H1 Paper 1 Answer Key

1. D	**2. B**	**3. C**	**4. D**	**5. C**	**6. C**	**7. D**	**8. D**	**9. A**	**10. A**
11. C	**12. B**	**13. D**	**14. B**	**15. B**	**16. C**	**17. B**	**18. C**	**19. C**	**20. C**
21. B	**22. B**	**23. D**	**24. B**	**25. D**	**26. C**	**27. D**	**28. A**	**29. B**	**30. B**

H1 Paper 2 Suggested Solution

Section A

Question 1

1	**(a)**	R = 300 ±10% = 300 ± 30 Ω Total resistance = 300 + 300 = 600 Ω Δ(R+R) = 30 + 30= 60 Ω Total resistance = 600 ± 60 Ω	**M1** **A1**
	(b)	R = 330 Ω hence ΔR = 5% of 330 Ω = 16.5 Ω Hence maximum value for a single resistor is (330 + 16.5) Ω = 346.5 Ω Hence minimum value for a single resistor is (330 - 16.5) Ω = 313.5 Ω Since combined resistance, R_c = R/2 Maximum value for R_c = 346.5/2 = 173.25Ω Minimum value for R_c = 313.5/2 = 156.75Ω Rounding off to the nearest ohm, Maximum value = 173 Ω Minimum value = 157 Ω	**M2** **A1**

Question 2

2	**(a)**	Using $v_y = u_y + a_y t$: At max height, $v_y = 0$. $0 = 30 \sin 30^o – (9.81)\, t$ t = 1.529 s time taken = 1.529 x 2 = 3.06s	**M1** **A1**
	(b)	Range = $u_x t$ = 30 cos 30° (3.06) = 79.5 m	**A1**
	(c)	60°	**A1**
	(d)	A straight line starting at 15 ms^{-1} to -15 ms^{-1} cutting through t = 1.529 s at the midway when v = 0	**B1**
	(e)	Key features to note: time taken upwards < time taken downwards gradient at x-intercept is still acceleration at free fall	**B1** **B1**

Question 3

3	**(a)**	**(i)**	Visible light, with wavelengths of about 10^{-7} nm, is only **diffracted** slightly. Radio waves, which have much longer wavelengths, are diffracted much more. Hence, the wavelength used by GPS must be longer than that of visible light and shorter than that of radio waves. The GPS uses microwaves.	**B1** **B1**
		(ii)	400 nodes correspond to 399 $\lambda/2$ segments, where $\lambda = c / f = (3.00 \times 10^8) / (90.5 \times 10^6) = 3.315$ m is the wavelength of the radio waves emitted by Gold 90.5 FM. Hence, distance is 399 x 3.315/2 = 661 m (3 s.f.).	**M1** **A1**
	(b)	**(i)**	Both transverse/longitudinal/same type Meet at a point/overlap	**B1** **B1**
		(ii)	$\Delta y = \lambda D / a$ $\Delta y = (690 \times 10^{-9}) \times (1.20) / (0.333 \times 10^{-3}) = 0.002486$ m = 2.49 mm (2 or 3 s.f.)	**M1** **A1**
		(iii)	Better contrast of pattern No change in fringe position	**B1** **B1**

Question 4

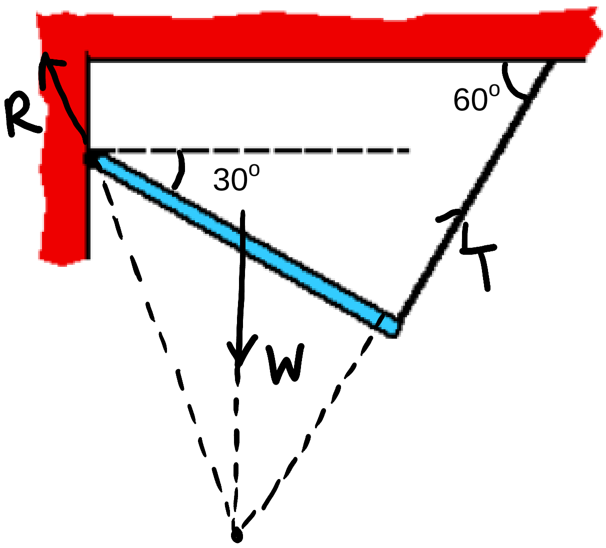
4	**(a)**	**(i)**	Provide a broad, continuous spectrum of wavelengths.	**B1**
		(ii)	Create a coherent source.	**B1**
	(b)	**(i)**	Transition from E_3 to E_1: $\Delta E = h f$ $\therefore E_3 - E_1 = h f$ $\therefore (-1.36 \times 10^{-19}) - (-5.46 \times 10^{-19}) = 6.63 \times 10^{-34} \times f$ $\therefore f = 6.18 \times 10^{14}$ Hz	**B1** **A0**
		(ii)	$(E_3 - E_1) = (E_3 - E_2) + (E_2 - E_1)$. Thus, $hf_{31} = hf_{32} + hf_{21}$ $\therefore f_{31} = f_{32} + f_{21}$. i.e. $6.18 \times 10^{14} = 1.60 \times 10^{14} + f_{21}$ $\therefore f_{21} = 4.58 \times 10^{14}$ Hz. Hence, the emitted wavelength, $\lambda_{21} = \frac{c}{f_{21}} = \frac{3\times10^8}{4.59\times10^{14}}$ $= 6.55 \times 10^{-7}$ m.	**B1** **A1**
	(c)		2 thin dark lines appear in a continuous spectrum (on one side) These thin line positions correspond to wavelengths absorbed by the gas X atoms through excitatory electronic transitions E_1 to E_3 & E_1 to E_2.	**B1** **B1**

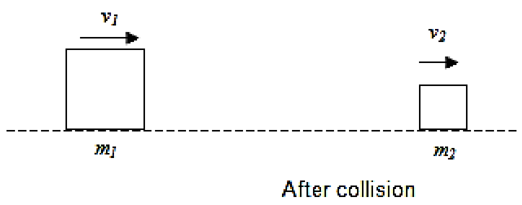
Question 5

5	**(a)**	No. Line is not straight / line curves / gradient is not constant / k is not constant (But) Hooke's law states extension or change in length is directly proportional to the force applied O R Extension is not proportional to force	**B1** **B1**
	(b)	Indication of use of area (could be marks on graph) / use of ½ *Fx* More detailed estimation, e.g. counting squares, for correct answer = 0.76 J (accept answers above from 0.7 J to just below 0.8 J)	**B1** **B1**
	(c)	During loading, energy is transferred to elastic potential energy of band (and some heat). During unloading (when the force is decreased), elastic potential energy decreases and some energy is transferred to heat/ internal energy.	**B1** **B1**
	(d)(i)	Equates stored energy with initial kinetic energy of aeroplane Use of KE = $1/2\ mv^2$ $0.76\ J = 1/2\ mv^2$ $v = \sqrt{(2 \times 0.76\ J / 0.027\ kg)}$ $= 7.5\ m\ s^{-1}$	**M1** **A1**
	(d)(ii)	Area under graph for increasing force > area for decreasing force OR one line higher than the other OR there is a gap between lines. Work done by rubber band is less than calculated energy stored OR energy stored > energy retrieved OR area between lines is energy transferred to heat OR area between lines is energy dissipated Not all energy is transferred to kinetic energy, hence smaller maximum speed	**B1** **B1** **B1**

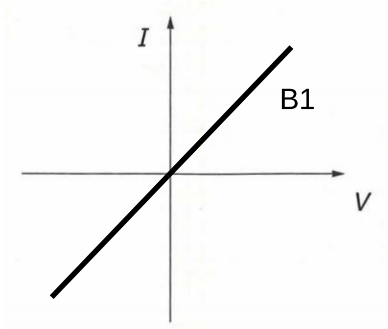
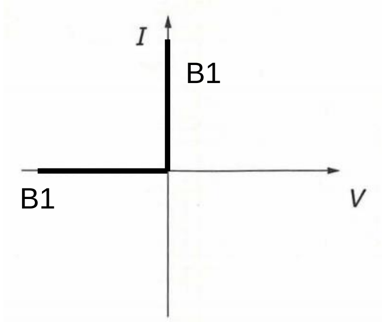
Section B

Question 6

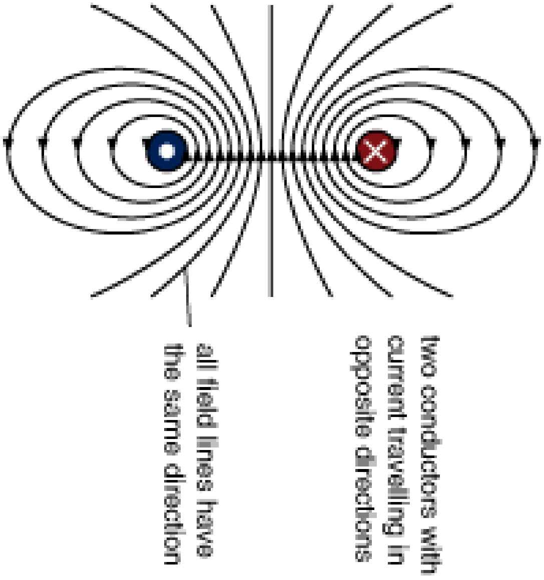
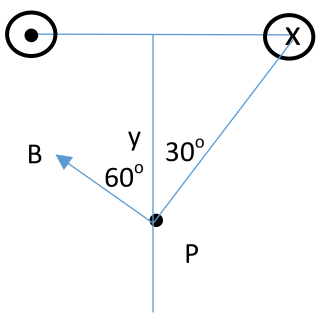
6	**(a)**	 W is the weight of the rod, T is the tension acting on the rod, R is the force acting on the rod by the hinge.	- All 3 forces correctly labeled and explained [1] - All 3 forces intersect to meet at a common point. [1] - Appropriate magnitudes of forces. [1] Any missing point deduct 1 mark.	**B1** **B1** **B1**
		(i)	Take moments about the hinge, $30\times 9.81\times \cos 30^{o}(\frac{L}{2}) = T\times L$ $T = 127.4 \approx 127N$	**M1** **M1**
		(ii)	$(\leftarrow +)\quad R_X = T\sin 30^{o} = 127.4\sin 30^{o} = 63.7N$ $(\uparrow +)\quad R_Y = 30\times 9.81 - T\cos 30^{o} = 184N$ $R = \sqrt{R_X^2 + R_Y^2} = \sqrt{63.7^2 + 184^2} = 194.7 \approx 195N$ $\tan\theta = \frac{184}{63.7} \Rightarrow \quad \theta = 70.9^{o}$ above the horizontal as shown in Fig.	**M1** **M1** **A1** **A1**
	(b)	**(i)**	The Principle of Conservation of Linear Momentum states that the total momentum of a system is constant if no net external force acts on the system.	**B1**
		(ii)	According to Newton's 3rd law, when body A exerts a force on body B, body B will exert a force on body A equal in magnitude but opposite in direction. The time over which for force acts for both bodies will be the same as well. Therefore, the impulse of the force on each body will be equal in magnitude but opposite in direction. By Newton's 2nd law, the impulse is equal to the change in momentum of the body. Therefore the gain in momentum of one body (eg body B) will be equal to the loss in momentum of the other body (eg body A). The total momentum of the system (body A and B) remains constant since there is no net change in momentum of the system.	**B1** **B1** **B1**
	(c)	**(i)**	1. the direction of motion after collision will be along the same line of motion before collsion. 2. the relative speed of approach is equal to the relative speed of separation.	**B1** **B1**

		(ii)	1. Relative speed of approach = 1.0 + 3.0 = 4.0 m s^{-1} Since it is a perfectly elastic collision, Relative speed of separation = 4.0 m s^{-1} 2.  $v_2 - (-2) = 4.0$ $v_2 = 2.0$ m s^{-1} to the right	**A1** **M1** **A1**
		(iii)	Velocities after collision will not be along the same line of motion before collision, and the velocity will be different. Since the collision is not head-on, the approach of using relative speed of approach equals relative speed of separation cannot be used.	**B1** **B1**

Question 7

7	(a) (i)			B1
	(ii)			B2
	(b)	(i)	The p.d. between 2 points in a circuit is the energy converted per unit electric charge from electrical to non-electrical forms when charges moved between the 2 points.	B2
		(ii)	Potential difference refers to energy conversion per unit charge from electrical to non-electrical forms. Emf refers to energy conversion per unit charge from non-electrical to electrical forms.	B1
	(c)	(i)	$N = Q/e = It/e$ = 2.3 x (6x60x60)/1.60x^{-19} = 3.11x10^{23}.	M1 C1
		(ii) 1.	$P=V^2/R$ $48=12^2/R$ R=3.0Ω	M1 C1
		2.	$A = \pi r^2 = \pi(9.1\text{x}10^{-5})^2$ $R=\rho L/A$ 3.0 = (8.1x10-7)L/π(9.1x10^{-5})^2 L = 9.64 cm	M1 M1 A1
		3.	During operation, I^2R (joule) heating causes the filament to heat up. The increased lattice vibration increases the resistance of the filament.	B1 B1
		4.	Effective resistance = (3/2) // (24/4) = 1.2 Ω Current = 12/(1.2+0.026) = 9.79 A Terminal p.d. = $E - Ir$ = 12 – (9.79)(0.026) = 11.75 V	M1 C1 A1
		5.	With the motor switched on, effective resistance of the circuit is lowered, leading to higher current from battery. With higher current, the potential difference across the internal resistance is larger, leaving less potential difference across the lamps.	B1 B1

Question 8

8	(a)	The **magnetic flux density** is defined as the **force per unit length per unit current** acting on an **infinitely long** current carrying conductor placed **perpendicularly to the magnetic field**. SI units for $B = \mathrm{N}\frac{1}{\mathrm{m\,A}} = \left(\mathrm{kg}\frac{\mathrm{m}}{\mathrm{s}^2}\right)\frac{1}{\mathrm{m\,A}} = \mathrm{kg\ s^{-2}\ A^{-1}}$		B2 B1
	(b)	$\frac{kg\ s^{-2}}{A} = unit\ of\ \mu_0\ (\frac{A}{m})$ units for μ_0 = m kg s^{-2} A^{-2}		B1
	(c)	(i)	 Marking points: Circles that are getting more distorted on the outside [1] not centred [1] and directions of B fields [1].	B1 B1 B1
		(ii)	$\frac{F}{L} = BI = \frac{\mu_o I^2}{2\pi d} = \frac{(4\pi\times10^{-7})(0.5)^2}{2\pi(0.2)} = 2.5\times10^{-7}\ \mathrm{Nm^{-1}}$ Direction of force is towards the left away from the right wire along the line joining the two wires.	C1 A1 B1
		(iii)	 The position of the two wires and point P forms an equilateral triangle. The direction of the magnetic flux density at P due to one of the wires is perpendicular to the line joining the wire and point P as shown in the diagram. At P, $B = 2\left(\frac{\mu_o I}{2\pi d}\right)\cos 60^o$	

			$= 2\left(\dfrac{(4\pi\times10^{-7})(0.5)}{2\pi(0.2)}\right)\cos 60^o$ $= 2.5\times10^{-7}$ T Direction: Pointing upwards from P towards the point equidistant between the two wires.	**B1** **A1** **B1**
	(d)	**(i)**	The direction of the magnetic field inside the solenoid is parallel to the axis of the solenoid. A **current carrying conductor perpendicular** to this field will experience a force. Based on Fleming left hand rule, the force is perpendicular to the directions of the magnetic fields and the current and points **downwards**. A **turning effect about the pivot along XY** is produced since the line of action of the **magnetic force is some distance away**.	**B1** **B1** **B1**
		(ii)	The directions of the currents in wire segment AX and CY are the same as that of the magnetic flux density. Based on Fleming's Left Hand Rule, the force is zero.	**B1**
		(iii)	Let length of wire segment AX = u = 0.600 m Length between T and wire segment XY = v = 0.400 m Length of AC = L = 0.200 cm Anti-clockwise moment = clockwise moment $(BIL)(u) = (mg)(v)$ Magnetic flux density $= \dfrac{mgv}{ILu}$ $= \dfrac{(0.030)(9.81)(0.400)}{(3.0)(0.200)(0.600)}$ $= 0.327$ T	**M1** **C1** **A1**