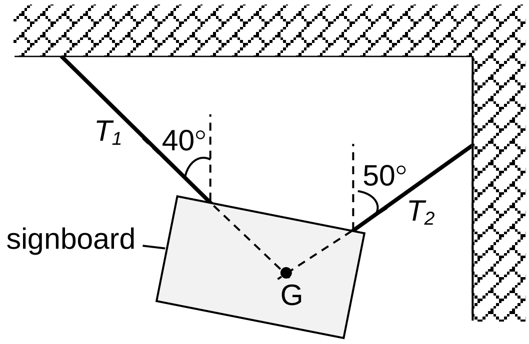
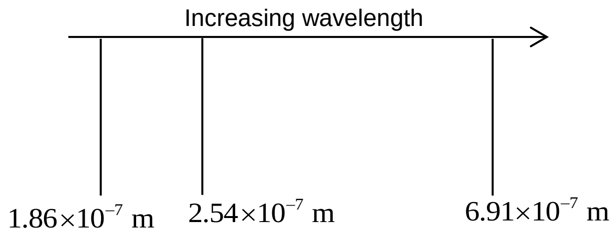
2014 AJC H1 Physics Prelim Paper 2 Mark Scheme
Section A

1a	Conditions for equations to be valid: • Constant acceleration • Motion in a straight line
1bi	$v_R = \sqrt{(v_x^2 + v_y^2)}$ $= \sqrt{(10.0^2 + 3.0^2)}$ $= 10.44$ ≈ 10 m s^{-1} $\theta = \tan^{-1}(\frac{10}{3})$ $= 73.3°$ $\approx 73°$
1bii	Taking downwards as positive, $S_{bag} = -10.0\ (4.0) + \frac{1}{2}(9.81)(4.0)^2$ $= 38.48$ m $S_{balloon} = -\ 10.0\ (4.0) = -\ 40.0$m Distance apart = 40.0 + 38.48 = 78.48 ≈ 78 m

2ai	There is <u>zero net force</u> acting on the signboard. There is <u>zero net torque about any axis</u> acting on the signboard.
ii	 G is at the intersection of lines of action of T_1 and T_2
iii	Weight = $T_1 \cos 40° + T_2 \cos 50°$ = 300 cos 40° + 252 cos 50° = 391.8 = 390 N
b	Net force acting on the board immediately after released = 20 N Initial net acceleration = F/m = 20/(391.8/9.81) = 0.501 ≈ 0.50 m s^{-2} [allow ecf from (aiii)]

3	From instant of release to first fully extended, GPE decreases from max value to min value, EPE increases from zero to max value & KE increases from zero to a max value (at equilibrium point when weight is equal to the tension by the spring) & decreases back to zero.

4	**(a)**	When temperature increases, there is an increase of charge carriers (holes and electrons) per unit volume in the metal, though insignificantly, resulting in decrease resistance of metal. However, there is also an increase in the amplitude of vibration of lattice core, resulting in more frequent collisions between them and mobile charge carriers and hence, reducing mean drift speed of charge carriers ie increased resistance. As the latter effect is more significant, the resistance of the metal thus increases.	
	(b)	**(i)**	Power dissipated in r = Total Power – Power dissipated in Load $I^2 r = \varepsilon I - P_L$ $(0.10)^2 r = (2.5)(0.10) - 0.23$ r = 2.0 Ω
		(ii)	Single cell Resistance of Load, $R_1 = \frac{0.23}{0.10^2} = 23\Omega$ Two cells 5.0 = 0.15R + 0.15 x 4.0 Resistance of Load, R_2 = 29 Ω As an ohmic device has constant resistance, since the load's resistance has changed/ increased, the load can be deduced as a non-ohmic device.

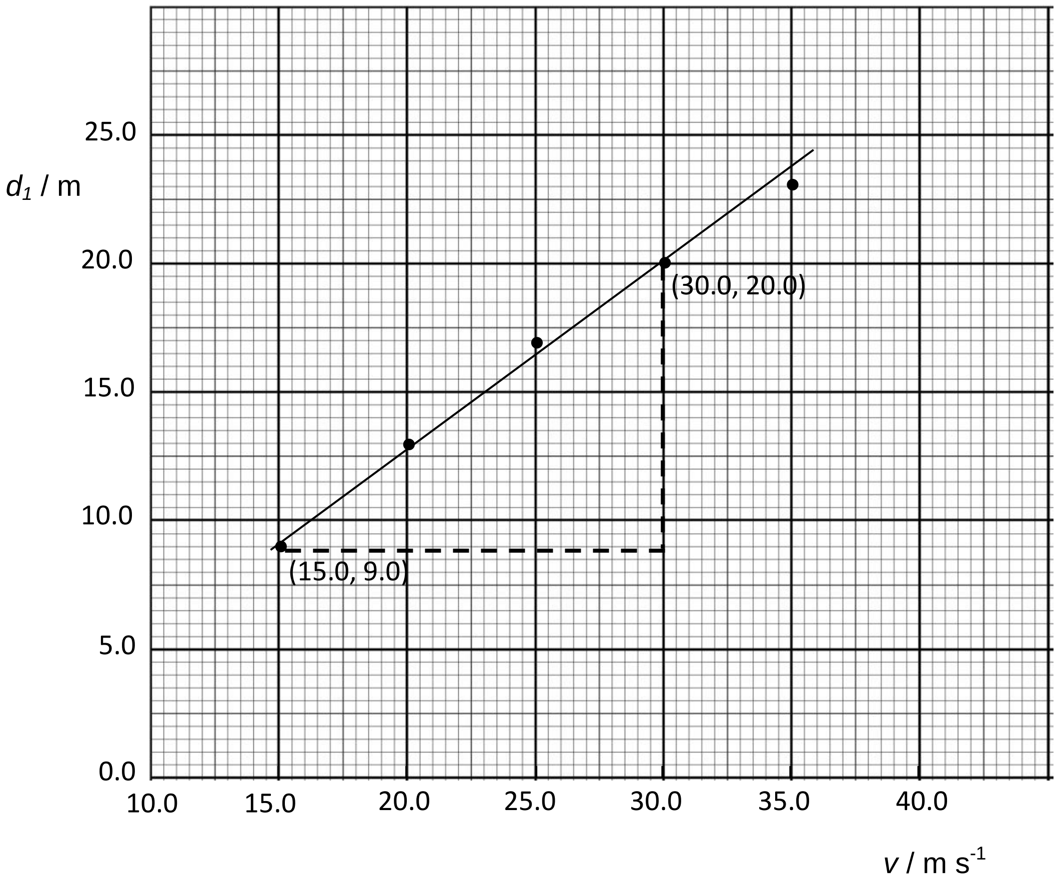
5a	${}^{5}_{2}C = 10$	
5b	**(i)**	For shortest wavelength, the atom is excited from the ground state to energy level -3.7 eV From $E = \dfrac{hc}{\lambda}$, $\lambda = \dfrac{(6.63 \times 10^{-34})(3 \times 10^{8})}{[-3.7 - (-10.4)] \times 1.6 \times 10^{-19}}$ $= 1.86 \times 10^{-7}$ m $= 186$ nm
	(ii)	Ultraviolet [10 nm to 400 nm]
	(iii)	 • 3 lines with 1.86×10^{-7} m labelled • Increasing spacing between the lines
5c	From Fig. 5.1, when a photon with energy corresponding to the difference of 2 energy levels is absorbed by the atom, the electron moves from a lower energy level to a higher energy level.	

6a

v / m s^{-1}	d / m	d_2 / m	d_1 / m
15.0	24.0	15.0	9.0
20.0	39.0	26.0	13.0
25.0	58.0	41.0	17.0
30.0	79.0	59.0	20.0
35.0	103.0	80.0	23.0

Reading of data from graphs
Correct computation of $d_1 = d - d_2$

b Plot the graph



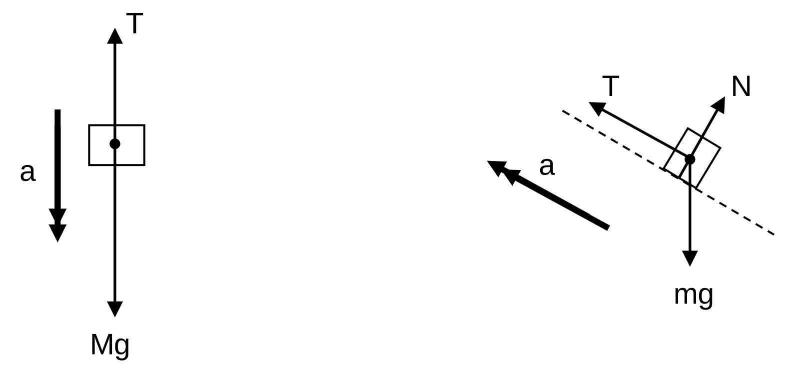
Fair scatter of points about best fit line

c Gradient = (20.0 – 9.0)/(30.0 – 15.0) = 0.733
A = 0.733 s range : 0.66 < A < 0.77

di Friction of the track surface will be reduced when the track is wet. This will reduce the magnitude of the motorist's deceleration.
This will increase the braking distance d_2, no effect on thinking distance d_1.

dii When the motorcyclist is not fully alert, his reaction time or thinking time will be delayed. This will increase the thinking distance d_1, no effect on braking d_2.

Section B

7a	Force is proportional to the rate of change of momentum of a body which is free to move and the change in momentum takes place in the direction of the force.
7b(i) **1.** **2.**	• length of arrow N (approximately) equal to component of mg perpendicular to slope $N \approx mg \cos\theta$ • correct direction of real forces • magnitude of $Mg > T > mg\sin 30^o$ (component of mg parallel to slope) Correct direction for acceleration of both masses.  mass *M* mass *m*
7b(ii)	$Mg - T = Ma$ -------------------- (1) $a = \frac{Mg - T}{M}$ $T - mg \sin 30^o = ma$ -------------------- (2) $T = ma + mg\sin 30^0$ $= m\left(\frac{Mg - T}{M}\right) + mg(0.5)$ $TM = mMg - mT + 0.5mMg$ $T(M+m) = 1.5mMg$ $T = \frac{1.5mMg}{M+m}$
7b(iii)	$T = \frac{1.5(6.0)(3.0)(9.81)}{(6.0 + 3.0)}$ $= 29.43$ N $a = \frac{(6.0)(9.81) - (29.43)}{6.0}$ $= 4.91$ m s^{-2}
7b(iv)	Loss in GPE of *M* = Gain in KE of (*M* + *m*) + Gain in GPE of *m* + WD against friction

7c(i)	Initial KE is zero but final KE is not. Hence KE is not conserved.
c(ii)	KE = 5.2×10^{-13} $\frac{1}{2} \times 4 \times 1.66\times10^{-27} \times v^2 = 5.2 \times 10^{-13}$ $v = 1.25 \times 10^7$ m s^{-1}
(iii)	Because there is no external force acting on system
(iv)	From COM, $4\,u \times 1.2515 \times 10^7 - 220\,u \times v = 0$ $u = 2.275 \times 10^5$ m s^{-1} $KE_{radon} = \frac{1}{2} \times 220\,u \times (2.275 \times 10^5)^2$ $= 9.45 \times 10^{-15}$ J

8a	Diagram (if drawn) must show light source (e.g. light / laser), object causing interference (i.e. double slit) and means of observation (e.g. screen) Light source must be monochromatic and coherent **OR** Description of setup must mention the above items. Instead of two bright fringes of the screen, a fringe pattern containing alternating light and dark fringes is observed. Note: drawing of wavefronts / ripples is not accepted as light wave are in multiple planes
8bi	From Fig. 8.1, period, T = 6 x 0.50 x 10^{-3} s = 3.0 x 10^{-3} s Hence, frequency = 1/T = 333.33 = 333 Hz
8bii	Using v = f λ, 330 = 333.33 λ λ = 0.99 m
8biii	Since Intensity ∝ $(1 / r)^2$, Using ratio, $\frac{I_{5.5}}{I_{1.2}} = \left(\frac{r_{1.2}}{r_{5.5}}\right)^2$ ➔ $I_{5.5} = \left(\frac{1.2}{5.5}\right)^2 0.65 = 0.031\ W\ m^{-2}$
8ci	Using Pythagoras' Theorem, Distance = $\sqrt{8.40^2 + 4.20^2}$ = 9.391 = 9.39 m **[shown]**
8cii	path difference = 9.391 – 8.40 = 0.99 m Hence path difference = λ or phase difference = 2π rad The waves from both speakers will arrive in phase at the sound detector. Hence constructive interference occurs and the intensity at the sound detector is a high.
8ciii	Using intensity ∝ $1/r^2$, intensity due to L_2 only at 9.39 m away from sound detector is $\frac{I_2}{I} = \left(\frac{8.4}{9.39}\right)^2$ ➔ $I_2 = 0.8003\ I$ Since intensity ∝ amplitude^2 and letting amplitude of sound due to L_1 alone at detector be a, $\frac{I}{I_2} = \left(\frac{a}{a_2}\right)^2$ ➔ $\frac{I}{0.8003\ I} = \left(\frac{a}{a_2}\right)^2$ ➔ $a_2 = 0.8946\ a$ Since from 8cii, constructive interference takes place, resultant amplitude at sound detector = $a + 0.8946a = 1.8946a$ Hence,

	$$\frac{I_{resultant}}{I} = \left(\frac{1.8946\,a}{a}\right)^2$$ ➔ $I_{resultant}$ = 3.6 I **[shown]**
8civ	Since the path difference is equal to 0 λ when L_2 is 8.4 m from sound detector, there must be a position in between where the path difference is 0.5 λ. Hence a low intensity (at path difference 0.5 λ) followed by a high intensity (at path difference 0 λ) will be observed at the sound detector. **OR** As L_2 moves to 8.4 m away from sound detector, path difference drops from 1λ to 0.5λ to 0λ. Hence, intensity of sound drops from loud (maximum) to soft (minimum) to loud (maximum) respectively.
8d	The microphones receive sound from the surrounding and the headphones then produces the same sound but in antiphase (π radian out of phase). This causes destructive interference of the sound from the surrounding and reduces the noise perceived by the listener.

9a	One **tesla** is the magnetic flux density which causes a force per unit length of one newton per metre on a straight wire carrying a current of one ampere and is at right angles to the direction of the magnetic field.
9bi	force per unit length on each wire is proportional to the product of the two currents /by Newton's third law/action and reaction pair of forces are equal and opposite so forces are equal
9bii	Force on XY is towards PQ, $\Rightarrow$ hence wire XY moves towards PQ $\Rightarrow$ as it moves towards PQ, **B** becomes larger (F=BIL), $\Rightarrow$ F↑, a↑, v↑
9ci	As seen from the increased balance reading, there is a downward force on magnet due to wire carrying current. By Newton's third law, there is an upward force on wire by magnet. By Fleming's left hand rule, pole P is a **north** pole
9cii	By Newton's 2nd law, W – BIL =0 $\Rightarrow$ W= BIL $2.3 \times 10^{-3} \times 9.81 = B \times 2.6 \times 4.4 \times 10^{-2}$ B = 0.20 T (g = 10, loses this mark)
9di1	resistance is ratio *V/I* (at a point), *I* increases more rapidly than *V* or ratio *V/I* decreases resistance of component C decreases with increasing potential difference. (If states R=reciprocal of gradient, then 0/2 marks)
9di2	resistance = *V* / *I* = 6/0.2 = 30 Ω (using the gradient loses this mark)
9dii1	Individual currents are 0.20 A and 0.30 A Current in battery = 0.50 A
9dii2	power = VI = 6.0x0.5 = 3.0 W
9diii	Since arranged in series, current in R and C is same & total p.d. across R and C is to be 10 V. From graph, *I* = 0.20 A. p.d. across C (6 V) is larger than that across R (4 V), so since power = VI, greater in C