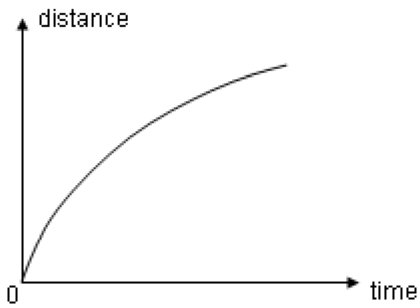
JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2015 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solution

Qn	Suggested solution	Remarks
1(a)	For an equation to be homogenous, all the terms in the equation must have the same base unit. Units of T = s Units of $2\pi\sqrt{\frac{I}{mgh}}$ = $\sqrt{\frac{kgm^2}{kgms^{-2}m}} = \sqrt{s^2} = s$ Since units of T = Units of $2\pi\sqrt{\frac{I}{mgh}}$, the equation is homogeneous.	**[1]** – correct base units of $2\pi\sqrt{\frac{I}{mgh}}$ **[1]** for comparing the units on LHS and RHS
(b)	$\frac{\Delta T}{T} = \frac{1}{2}(\frac{\Delta I}{I}) + \frac{1}{2}(\frac{\Delta m}{m}) + \frac{1}{2}(\frac{\Delta h}{h})$ = ½ (0.0001/0.2085) + ½ (0.5/4.1) + ½ (0.1/47.0) = 0.0623 Mean value of period, T = $2\pi\sqrt{\frac{0.2085}{(4.1)(9.81)(47.0x10^{-2})}}$ = 0.660 s Hence, absolute uncertainty in period, ΔT = (0.0623)(0.660) = 0.04 s Therefore, $T = (0.66 \pm 0.04)\ s$	**[1]** correct expression **[1]** ans for T **[1]** ans for ΔT (allow ecf) **[1]** final ans (allow ecf)
2(a)	Acceleration is defined as the rate of change of velocity.	**[1]**
(b)(i)	In order not to collide into the train in front at the time Anthony's train close the 100 m gap, his train must be moving at less than or 54 km h^{-1} $= \frac{(54)(1000)}{3600} = 15ms^{-1}$	**[1]** deduce **[1]** convert
(ii)		**[1]** convex shape (finite, non-zero gradients at both ends)

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(ii)	Let the time taken be t. In time t, distance moved by the other train = 15t and the distance moved by Anthony's train = $\frac{20+15}{2}t$ In order to just avoid a collision, $\frac{20+15}{2}t = 15t + 100$ t = 40 s minimum deceleration $= \frac{5}{40} = 0.125$ m s-2	**[2]** Any correct method **[1]** Ans
3(a)(i)	For every material of C irradiated, there is a maximum wavelength beyond which no electron would be emitted from the surface. (at 240 nm) Since the energy of a photon is expressed as hf, hence the minimum photon energy required to liberate an electron from its surface must correspond to a maximum wavelength or minimum frequency.	**[1]** **[1]**
(ii)	Apply negative potential at the collector and slowly increase potential difference until photo-current drops to zero. The potential difference when the photo-current just reduces to zero is the stopping potential Vs. and the maximum kinetic energy is determined by Ek, max = eVs.	**[1]** **[1]** **[1]**
(b)	$\frac{hc}{\lambda} = \phi + E_{k,max}$ $\frac{(6.63\times10^{-34})(3.0\times10^{8})}{50\times10^{-9}} = \phi + (20.0\times1.60\times10^{-19})$ $\phi = 7.78\times10^{-19}\text{ J} = 4.86\text{ eV}$	**[1]** read off correctly from graph **[1]** sub **[1]** ans

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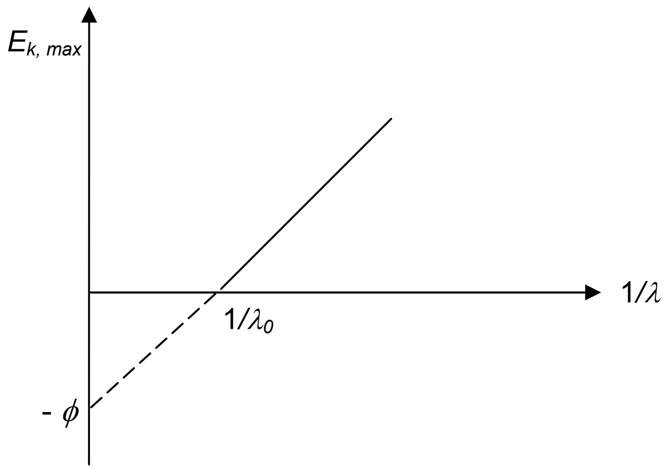
(c)		**[1]** correct relationship **[1]** dotted or no line in bottom half
4 (a)	$v^2 = u^2 + 2as \Rightarrow as = \left(\dfrac{v^2 - u^2}{2}\right)$ work done = Force $\times$ Displacement = $mas = m\left(\dfrac{v^2 - u^2}{2}\right)$ The work done on the stationary object (i.e. u = 0), which is equal to the increase in kinetic energy (Ek - 0), hence Ek = $\frac{1}{2}$ m v2	**[1]** **[1]** **[1]**
(b)	Lose in GPE_B = Gain in GPE_A + Gain in KE_{A+B} + Work done against friction $m_B g h_B = m_A g h_A + \frac{1}{2}(m_A + m_b)v^2$ + Work done against friction Work done against friction $= (6 \times 9.81 \times 5) - (2 \times 9.81 \times 5 \sin 30^\circ) - \frac{1}{2}(8 \times 4^2)$ $= 181.25$ Average frictional force $\times$ displacement = 181.25 Average frictional force = $\dfrac{181.25}{5} = 36.25 \approx 36.3$ N	**[1]** for correct equation based on COE. **[1]** for correct expression for work done against friction **[1]** for correct substitution **[1]** for correct answer
5(a)	$B = \dfrac{F}{IL\sin\theta}$ where, *B* = magnetic flux density, *F* = magnetic force acting on the conductor *I* = current, *L* = length of conductor, θ = angle between *B* and *I*	**[1]** formula **[1]** descriptions
(b)i)	Into the page	**[1]**
(ii)	Showed arrow towards X	**[1]**

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(iii)1.	Showed that Bd =constant i .e Br = (3.6×10^{-6} Tm) for at least 3 points	**[1]** for correct method **[2]** for using 3 points. Deduct 1 mark for using less than 3 points.
(iii)2.	F = (12×10^{-5})(18)(0.25) = 5.4×10^{-4} N	**[1]** Read off correctly **[1]** Ans
6(a)	The resistance of a circuit component is defined as the ratio of the potential difference across it to the electric current flowing through it.	**[1]**
(b)(i)	Current through second lamp = 0.30 – 0.10 = 0.20 A [P = VI] Power = (12)(0.20) = 2.4 W	**[1]** Ans **[1]** Ans
(ii)	[V = IR] 12 = (0.60)R $\Rightarrow$ R = 20 Ω	**[1]** Wkg **[1]** Ans
(iii)	1. lamp 1 (lowest current, highest resistance.) 2. lamp 3 (highest power hence hottest)	**[1]** **[1]**
(iv)	Resistances of lamps 1, 2 and 3 are 120 Ω, 60 Ω and 40 Ω respectively. (since the rated currents of lamps 1, 2 and 3 are 0.1 A, 0.2 A and 0.3 A respectively.) When all the three lamps are connected in series to the 36 V source, the same current flowing through them = 36/(120+60+40) = 0.164 A All Lamps will work under the maximum allowed current and hence voltage. Student is correct. <u>Alternate method</u>: Analysis will be based on p.d. across the lamps. V_1= 19.6 V, V_2= 9.8 V, V_3= 6.6 V	**[1]** lamp resistances **[1]** circuit current **[1]** explain **[1]** conclude
(c)(i)	The electromotive force of a source is defined as the non-electrical energy converted to electrical energy per unit charge delivered through the source.	**[1]**
(ii)	Electromotive force is defined for a source whereas potential difference is defined across any two points in an electric circuit. Electromotive force defined using non-electrical energy converted to electrical energy whereas potential difference is defined using electrical energy converted to non-electrical energy.	**[1]** **[1]**

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(d)(i)	Current $= \dfrac{\text{e.m.f.}}{\text{total resistance}}$ $I = \dfrac{E}{R_1 + R_2}$ V = IR_2 $= \left(\dfrac{E}{R_1 + R_2}\right) R_2 = \left(\dfrac{R_2}{R_1 + R_2}\right) E$	**[1]** **[1]** **[1]**
(ii)	As temperature increases, the resistance of the thermistor decreases. The current I increases since total resistance decreases. The voltmeter reading V = (I)(100 Ω) and therefore increases.	**[1]** **[1]** **[1]**
7(a)(i)	microwave	**[1]** - Ans
(ii)	0.040 m – 1.0 m	**[1]** - Ans
(iii)	Path difference: $\Delta x = 0.18 \text{ m} = 4.5\lambda$ The waves arrived at P 180° out-of-phase /in anti-phase and destructive interference takes placed.	**[1]** – Ans **[1]** – Ans **[1]** - Ans
(iv)	$\dfrac{\text{Intensity at P}}{\text{Intensity at O}} = \left(\dfrac{\text{Amplitude at P}}{\text{Amplitude at O}}\right)^2 = \left(\dfrac{2A - A}{2A + A}\right)^2 = 0.111$	**[1]** – Subs **[1]** - Ans
(v)	constructive	**[1]** - Ans
(b)(i)	$f = \dfrac{v}{\lambda} = \dfrac{\sqrt{(9.81)(0.026)}}{0.025} \approx 20.2 \approx 20$ Hz	**[1]** – Subs **[1]** - Ans
(ii)	0.125 m = 5λ $t = 5T = 0.25$ s	**[1]** – Subs **[1]** - Ans
(c)(i)	Two waves are said to be coherent if they have a constant phase difference between them.	**[1]** Ans **[1]** relevant diagram

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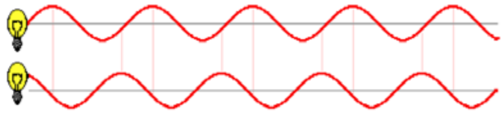
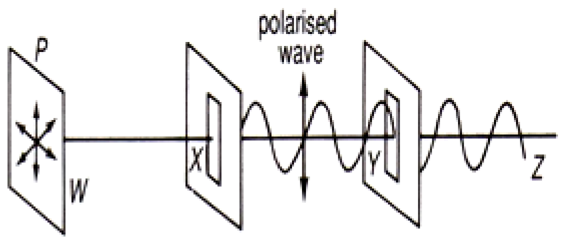
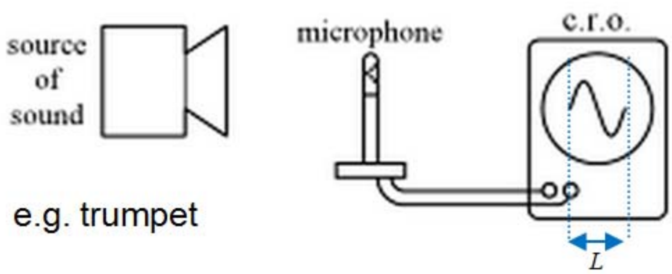
		
(ii)	Polarisation refers to the process of transforming unpolarised electromagnetic radiation into polarised electromagnetic radiation. In an unpolarised electromagnetic radiation, the wave elements in the transverse wave oscillate in many directions in the plane normal to the direction of energy transfer of the wave while in a polarised electromagnetic radiation, the wave elements in the transverse wave oscillate in one direction only in the plane normal to the direction of energy transfer of the wave. **Or simply:** **Polarisation** is a phenomenon in a **transverse wave** where the **vibrations of the elements are in one direction only, in the plane normal to the direction of energy transfer**  	**[1]** Ans **[1]** relevant diagram
(d)	 e.g. trumpet Set up the experiment as shown in the diagram. The trumpet is placed a short distance from a microphone connected to a calibrated c.r.o. The time-base of the c.r.o is adjusted until at least one complete sinusodial wave can be observed. The period T of the sound wave is given by the product of the length L of one	**[1]** relevant well-labelled diagram **[1]** procedure to determine suitable time-base **[1]** method to find period **[1]** method to find frequency

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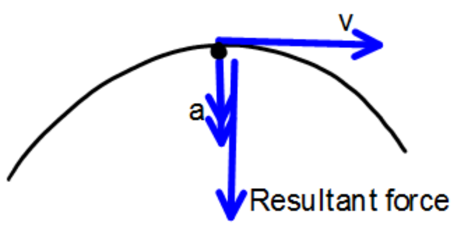
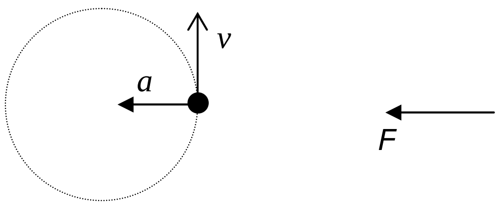
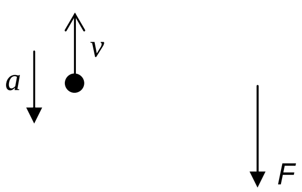
	complete sinusodial wave and the time-base setting b i.e. T = Lb. The frequency of the trumpet is the reciprocal of its period i.e. $f = \frac{1}{T} = \frac{1}{Lb}$	
8(a)	The rate of change of momentum of an object is directly proportional to the resultant force acting on it. The change in momentum takes place in the direction of that force. When object A exerts a force on object B, then object B exerts a force of the same type that is equal in magnitude and opposite in direction on object A.	**[2]** **[2]**
(b)	Force is proportional to the rate of change of momentum.	**[1]**
	Most candidates gave force correctly as proportional to the rate of change of momentum.	
(c)(i)	At maximum height of projectile motion,  Or In uniform circular motion, the acceleration of the object is always perpendicular to the velocity. This is known as the centripetal acceleration. 	**[1]** for correct situation **[1]** for correct diagram
(ii)	An object thrown up will have a velocity UPWARDS, but the acceleration due to the gravitational pull is DOWNWARDS. 	**[1]** for correct situation **[1]** for correct diagram

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(d)(i)	The Principle of conservation of momentum states that the total momentum of a system of interacting bodies is constant provided no external resultant force acts on it.	**[1]**
(ii)	Yes, the law will still apply. The force on the ball by the particle and the force on the particle by the ball are equal and opposite and thus there is no resultant force acting on the system. Despite the system losing kinetic energy, the total momentum of the system is still conserved.	**[2]**
(e)(i)	Using C.O.M: $1.2u + 0.6(-0.2) = 1.2v + 0.6(0.1)$ $1.2u = 1.2v + 0.18 ----(1)$ Using relative speed of approach = relative speed of separation: $u + 0.2 = 0.1 - v -----(2)$ Solving (1) and (2) u = 0.025 m s^{-1}	**[1]** **[1]** **[1]** for sub **[1]** for ans
(ii)	Solving (1) and (2) v = -0.125 m s^{-1}	**[1]** for sub **[1]** for ans
(f)	The equations used in (e) will not apply as friction is an external force acting on the system and thus the total momentum before and after the interaction is not constant.	[1] [1]