2 - 117.6x - 235.2$$

$$0 = x^2 - x - 2$$

$$x = 2 \text{ or } -1$$

ignore

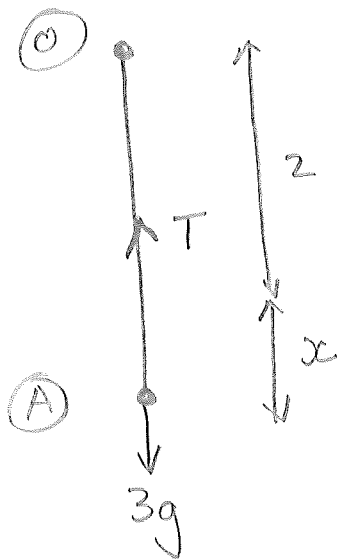
Distance fallen

$$= 2 + 2 = \underline{\underline{4m}}$$

(3D)

7)

b)



$$T = 3g$$

$$x$$

$$L = 2$$

$$\lambda = 117.6$$

$$T = \frac{\lambda x}{L}$$

$$3g = \frac{117.6 x}{2}$$

$$6g = 117.6 x$$

$$x = 0.5$$

	O	A
KE	0	$\frac{1}{2}(3)v^2$
GPE	$(3)(g)(1.5)$	0
EPE	0	$\frac{117.6(0.5)^2}{2(2)}$

$$7.5g = \frac{3v^2}{2} + 7.35$$

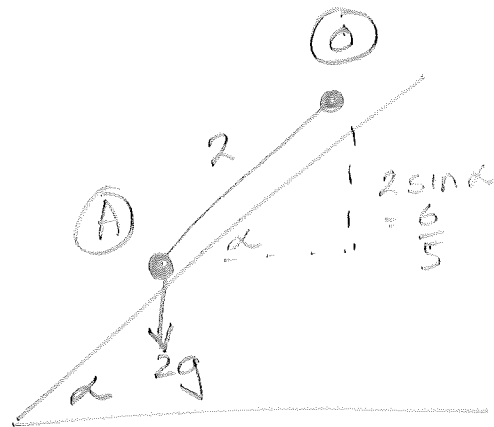
$$15g = 3v^2 + 14.7$$

$$v^2 = 44.1$$

$$v = \underline{\underline{6.64 \text{ ms}^{-1} (3 \text{ sf})}}$$

3D

8)



$$\tan \alpha = \frac{3}{4}$$

$$\cos \alpha = \frac{4}{5}$$

$$\sin \alpha = \frac{3}{5}$$

$$\text{Friction} = \mu R$$

$$= \mu (2g \cos \alpha)$$

$$= \mu \left(2g \frac{4}{5} \right)$$

$$= 15.68\mu$$

		O	A
	KE	0	0
mgh	GPE	$(2)(9.8)\left(\frac{6}{5}\right)$	0
$\frac{\lambda x^2}{2L}$	EPE	0	$\frac{40(1)^2}{2(1)}$
Work out Work against	Friction	0	Distance $\times$ Friction $(2)15.68\mu$

$$23.52 = 20 + 31.36\mu$$

$$\mu = \underline{\underline{0.112}} \quad (3sf)$$