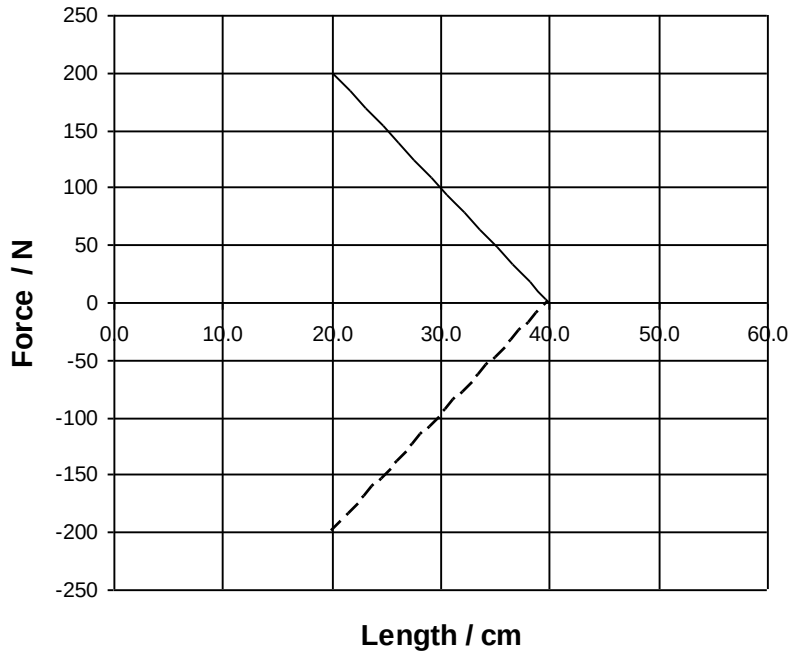
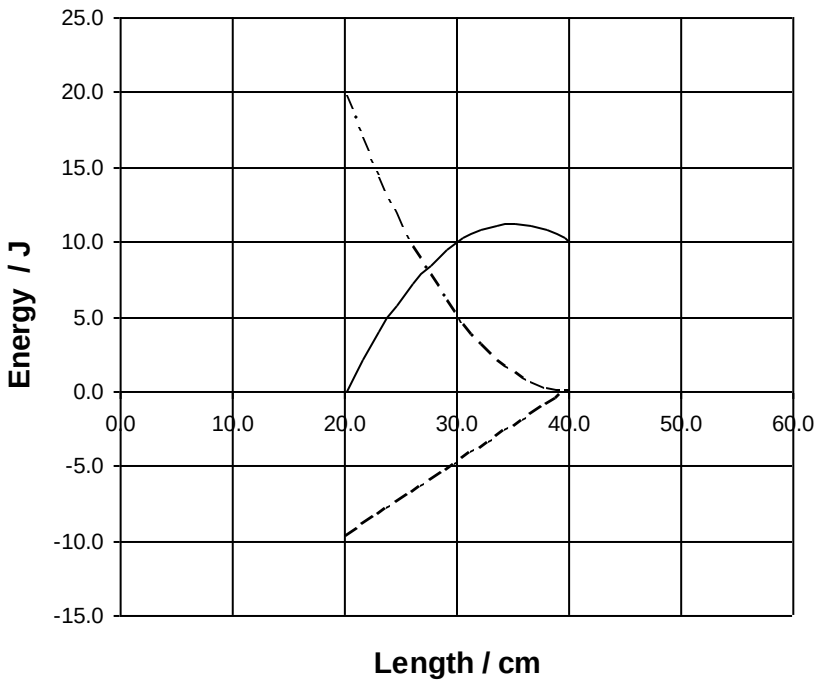
Qn	
1(a)	Systematic errors are errors in measurements whereby the errors have a fixed magnitude and sign or (*Systematic errors are errors in measurements whereby the measurements deviate from the true value by a fixed magnitude and in the same direction*.) Random errors are errors in measurements whereby the errors have varying magnitude and sign or (*Random errors are errors in measurements whereby the measurements deviate from the true value by a fixed magnitude and a direction that is not fixed*.)
(b)	g = 9.869 m s^{-2}
	$\pm\frac{\Delta g}{g} = \pm\left(\frac{\Delta l}{l} + \frac{2\Delta t}{t}\right)$ (or $\left(\frac{\Delta l}{l} + \frac{2\Delta T}{T}\right)$)
	= (0.1% + 2%)
	$\pm\ \Delta g = \pm 0.21$
	g = 9.9 $\pm$ 0.2 m s^{-2}
2	
(a)	Total initial momentum of system = total final momentum of a <u>system</u> provided there is no net external force acting on the system.
(b)	Apply COM, 0.02(500) + 0 = (40 + 0.02) *v* *v* = 0.24988 m s^{-1} Apply COE, KE lost by block and bullet = GPE gained by block and bullet ½ $mv^2 = mgh$ ½ $(0.24988)^2$ = 9.81 *h* *h* = 3.18 x 10^{-3} m Assumption: All KE converted to GPE / Air resistance is negligible
3	
(a)	Sum of forces zero in all directions Sum of torque / moments zero about any axes / point
(b)(i)	Taking moments about line of action of *R*, Clockwise *M* = Anti-clockwise *M* *T*sin70° (0.07) + *W* / 7 (0.03) = *W* (0.11) *T* = 1.60713 *W* Resolving forces in the x-direction, R_X = 1.60713 *W* cos70° = 0.54967 *W* Resolving forces in the y-direction, R_Y = *W* + 1.60713 *W* sin70° - *W* / 7 = 2.36735 *W*

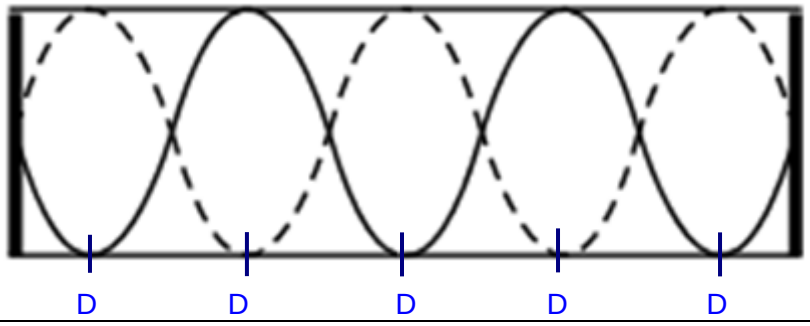
	$R = \sqrt{(0.54967\ W)^2 + (2.36735\ W)^2}$ $= 2.43033\ W$
(b)(ii)	When taking moments about line of action of *R* to determine *T*, the moment due to the upward force on the foot is greatly reduced as both the upward force on the foot (due to the cane) and perpendicular distance from the foot to *R* is reduced, leading to a smaller *T* (and horizontal component of *R*) The reduced upper force on the foot (due to the cane) and smaller *T* also reduced the vertical component of *R*. Therefore *R* is reduced.
4a	Bulb in 1 can be fully dark (or totally switched off)
	In 2, there is always pd across bulb/ there is always current through bulb (or equivalent)
b	Diagram with a switch in series with resistor
	Discuss the position of switch
ci	$R = \frac{V^2}{P} = \frac{240^2}{60}$ $= 960\ \Omega$
ii	Room temperature lower than working temperature
	Lower lattice vibration; Resistance lower
5	
(a)	Minimum freq of em radiation/photon for release of electrons from surface of metal
(b)	E_{MAX} corresponds to electron emitted from surface
	electron (below surface) requires energy to bring it to surface, so less than E_{MAX}
(c)(i)	$\Phi = hc/\lambda_o$
	$= 6.63 \times 10^{-34} \times 3.00 \times 10^8 \times 1.85 \times 10^6$
	$= 3.68 \times 10^{-19}$ J
(ii)	$1/\lambda = 2.5 \times 10^6$, $E_{max} = 1.3 \times 10^{-19}$ J
	$\lambda = h/p$
	$= \frac{h}{\sqrt{2mE}}$
	$= 1.36 \times 10^{-9}$ m
6	
(a)	

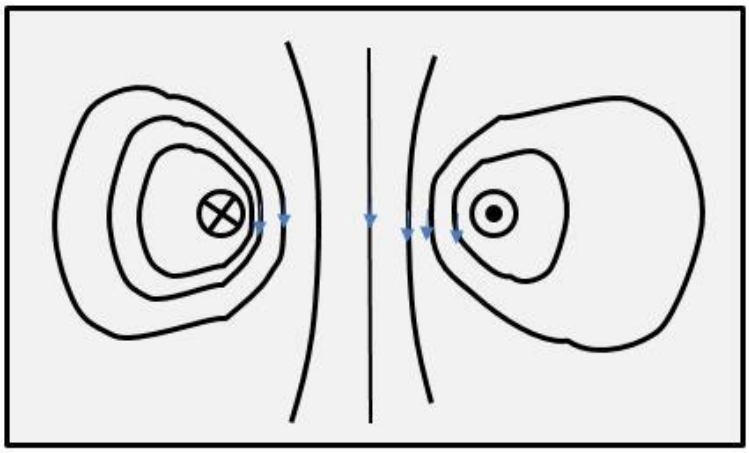
Speed (km / h)	Stopping distance (m)	Thinking distance (m)	Braking distance (m)
30	12.0	5.6	**6.4**
40	18.0	7.5	10.5
50	25.0	9.5	**15.5**
60	33.0	11.3	21.7
80	52.0	15.0	37.0
100	70.0	18.8	**51.2**
120	102.0	22.5	**79.5**

(b)(i)	t = thinking distance / v = 5.6 / (30 x 1000 / 60 x 60) = 0.672 s
(b)(ii)	$a = (v^2 - u^2) / 2s$ $= (0 - (80 \times 1000 / 60 \times 60)^2) / 2\ (37)$

	= - 6.67334 m s^{-2}
(c)	For speeds 80 km h^{-1} and below, the 2 second rule is safe as the distance travelled by the car (44.4 m) is less than the stopping distance (52.0 m).
7(ai)	2011 ACJC Prelims WD by external agent = Force x displacement = $ma \times s = \frac{1}{2}m(v^2 - u^2)$ (show proof using equation of motion) $= KE_f - KE_i$ Not awarded if uses u = 0 Hence $KE = \frac{1}{2}mv^2$
(bi)	Ability of a body to do work due to its motion
(bii)	Ability to do work
	due to change of shape/deformation of a material
(ci)	
(cii)	Work done by spring = −area under graph
	$=\frac{1}{2} \times 100 \times (40.0 - 30.0) \times 10^{-2}$ (must be negative)
	$=-5.00$J
(ciii)	EPE = +5.00J (ecf from cii, no credit if same sign as in cii)
(di)1	When length of spring = 40cm KE=10J, GPE=0J When length of spring = 20cm KE=0J, GPE = $-(5)(10)(0.20) = -10J$ Final GPE-Initial GPE = Change in GPE Final GPE-0= $-mgh$ Final GPE = $-(5)(9.81)(0.20)$ Final GPE $= -9.81\ J$
(di)2	Spring constant

	=Force/displacement =1000 $N\ m^{-1}$ EPE=$\frac{1}{2}(1000)(0.20)^2$ $= 20\ J$
(dii)	
(diii)	Contact with spring to length 35cm
	Loss in GPE converted into KE
	Loss in GPE converted into EPE
	Length 35cm to 20cm
	Loss in KE and GPE is converted to EPE
8a)i.	**Diffraction** is the bending or spreading of a wave into its geometrical shadow when it is incident on an edge, an aperture/opening, or edge of obstacle
ii.	**Phase difference** between two waves at a point is the difference in the phases of their oscillation cycle which is expressed either in terms of an angle or in terms of fraction of one complete cycle.
iii	Two wave sources are said to be **coherent** if the phase difference between the sources is constant with time.
(b)i.	The two emitters must emit coherent waves.
	Along AB, constructive interference occurs at points where the path difference is an integer number of wavelengths. Waves meet in phase at these points and detector will read maximum intensity (or amplitude).
	Along AB, destructive interference occurs at points where the path difference is an odd integer number of half wavelengths. Waves meet π radian out of phase at these points and detector will read zero intensity (or amplitude).
ii.	Fringe positions remain unchanged.
	Fringes' maximum intensity is ~~lesser~~ than previous. Fringes' minimum intensity is not zero,

iii.	Fringes' position for maximum and minimum intensity switches position.
	Fringes's maximum and minimum intensity remains unchanged.
8(c)	
(i)	There are standing waves produced in the microwave oven during the cooking process because incident wave from the right gets **reflected** by the reflective wall on the left and they **superimpose /overlap /interfere**
	The conditions must be right such that the distance between the source and wall must be **integral multiples of half the wavelength** of the microwave.to form standing wave
	as they have the **same speed, frequency and almost the same amplitude**
(ii)1.	Intensity of the microwave is **strongest (largest amplitudes) at the antinodes**, hence the **dry regions are the regions of antinodes**
	Wavelength = $3.0 \times 10^8 / 2.45 \times 10^9$
	= 0.1224 m = 12.2 cm
	Hence distance apart is 6.1 cm
2.	
(iii)	*So there are regions in the oven where the microwave has high amplitude (antinodes) and there are region where the microwave has no displacement (node). Thus ants can stay away from the regions of high amplitude which has high heat and thus stay alive*.
(iv)	The turntable enables different parts of the food to move to the antinodes of the standing wave and get heated up. Thus it helps heat up the food more uniformly. (No credit if simply state for uniform heating of food)
9 (a)	
(i)	B-field is a region of space where a charge moving not parallel to the field or conductor carrying a current not placed parallel to the field or a magnetic object experience a magnetic force.
(ii)	The tesla is the SI unit for magnetic flux density and is
	the force experienced by a current carrying conductor is **1 N m^{-1}**
	when it is carrying a current of **1 A**
	when placed **perpendicular to the field**.
(b)	
(i)	S pole of a magnet

(ii)		
	Direction of the field is correct Field strength for each wire **stronger on side facing each other**	
	Relative Field strength correct Ie Field strength goes from **high to mimium to high and Field stronger near current going in.** **Minimum B closer to curent coming out**	
(c)	maximum force shown at θ = 90°	
	zero force shown at θ = 0°	
	reasonable curve with F about ½ max at 30°	
(d)		
(i)	$0.4 \times 10^{-3} \times 9.81 = 3.9(2) \times 10^{-3}$ N	
	current (*flow in rod*) produces magnetic field around the rod this field **interacts with the permanent field** (of the U-shaped magnet) so rod experiences a **magnetic force upwards**.	When **a current (*flows in the rod from L to R)* in the presence of an external (*perpendicular)* B-field** (*into the page*) it experiences a **magnetic force upwards by FLHR**
	By N3L, the rod **exerts a force on the magnet downwards.**	
	Which **compresses the spring balance more**.	
(iii)1	Direction is **vertically upwards**	
2	F = BIL	
	$3.92 \times 10^{-3} = 28.6 \times 10^{-3} \times I \times 6.7 \times 10^{-2}$	
	I = 2.0(5) A	
3	82.0 – 0.4 = 81.6 g	