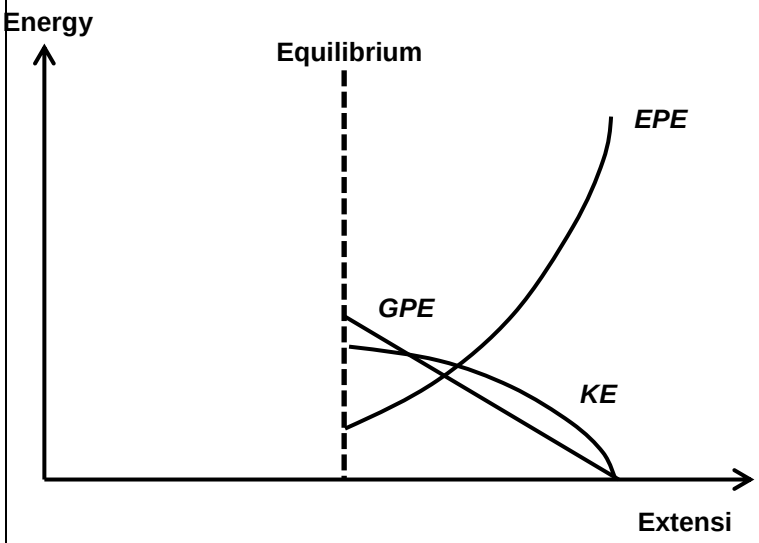
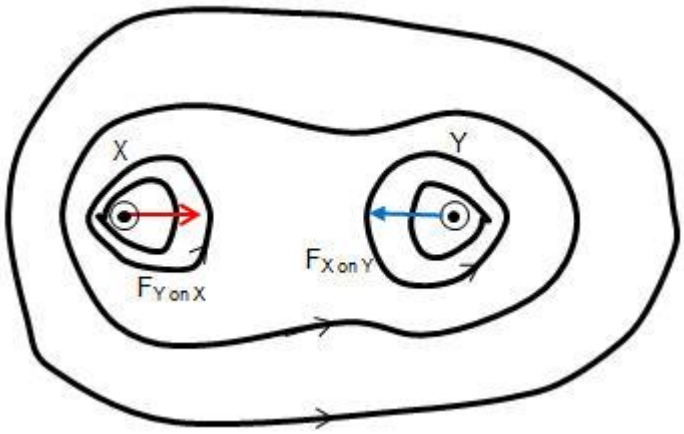
Qn	Suggested MS		
1			
(a)	$x = v_x t$ ------ (1) find time to reach ground $v_y = gt$ ------(2) solve for v_y and substitution Solving (1) and (2) gives $v_y = 9.81\left(\frac{x}{v_x}\right) = 9.81\left(\frac{0.5}{1.5}\right) = 3.2(7)\ \text{m s}^{-1}$		
(b)	$v = \sqrt{(3.27)^2 + (1.5)^2} = 3.6\ \text{m s}^{-1}$		
(c)(i)	parabolic curve (with GPE = 0 given; start with horizontal gradient)		
(c)(ii)	KE = E_T – GPE (Initial KE +ve; mirror image of GPE graph; ensure ET approx. shown to be constant)		
2			
(a)	The resultant force in all directions is equal to zero The resultant torque about any axes is equal to zero		
(b)(i)	Taking moments about support where *P* acts, *1 x Q = d x V* + 0.5 x *W*;		
(ii)	As *d* increases, moment of *V* from edge increases, hence *Q* must increase to balance this.		
(iii)1.	*V* is found from gradient, and *W* from intercept		
	***V* calculated correctly from gradient**		
(iii)2.	When *d* = 0, 0.45 = 0.5*W* Hence ***W* = 0.90 N**		

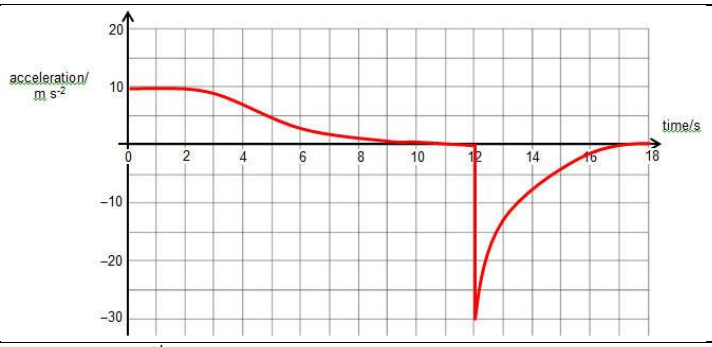
3			
(a)	Work done by external force on spring = Area under *F-x* graph = ½ *F x* = ½ (*kx*)(*x*) (Apply Hooke's Law) = ½ kx^2 Work done by external force on spring = *EPE* stored in spring		
(b)			
4			
(a)(i)	When R=0 Ω, I=I_{max} and total resistance in circuit is 6 Ω Hence $I_{max} = \frac{12}{6} = 2.0$ A		
(a)(ii)	When R=12 Ω, I=I_{min} and total resistance in circuit is 18 Ω, hence $I_{min} = \frac{12}{18}$ =0.67 A		
(b)(i)	When maximum current I_2 flows through the ammeter, minimum current must flow through the resistor R; hence value for R is set at its maximum value which is 12 Ω		
(b)(ii)	Then potential difference across R=12 Ω is equal to the potential difference across the 6.0 Ω Hence maximum current I_2 flowing through the ammeter is $\frac{12}{6} = 2.0$ A		
(iii)	When the variable resistor R is set at 6.0 Ω the resistance in the whole circuit is (3.0+6.0)= 9.0Ω Hence the current in the whole circuit is $\frac{12}{9}$ A therefore the current current I_2 flowing through the ammeter is $\left(\frac{1}{2}\left(\frac{12}{9}\right)\right)$A = $\frac{2}{3}$ A		

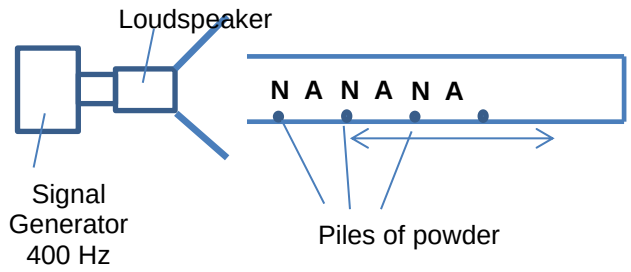
5			
(a)			
	Lines density correct – B-field stronger near X		
	Shape as shown (ignore position of correct neutral point;		
	Direction correct		
	Neutral point nearer Y		
(b)	Correct direction of F on diagram (attractive forces) and equal length		
(c)	The two forces are action and reaction pairs according to N3L , hence Magnitude of $F_{Y\ on\ X}$ = Magnitude of $F_{X\ on\ Y}$		
6			
(a)(i)	lg 350 = 2.544 lg 5 = 0.699		
(a)(ii)	Ratio of lg P_{out} / lg v not the same Therefore is not proportional		
(b)	P_{in} $= KE/t$ $= 1/2mv^2/t$ $= 1/2\rho Axv^2/t$ $= 1/2\rho Av^3$		
(c)(i)	P_{in} $= ½(1.3)(\pi 3.5^2)(6.0)^3$ = 5403.22521 = 5400 W (2 s.f.)		
(c)(ii)	P_{out} = 1600 W Efficiency = (1600 / 5403.22521) = 0.29612 = 0.296 (3 s.f.)		
(d)	Blade design (aerodynamics) / Friction with blades / Air temperature / Altitude / Obstructions		
(e)	Excessive load on blades causing breakage / Excessive load on windmill base causing instability / Motor to withstand and handle large torque		

<table>
<tr><td>7</td><td></td><td></td><td></td></tr>
<tr><td>(a)</td><td>Change of velocity with time / Rate of change of velocity
(and acts in the direction of change of velocity)</td><td></td><td></td></tr>
<tr><td>(b)(i)</td><td>Knows that dist is area under graph
Suitable method to find area
Range accepted: 380 – 400 m</td><td></td><td></td></tr>
<tr><td>(b)(ii)1</td><td>Uniform acceleration
Only weight/gravitational force acting</td><td></td><td></td></tr>
<tr><td>(b)(ii)2</td><td>Acceleration decreasing /speed increasing at decreasing rate
Air resistance increases as speed increase hence resultant force downwards decreases</td><td></td><td></td></tr>
<tr><td>(b)(ii)3</td><td>Uniform speed
Air resistance = weight, resultant force zero</td><td></td><td></td></tr>
<tr><td>(b)(iii)</td><td>Tangent drawn at 6.0 s
Ans: 2.84 m s^{-2}</td><td></td><td></td></tr>
<tr><td>(b)(iv)</td><td>
<table>
<tr><th>t/s</th><th>v/ m s^{-1}</th><th>a/ m s^{-2}</th><th>(g - a) / m s^{-1}</th><th>(g - a)/v^2 /10^{-3} m^{-1} s^{-2}</th></tr>
<tr><td>3.0</td><td>28.5</td><td>6.90</td><td>3.10</td><td>3.81</td></tr>
<tr><td>6.0</td><td>43.2</td><td>2.84</td><td>7.16</td><td>3.84</td></tr>
<tr><td>9.0</td><td>48.0</td><td>1.20</td><td>8.80</td><td>3.82</td></tr>
</table>
g - a at 6.0 s determined correctly

Resultant force = $mg - kv^2 = ma$
Hence if F_v is proportional to v^2, (g - a)/v^2 is a constant.

Calculated value of (g - a)/v^2 all correct

Since values are almost the same, hence true.
</td><td></td><td></td></tr>
<tr><td>(c)(i)</td><td>From tangent, derivations showed that a = - 30 m s^{-2}</td><td></td><td></td></tr>
<tr><td>(c)(ii)</td><td> 
</td><td></td><td></td></tr>
<tr><td></td><td>Graph for 1st 10 s correct trend
Graph from 12 to 18 s correct trend
Acceleration at t = 0, 11-12, 12, 16-18 s plotted correctly</td><td></td><td></td></tr>
<tr><td></td><td></td><td></td><td></td></tr>
<tr><td>8</td><td></td><td></td><td></td></tr>
<tr><td>(a)</td><td>The observation of the variation of intensity of the resultant wave when two of more waves meet at a point</td><td></td><td></td></tr>
</table>

	as a result of the resultant displacement being given by the vector sum of the displacement of the individual waves at the point.		
(b)(i)			
(b)(ii)	When the sound wave that are produced by the source is **reflected** at the glass boundary with a phase difference of π The incident and reflected wave **overlaps** and as they have the **speed** and **frequency**, resulting in the formation of nodes and antinodes of a standing wave The **piles of power gather at the nodes** as at the nodes no oscillation occurs.		
(b)(iii)	Wavelength of stationary wave =123 X 2/3 = 82 cm Hence speed of wave = 400 Hz X 0.82 m = 328 = 330 m		

(b)(iv)	At a distance of 1000 m above the sea level, Temperature is **lower** Hence air particles are further apart and speed of sound waves **decreases (Or from given equation)** Hence **wavelength decreases (From given equation)** and distance between adjacent piles **decreases**		
(b)(v)	Since helium gas are much lighter than air molecules (Think of the high pitched sound that people make when they inhale helium. Sound travels faster in helium than it does in normal air, because helium is less dense than normal air. The wavelength of the sound produced by your voice is fixed by the size of your mouth and throat. If the speed goes up but the wavelength stays the same, the frequency has to go up too. We hear this as a higher pitch.) **Speed of sound increases (***as Refractive index is lower)* Since **frequency is fixed, the wavelength increases** Therefore the distance between piles **increases**		
(c)(i)	There are 6 nodes and 2.75 λ as seen in the diagram Length of instrument = $2.75 \times \frac{330}{400} = 2.27\ m$		
(c)(ii)	End Correction		
(d)	L = 9λ/4, hence λ = 1.0 m Hence the distance between adjacent nodes =0.50 m		
9			
(a)(i)	A: **absorption** spectrum; B: **emission** *(line)* spectrum		
(a)(ii)	**Each line** corresponds to a **fixed freq** emitted These frequencies correspond to only certain energy differences for **transition between discrete upper and lower energy levels** Hence atom has discrete any levels		
(a)(iii)	Each element only absorb certain frequencies of light. The set of dark lines correspond to a particular element.		

(b)(i)	Particles can have wave properties; and waves can have particulate properties			
(b)(ii)	**Accept any one** • Minimum frequency is needed to emit electrons from a metal indep on intensity • Instantaneous emission as long as f > fo, indep on intensity • Max KE of photoelectrons is dep on freq of light but indep on freq.	• Energy of wave dependent on freq of wave and not intensity. • Intensity only gives number of photons arriving per unit time • One-to-one interaction between photons and electrons.		
(c)(i)	**Energy** of Light of freq 5.6×10^{14} Hz is **less than the work function** of the metal.			
(c)(ii)	$\phi = hf_o$ $= 5.6 \times 10^{14}$ Hz $\times 6.63 \times 10^{-34}$ J			
	$= 3.71 \times 10^{-19}$ J			
(c)(iii)	Gradient gives *h* Find gradient 1.8/4.4 Convert to correct unit: 6.5×10^{-34} J s			
(c)(iv)	Intercept gives work function Hence shift to the left			
	As h const Gradient is the same			