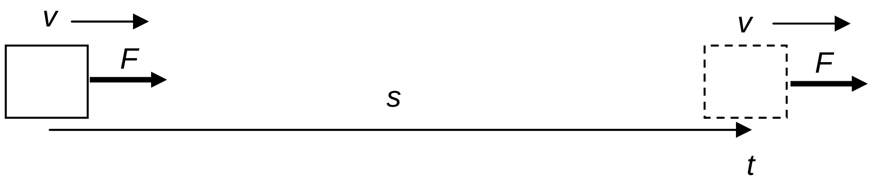
JURONG JUNIOR COLLEGE
PHYSICS DEPARTMENT
2014 JC2 Preliminary Examination
8866 H1 Physics Paper 2
Suggested Solutions

Qn	Suggested solution	Remarks
	SECTION A	
1(a)(i)	$v^2 = u^2 + 2as$ $9^2 = 0 + 2a(3)$ $a = 13.5 \text{ m s}^{-2}$	**[1] - Sub** **[1] - Ans**
1(a)(ii)	The ramp cannot be frictionless so that the **ramp can exert** a resultant **forward force on the wheels to accelerate up the ramp.**	**[1]**
1(b)	When the motorcyclist takes off and reaches the same height as the car, s_y = 0 m $s_y = u_y t + \frac{1}{2}at^2$ $0 = \left(9\sin 30^o + \frac{1}{2}(-9.81)t\right)t$ $t = 0$ s OR 0.917 s Let x = number of cars that can jump over $1.6x = (9\cos 30^o)(0.917)$ $x = 4.5 = 4$	**[1] – t** **[1] – Sub** **[1] – Ans**
2(a)	Suppose a constant force F displaces an object, moving at a constant velocity v, by a distance s over a time interval t, and that F, v and s all point along the same line.  Power P developed by the constant force F, $P = \frac{W}{t} = \frac{Fs}{t} = F\left(\frac{s}{t}\right) = Fv$	**[1] Working**
2(b)	For the cyclist to move at constant velocity, applied force F must be equal to the drag force D. $\Rightarrow F - D = 0$ $\Rightarrow F = D$ Using $P = Fv$ **200 = *F* x 5.0** F = 40 N Drag force = **40 N**	**[1] Sub** **[1] Ans**

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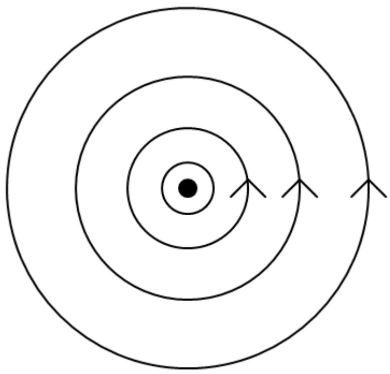
2(c)(i)	Given drag force $D \propto v$ $\Rightarrow D = kv$ Using $P = Fv$ $= Dv$ $= (kv)(v)$ $= kv^2$ Hence $P \propto v^2$	**[1] Working**
2(c)(ii)	Using $P \propto v^2$ $\mathbf{200 \propto (5.0)^2}$ ----- (1) $\boldsymbol{P \propto (6.0)^2}$ ------ (2) $\frac{(2)}{(1)} \quad \frac{P}{200} = \frac{6.0^2}{5.0^2}$ P = **288 W**	**[1] Sub** **[1] Ans**
2(d)	Power developed P = power to overcome drag force + power to climb up $= 200 + mg\,(v \sin\theta)$ **= 200 + 100 x 9.81 x 5.0 x sin 10^0** **= 1050 W**	**[1] Sub** **[1] Ans**
3(a)	Magnetic flux density is defined as the **force per unit length** acting on a **straight conductor** with unit current placed **perpendicular** to the magnetic field.	**[2] – Two or nothing**
3(b)(i)		**[1] – Correct direction** **[1] – Three concentric circles with increasing spacings**

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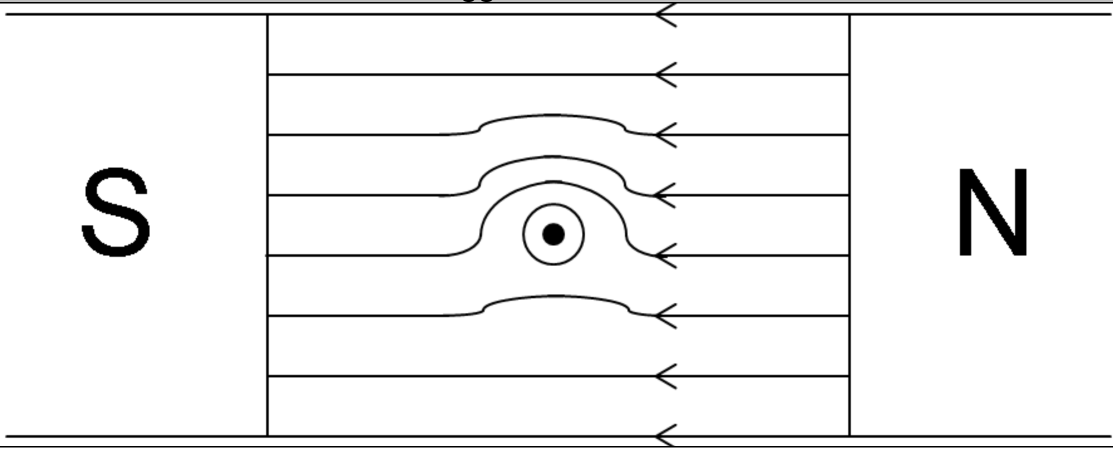
3(b)(ii)		**[1] – Uniform field near poles of magnetic** **[1] – Stronger field on top, weaker field below**
3(b)(iii)	Towards the bottom of the page.	**[1] - Ans**
3(b)(iv)	Magnetic force = (0.50)(1.5)(0.10) = 0.075 N	**[1] - Ans**
4(a)	$E = \frac{hc}{\lambda} = \frac{(6.63\times10^{-34})(3.0\times10^{8})}{(480\times10^{-9})} = 4.14\times10^{-19}$ J = **2.59 eV**	**[1]** – Sub **[1]** – Ans
4(b)(i)	**4.5 × 10^{14} Hz**	**[1]** – Ans
4(b)(ii)	From (b)(i), work function for sodium, $\Phi = hf_o$ = (6.63 × 10^{-34})(4.5 × 10^{14}) = 2.98 × 10^{-19} J = 1.86 eV From (a), photon energy, hf = 2.59 eV where $f = \frac{c}{\lambda} = \frac{3.0\times10^{8}}{480\times10^{-9}}$ = 6.25 × 10^{14} Hz From Einstein's equation, the maximum kinetic energy of the emitted electron, $E_{max} = hf - \Phi$ = 2.59 – 1.86 = 0.73 eV From Fig. 4, for f = 6.25 × 10^{14} Hz, the corresponding value of E_{max} is consistent with that obtained from Einstein's equation.	**[1]** – Value of Φ **[1]** – Value of f and E_{max}
4(c)(i)	Energy of a photon is given by $E = hf$. Since the small circles on the graph in Fig. 4 are the only frequencies obtained in this range, the **emitted photons** from the hydrogen lamp will only **have discrete values of energy**, given by the equation above. Since a **photon is emitted when an electron in a hydrogen atom transit from an excited state to a lower energy level**, it shows that hydrogen atoms have discrete energy levels.	**[1]** **[1]**

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4(c)(ii)		**[1]** – 5 or more lines with smaller gaps above and bigger gaps below
5(a)(i)	see table below	**[2] – for four correctly filled blanks** **1 mark for two correctly filled blanks**

n	***E* / eV**
1	–13.6
2	**–3.40**
3	**–1.51**
4	–0.85
5	**–0.54**
6	**–0.38**
∞	0

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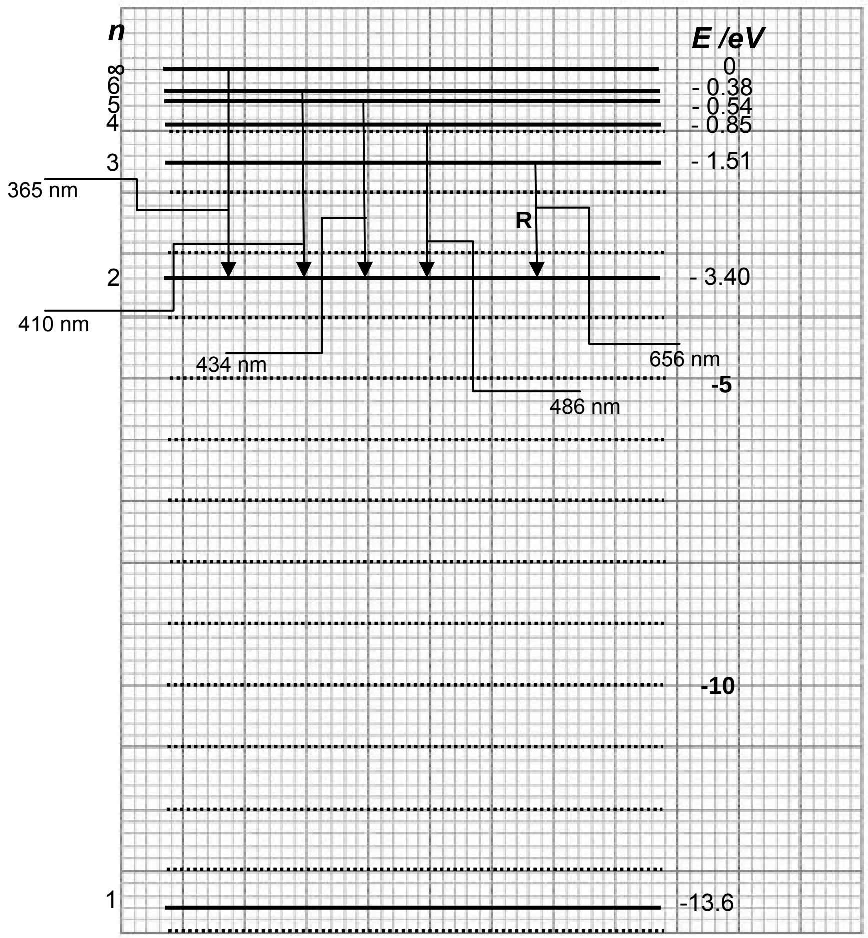
5(a)(ii)		**[2] – for four correctly drawn lines,** **1 mark for two correctly drawn line**
5(b)(i)	See above figure. **Draw five accurate arrows**. (deduct 1 mark for each inaccuracy e.g. wrong direction, missing arrows etc.)	**[2]**
5(b)(ii)	Consider transition from n = 3 to n = 2 $E_3 - E_2 = -1.51 - (-3.40) = 1.91$ eV Using $E = \frac{hc}{\lambda}$ $\lambda = \frac{(6.63\times10^{-34})(3\times10^{8})}{(1.91)(1.6\times10^{-19})} = 650$ nm (belongs to visible region) Other transitions that may be considered are: $E_\infty - E_2$ = 3.40 eV ------ photon with wavelength $\lambda = 365$ nm $E_6 - E_2$ = 3.02 eV ------ photon with wavelength $\lambda = 410$ nm $E_5 - E_2$ = 2.86 eV ------ photon with wavelength $\lambda = 434$ nm $E_4 - E_2$ = 2.55 eV ------ photon with wavelength $\lambda = 486$ nm	**[1] – Energy gap** **[1] - Sub** **[1] - Ans**

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5(b)(iii)	$E = \frac{hc}{\lambda}$ $= \frac{(6.63 \times 10^{-34})(3.00 \times 10^{8})}{6.56 \times 10^{-7}}$ $= 3.03 \times 10^{-19}$ J = 1.9 eV $E_3 - E_2 = -1.51 - (-3.40) = 1.9$ eV **R** is indicated in the graph above.	**[1] – R marked correctly**
	SECTION B	
6(a)	The **resultant force** acting on the object is **zero**. The **resultant torque** acting on the object is **zero**.	**[1]** **[1]**
6(b)(i)	$\sum F_X = 0$ => $\boldsymbol{T_1 \sin 36.9^0 = T_2 \sin 53.1^0}$ $T_1 = 1.33\ T_2$	**[1] Working**
6(b)(ii)	Take moment about the C.G Total clockwise moment = Total anticlockwise moment $\boldsymbol{(T_1 \cos 36.9^0)(x) = T_2 \cos 53.1^0 \times (6.10 - x)}$ $(1.33\ T_2 \cos 36.9^0)(x) = T_2 \cos 53.1^0 \times (6.10 - x)$ x = **2.20 m**	**[1] Sub** **[1] Ans**
6(c)(i)	The **car driver** will suffer more serious injury. Both the car and the truck **experience the same magnitude of force** during collision. Since the **mass of the car is smaller, the car has a bigger deceleration**. Thus the car driver also has a bigger deceleration and hence will experience a greater force.	**[1] Ans** **[1] Explanation**
6(c)(ii)	The (inflated) air-bag **increases the duration of time for the momentum of the driver to decrease to zero** during collision. This result in a smaller **force acting on the driver**, hence **reduce the injury** on the driver.	**[1]** **[1]**
6(d)(i)	By Conservation of Linear Momentum, $\boldsymbol{(2m + 3m)V_0 = (3m)(-\frac{1}{3}V_o) + 2mV_A}$ $V_A = \boldsymbol{3V_0}$	**[1] sub** **[1] ans**

Qn	Suggested solution	Remarks
6(d)(ii)	The internal explosion in the two-stage rocket **gives additional forward force to component A,** and hence its velocity increases. Furthermore, with a **decrease in mass after discarding component B** which is used as a fuel module, a **greater acceleration can be experienced with the same thrust.**	**[1]** **[1]**
6(e)(i)	**The object experiences two forces acting on it namely weight *W* acting downwards and a viscous force *R* acting upwards which opposes its motion.** Net force on object, $W - R = \text{m}a$ As the **speed** of object **increases, viscous force increases,** **acceleration of the object decreases until zero which implies that the object is moving at constant velocity.** Hence the speed increases to a constant terminal value.	**[1] statement** **[1]** **[1]**
6(e)(ii)	At constant terminal speed, **kinetic energy is constant**. As the object falls, there is loss in gravitational potential energy. The **loss of gravitational potential energy is converted to thermal energy / work done against the viscous force**	**[1]** **[1]**
6(e)(iii)	Given $v \propto a^2$ $\mathbf{0.5 \propto (2.0)^2}$ ----- (1) $\mathbf{0.25 \propto (a_2)^2}$ -------(2) $\frac{(1)}{(2)} \quad \frac{0.5}{0.25} = \frac{2.0^2}{(a_2)^2}$ a_2 = **1.4 mm**	**[1] sub** **[1] ans**
7(a)	The electromotive force (e.m.f.) of a <u>source</u> is defined as the energy converted from **non-electrical to electrical per unit charge driven through the source** while potential difference **between two points** is defined as energy converted from **electrical to non- electrical per unit charge passing from one point to the other.** Or "emf of source" vs "pd across 2 points in a circuit" "non-electrical to electrical" vs "electrical to non-electrical"	**[1] - Ans** **[1] - Ans**
7(b)(i)	potential difference across the 1.2 kΩ resistor = 2.0 V	**[1] – Ans**

Qn	Suggested solution	Remarks
7(b)(ii)	Using $V = IR$ $2.0 = (1.2 \times 10^{3})\, I$ $I = 1.67 \times 10^{-3}$ A $R = \dfrac{V}{I} = \dfrac{7.0}{1.67 \times 10^{-3}}$ = 4200 Ω = 4.2 kΩ	**[1] - Sub** **[1] - Ans**
7(b)(iii)	From **Fig. 7.1**, light intensity = 24 W m^{-2}	**[1] – Ans**
7(b)(iv)	Length of strip, $\ell = (10 \times 5.0 \times 10^{-3}) + (10.0 \times 10^{-3}) = 0.060$ m Using $R = \dfrac{\rho \ell}{A}$, $\rho = \dfrac{RA}{\ell} = \dfrac{4200 \times 5.0 \times 10^{-7}}{0.060} = 3.5 \times 10^{-2}\ \Omega \text{m}$	**[1] – Value of *l*** **(ecf for *l*)** **[1] – Ans**
7(c)(i)	nature of fault: lamp is short-circuited faulty lamp: lamp E	**[1] – Ans** **[1] – Ans**
7(c)(ii)	Short-circuited lamp could cause **excessive current** to flow in the circuit that could cause **damage to the power supply / other lamps / blow fuse in power supply.**	**[1] – Ans**
7(c)(iii)	Resistance of one non-faulty lamp = 30.0 / 2 = 15.0 Ω	**[1] – Ans**
7(c)(iv)	(see table below)	**[4] One mark each blank**
(c)(v)1.	Using $V = I\, R$ $R = V / I$ = 12.0 / 0.40 = 30.0 Ω	**[1] - Ans**
(c)(v)2.	Using $P = V I$ or $I^2 R$ or V^2 / R $P = 12.0 \times 0.40$ = 4.8 W	**[1] - Ans**

7(c)(iv) table:

switch			metre reading
S_1	S_2	S_3	/ Ω
open	open	open	∞
closed	open	open	30.0
closed	closed	open	25.0
closed	closed	closed	15.0

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(c)(vi)	In practical usage, the resistance of a lamp filament varies with temperature. Lamp filament is **cold and has lower resistance** when measuring with ohm-meter in **(iii)**. **Resistance of filament rises as temperature rises** when lamp operates at normal brightness in **(v)1**.	 **[1] – Ans** **[1] - Ans**
8(a)	In a longitudinal wave, the **direction of propagation of the wave is parallel to the direction of vibration of the particles** in the wave. In a transverse wave, the **direction of propagation of the wave is perpendicular to the direction of vibration of the particles** in the wave.	**[1]** – Ans **[1]** – Ans
8(b)	$x = \frac{\phi}{2\pi}(\lambda) = \frac{\pi/4}{2\pi}(1)$ = **0.125 m**	**[1]** – Sub **[1]** – Ans
8(c)	Resultant amplitude, $A_R = 3A - A = 2A$ $I = kA^2$ → Resultant intensity $I_R = kA_R^2 = k(2A) = k(4A^2)$ $= 4I$	**[1]** – Value of A_R **[1]** – Ans
8(d)(i)	As the microphone is moved between the loudspeaker and the reflector, mark a **position** where the CRO attached shows the **maximum (or min) amplitude**. Then move the microphone along to the **NEXT position** where the **amplitude** shown is **maximum (or min)** again. The **distance between these two positions is half a wavelength**.	**[1]** – How to locate the 2 positions **[1]**
8(d)(ii)	When microphone detects a maximum, its diaphragm vibrates with maximum amplitude. This means that the **air pressure** there has a **maximum change**. It implies that that position is alternatively **a compression and a rarefaction**, which is a displacement node.	**[1]** **[1]**
8(e)(i)	Coherence of the two waves means these two waves have a **constant phase difference**.	**[1]** – Ans
8(e)(ii)	When a wave front meets the pair of slits, the **wave front emerges from the slits** as divergent wave fronts which **are in phase with each other**, i.e. the two slits act as two coherent sources of divergent waves which are in phase. Hence the coherence condition for interference is obtained.	**[1]** – Ans
8(f)	$\frac{x}{D} = \frac{\lambda}{a}$ → $x = \frac{\lambda D}{a} = \frac{(5.24 \times 10^{-7})(0.945)}{0.220 \times 10^{-3}}$ $= \mathbf{2.25 \times 10^{-3}}$ **m**	**[1]** – Sub **[1]** – Ans

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8(g)(i)	For open pipe, at resonant frequency f_o, the length AB, $L = \frac{\lambda}{2}$ → $\lambda = 2L$ → $f_o = \frac{v}{2L}$ For closed pipe at resonance, $L = \frac{\lambda}{4}$ → $f = \frac{v}{4L}$ $= \frac{f_o}{2}$	**[1]** – Exp **[1]** – Exp **[1]** – Ans
8(g)(ii)	At fundamental mode, the transverse wave in the string has the same wavelength as the sound wave in the open pipe in (g)(i). For the same wavelength, v is proportional to f. $v = f\lambda$ Since the frequency of the transverse wave in string $= \frac{f_o}{4}$ the speed of transverse wave in string, $v = \frac{v_s}{4} = \frac{330}{4}$ $= 82.5 \text{ m s}^{-1}$	**[1]** – $\lambda = 2L$ **[1]** – Sub **[1]** – Ans

~ THE END ~