Paper 2 Structured Questions Solution template:

Section A

1	**(a)**		$v^2 = 2gs \quad = 2x9.81x\ 4.5$ $v = 9.4\ ms^{-1}$	**C0** **A1**
	(b)		**(ii)** *either* F (= $3.2 \times 10^{-4} \times 1.2 \times 10^{-2} \times 9.4$) = 3.6×10^{-5} N — M1 weight of sphere (= mg = $15 \times 10^{-3} \times 9.8$) = 0.15 N — M1 3.6×10^{-5} << 0.15, so justified — A1 *or* $mg = crv_T$ — (M1) terminal speed = 3.8×10^4 m s^{-1} — (M1) 9.4 << 3.8×10^4, so justified — (A1)	
2	**(a)**	**(i)**	Car uses 210/14 = 15 litres of fuel Volume reading = 45 litres	 **B1**
		(ii)	From full to ¾ mark	**B1**
	(b)	**(i)**	Line/graph does not pass through empty or zero, there is an y-intercept	**B1**
		(ii)	Acts as a reserve, (meter show zero fuel, but there is some left in the tank)	**B1**
3	**(a)**		Resultant forces is zero Resultant torque about any point is zero	**B1** **B1**
	(b)	**(i)**	Force due to wire P = 5.0 – 2.0 = 3.0 N	**C0** **A1**
	(b)	**(ii)**	5.0(d) = 2.0(0.90) d = 0.36 m	**C1** **A1**
4	**(a)**		EPE = ½ k s^2 = ½ (120)$(10 \times 10^{-2})^2$ = 0.60 J	**C0** **A1**
	(b)		Using COE: KE + GPE + EPE + Won = KE + GPE + EPE + Wagainst 0 + (2.0)(9.81)(0.10sin40) + 0 + 0 = ½ (2.0)$(V)^2$ + 0 + 0.60 + 0 V = 0.813 m s^{-1}	 **M0** **C1** **A1**
	(c)		Using COE: KE + GPE + EPE + Won = KE + GPE + EPE + Wagainst 0 + (2.0)(9.81)(Dsin40) + 0 + 0 = 0 + 0 + ½ (120)D^2 + 0 D = 0.210 m	 **M0** **C1** **A1**

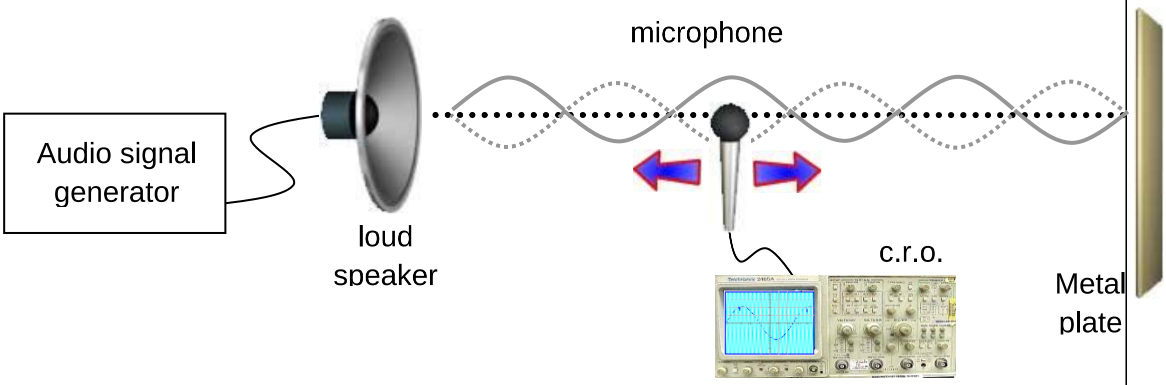
	(d)		T – 2 g sin 40 = 2a kD – 2 g sin 40 = 2a (120)(0.210) – 2 (9.81)sin40 = 2a a = 6.29 m s^{-2}	C1 A1
5	(a)		Q = It = 0.22x6 =1.32 C	C0 A1
	(b)		Q= Ne N= 1.32/1.6x10^{-19} = 8.25 x 10^{18}	 C0 A1
	(c)		E= I(R+r) R+r= 1.5/0.22 = 6.81 Ω R= 6.81-1.2= 5.62 Ω	M0 C1 A1
	(d)		Power = I^2r = $(0.22)^2(1.2)$ = 0.058 W	 C1 A1
	(e)		Power = I^2R =$(0.22)^2(5.62)$ = 0.272 W	C0 A1
	(f)		Fraction = 0.272/EI = 0.272/0.22(1.5) = 0.824	C0 A1
6	(a)		V=IR = 2 x 30 = 60 V	C0 A1
	(b)		V = 110 – 60 = 50 V I = V/R = 50/50 = 1.0 A	B1 C0 A1
	(c)		I_{ldr} = 2.0 - 1.0 = 1.0 A R_{ldr} = 50 /1.0 = 50.0 Ω	B1 C0 A1
	(d)		As the light gets dimmer the **resistance of LDR increases** Hence **effective resistance of all the resistors increases**. Current will decrease.	B1 B1
7	(a)		By principle of moments: F_B (y) = F_G (x) x/y = BIL /mg	 M1

			$= (5 \times 10^{-3})(2.0)(5 \times 10^{-2})/(0.1 \times 10^{-3})(9.81)$ $= 0.51$	**C1** **A1**
	(b)		Rightwards By principle of moments, the magnetic force on the wire DC is into the plane. Since current is flowing from D to C in wire DC and magnetic force on wire DC is downwards, the magnetic field due to solenoid is rightwards by Fleming's Left Hand rule.	**M1** **A1**
	(c)		Wire frame will not be balanced and will **rotate in the anti-clockwise direction** about sharp edge.	**B1**

Section B

8	**(a)**	**(i)**	k is the reciprocal of the gradient of the graph k= 32 / (4x 10^{-2}) = 800 N m^{-1}	**C1** **A1**
		(ii)	Either energy = average force x extension or ½ kx^2 or area under the graph line energy = ½ (800) (3.5 x $10^{-2})^2$ or ½ (28 x 3.5 x 10^{-2}) energy = 0.49 J	 **C1** **M1** **A0**
	(b)	**(i)**	Momentum before cutting thread = momentum after 0 = (2400 x V) – (800x v) v/V = 3.0	**C1** **M1** **A0**
		(ii)	Energy stored in spring = kinetic energy of trolleys 0.49 = ½ (2.4) (1/3 v)^2 + ½ (0.8) (v^2) v= 0.96 m s^{-1} (if only one trolley considered, or masses are combined, allow max 1 mark)	**C1** **C1** **A1**
	(c)	**(i)**	**1.** $v^2 = u^2 + 2as$ $0 = (1.2)^2 + 2(-a)(1.9)$ a = 0.38 m s^{-2} **2.** F = ma = (42) (0.38) = 16 N	 **M1** **A1** **M1**
		(ii)	$F_{ext} = F_{opp}$ = 16 N (since v is constant) Power = F_{ext} v = (16)(1.2) = 19 W	**B1** **C0** **A1**

		(iii)	**1.** Component = 42 (9.81) (sin 2.8^o) = 20.1 N	**C1** **A1**
			2. $\Sigma F = ma$ 20.1 – 16 = 42 a a = 0.097619 m s^{-2} s = ½ a t^2 3.5 = ½ (0.097619) t^2 t = 8.47 s	**B1** **C1** **A1**
		(iv)	This is because if slope is steeper, it means that the net force or downslope acceleration would be large which implies that the time taken for the trolley to travel 3.5 m downslope would be very short and people standing 3.5 m downslope would not have sufficient time to react.	**B1**
9	**(a)**	**(i)**	Photoelectric effect is the <u>emission of electrons from the surface of a metal</u> when <u>electromagnetic radiation of high enough frequency is incidenced on it</u>.	**B1** **B1**
		(ii)	$E = hc/\lambda$	**B1**
		(iii)	$E = hc/\lambda = (6.63 \times 10^{-34})(3 \times 10^{8})/(700 \times 10^{-9}) = 28.414 \times 10^{-20}$ J $\Delta E/E = \Delta\lambda/\lambda$ $\Delta E/28.414 \times 10^{-20} = 30/700$ $\Delta E = 1.22 \times 10^{-20} = 2 \times 10^{-20}$ J (1sf rd up) Correct precision $(28 \pm 2) \times 10^{-20}$ J	**B1** **M1** **C1** **A1**
	(b)		$\Phi = hc/\lambda_1 - eV_1$ ---(1) $\Phi = hc/\lambda_2 - 2eV_1$ ---(2) (1) × 2 – (2): $\Phi = 2hc/\lambda_1 - hc/\lambda_2$ $= (6.63 \times 10^{-34})(3 \times 10^{8})\,[(2/388 \times 10^{-9}) - (1/283 \times 10^{-9})]$ $= 3.22431 \times 10^{-19}$ J = 2.02 eV	 **M1** **C1** **A1**
	(c)	**(i)**	$N_e/t = I/e = (8.5 \times 10^{-6})/(1.60 \times 10^{-19})$ $N_e/t = 5.31 \times 10^{13}$ electrons s^{-1}	**C1** **A1**
		(ii)	$N_p/t = 8(N_e/t) = 8\,(5.31 \times 10^{13})$ $= 4.25 \times 10^{14}$ photons s^{-1}	**C0** **A1**
		(iii)	$E = hc/\lambda = (6.63 \times 10^{-34})(3\times10^{8})/(480 \times 10^{-9}) = 4.14375 \times 10^{-19}$ J $P = (N_p/t)(E) = (4.25 \times 10^{14})\,(4.14375 \times 10^{-19}) = 1.76 \times 10^{-4}$ W	**C1** **A1**
		(iv)	When intensity is doubled, the number of photons per unit time, Np/t, arriving at metal also doubled. (intensity α Np/t) Since frequency, f of source remains constant, the energy of a photon, E remains	**B1**

			constant. (E α f) As a result, power of source, P also doubled. (P α Np/t since E = constant)	B1 M1
	(d)		$\lambda = hc/(E_5 - E_3)$ $= (6.63 \times 10^{-34})(3 \times 10^{8})/[-0.545 - (-1.51)][1.60 \times 10^{-19}]$ $= 1.29 \times 10^{-6}$ m	 C1 A1
10	**(a)**		The **displacement** of the wave's particle is in the **same direction** as direction of **propagation of the sound wave.**	B1 B1
	(b)	**(i)**	The sound from the speakers has **a constant phase difference** and of the **same frequency**.	B1
	(ii)	**1**	v= f λ λ= 340/13600= 0.025 m n= 5/0.025 = 200	 C1 A1
		2	NP= $\sqrt{(5^2+0.5^2)}$= 5.025m m = 201	C1 A1
		3	The intensity at P is high (loud sound) . The waves from the two sources have a **path difference of 1 wavelength**, hence they are in phase and **interfere constructively**.	M1 A1 A1
		4	The observer will hear a high and low intensity alternately as he walks 0.75 m from P. There will be **3 high intensity excluding point P and 3 low intensity** as he walks 0.75 m in the opposite direction .	B1 B1
	(c)	**(i)**	The two waves must travel with the **same speed**, in the **opposite direction** and are of the **same frequency** and **amplitude**.	B1 B1
		(ii)	a) Using the following set up, produce sound waves by feeding signals from an audio signal generator to a loud speaker.  b) Place a metal plate at a certain distance from the speaker to reflect the emitted wave.	

			c) Connect a microphone to a cathode ray oscilloscope (c.r.o.) and use it to detect the nodes and antinodes at different positions. As the microphone is moved between the loudspeaker and the metal plate, the c.r.o. signal on its display screen will vary, having a maximum signal at the pressure antinodes (corresponding to displacement nodes) and a minimum signal at the pressure nodes (corresponding to displacement antinodes). Note : diagram (2 marks for correct arrangement of apparatus) . Detections of nodes and antinodes by moving the microphone and CRO observations. (2 marks)	**B2** **B2**
		(iii)	a. Measure the distance between two adjacent nodes, NN or two adjacent antinodes, AA. b. Find the wavelength of the sound, λ by using λ = 2 × distance between NN or AA. c. Calculate the frequency of the sound wave f using $f = v/\lambda$.	**B1** **B1**

Table of Specifications

Level of difficulties: 20% (Knowledge), 55% (Comprehension), 25% (Application)

Paper	Topic	LO	Knowledge		Comprehension		Application	
			Question	Marks	Question	Marks	Question	Marks
1	Waves	e	20	1				
1	Superposition	a	21	1				
1	Superposition	i			22	1		
1	Superposition	b					23	1
1	Superposition	b					24	1
1	COE	i			25	1		
1	COE	i			26	1		
1	COE	f			27	1		
1	DC	c			28	1		
1	DC	d			29	1		
1	DC	e					30	1
3	Waves	b	3a	2				
3	Waves	a	3bi	2				
3	waves	c			3bii(1)	2		
3	Superposition	g			3bii(2)	2		
3	superposition	h			3bii(3)	2		
3	superposition	h					3bii(4)	2
3	Superposition	c	3Ci	2				
3	waves	i	3cii	4				