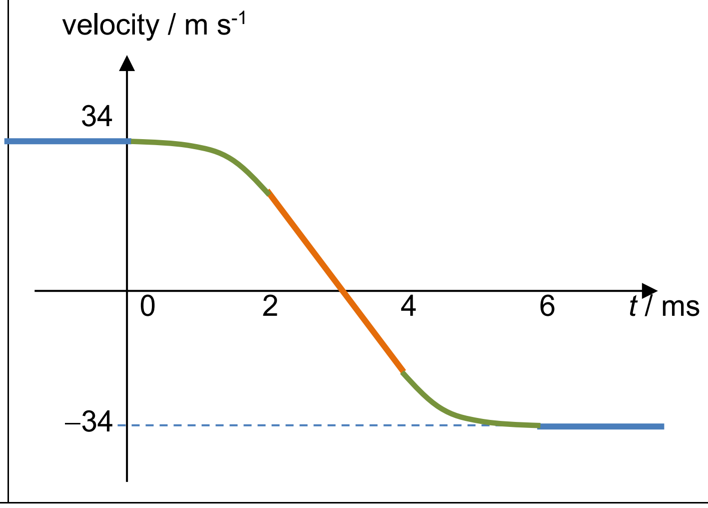
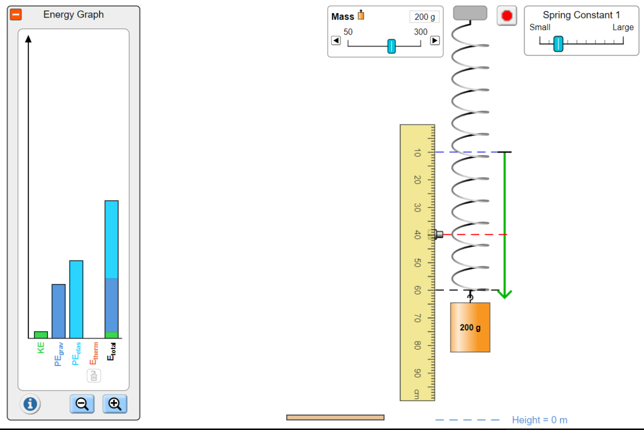
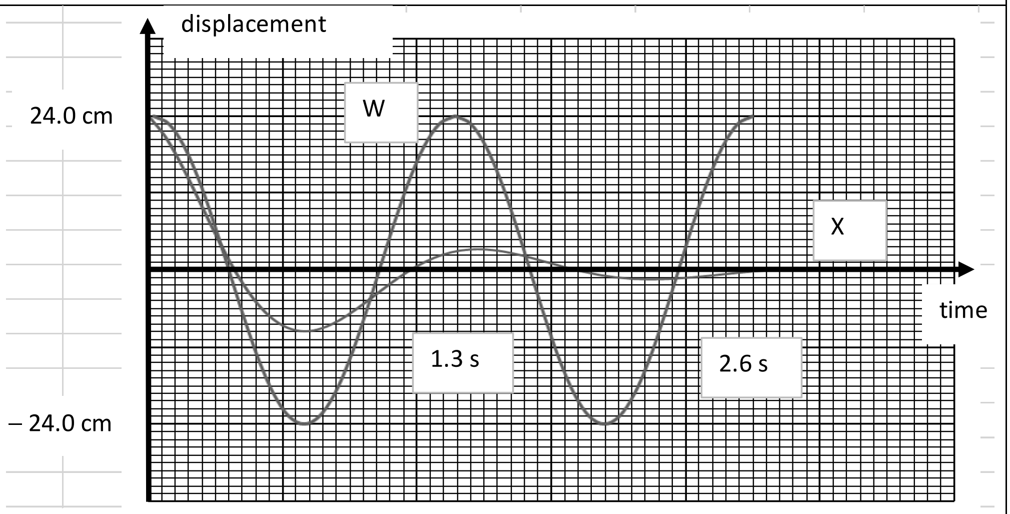
RVHS JC2 H2 Physics Preliminary Examinations Paper 2 Mark Scheme

Questions			Answers	Marks
1	(a)		Impulse is defined as product of (average) force exerted on wall and time of impact	B1
	(b)		$\Delta p = 0.058 \times (-34 - 34)$	M1
			$= -3.944 \text{ kg m s}^{-1}$	A1
	(c)		impulse = change in momentum = area under $F - t$ graph	M1
			$F_{max} \times \frac{4}{1000} = 3.944$ giving $F_{max} = 986 = 990$ N (2 s.f.)	A1
	(d)		From t = 0 to t = 2 ms: decrease at increasing rate. From t = 4 ms to t = 6 ms: decrease at decreasing rate.	B1
			From t = 2 ms to t = 4 ms: decrease at constant rate.	B1
			after t = 6 ms, velocity at –34 m s^{-1}	B1
			Example  	

Questions			Answers	Marks
2	(a)		molecules has component of velocity in 3 directions, hence $c^2 = c_x^2 + c_y^2 + c_z^2$ ------- (1)	M1
			their motions are random, so averaging gives $\langle c_x^2 \rangle = \langle c_y^2 \rangle = \langle c_z^2 \rangle$ --------- (2)	M1
			Hence substitute the result of (2) into (1), then $\langle c^2 \rangle = 3\langle c_x^2 \rangle$	A1

			Hence for *N* molecules, we have $pV = \frac{1}{3}Nm\langle c^2\rangle$	A0
	(b)	(i)	pressure $pV = nRT$ or $p = \frac{nRT}{L^3} = \frac{3\times8.31\times(20.0+273.15)}{0.200^3}$	M1
			so force on each sides $F = pA = \frac{3\times8.31\times(20.0+273.15)}{0.200^3} \times 0.200^2$	M1
			$F = 36\,500\ \mathrm{N}$	A1
		(ii)	particles would <u>attract</u> one another	B1
			so average force on wall will <u>decrease</u>	B1

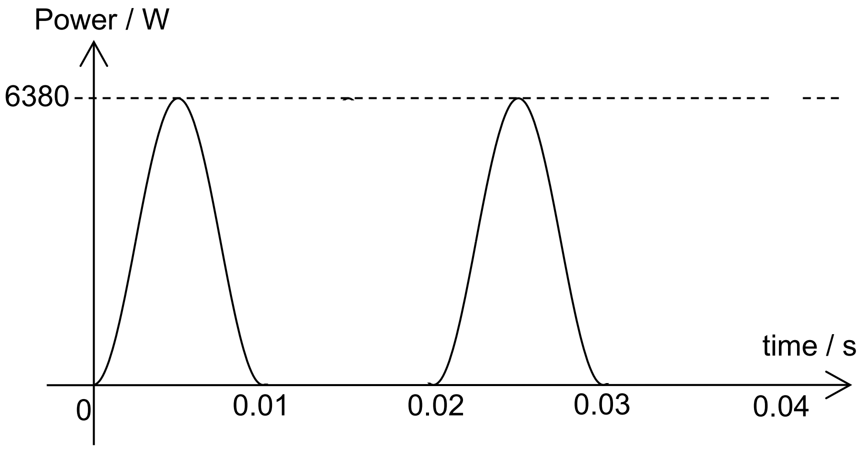
3	(a)	(i)	$\omega = 2\pi f$ [M1] $\rightarrow f = \frac{1}{2\pi}\sqrt{\frac{10.5}{0.450}} = 0.76879 \sim 0.77\ \mathrm{Hz}$ [A1]
		(ii)	From 50 cm to 80 cm position, a change of 0.300 m: $\Delta GPE = Mg(extension) = 0.450 \times 9.81 \times 0.300 = 1.32435\ \mathrm{J}$ [M1] When mass was initially held at 50 cm position, spring was already experiencing EPE, as unstretched length of spring is 32 (or 32.5 cm), therefore initial EPE is due to e = 18 cm. When mass ends up at 80 cm position, spring would have stretched by e = 48 cm. $\Delta EPE = \frac{1}{2}k({e_2}^2 - {e_1}^2) = \frac{1}{2}(10.5)(0.480^2 - 0.180^2) = 1.0395\ \mathrm{J}$ [M1] So, at the position of 80 cm, the KE present in the mass would be: $\Delta KE = 1.32435 - 1.0395 = 0.28485\ \mathrm{J}$ [C1] $0.28485 = \frac{1}{2}mv^2 \rightarrow v = 1.12517 \sim 1.13\ \mathrm{m\ s^{-1}}$ [A1]
			

			When considering energy conversion for a vertical spring-mass system, there are GPE, EPE and KE. This is at a position close to the maximum displacement.
	(b)	**(i), (ii)**	 **Fig. 3.3** Labels – <u>Displacement</u> of +/- 24.0 cm, 2 cycles of <u>period</u> 1.3 s (for Line W) [B1] When spring-mass is at equilibrium, reading off the graph, the length of the spring should be 74.0 cm. Given the start length of the spring is 50.0 cm, therefore the displacement of free oscillations will be 24.0 cm. Line W – Accept +ve/-ve <u>Cosine</u> graph [B1] Line X – Check-by-eye <u>decreasing displacement</u> over time, 2 cycles of <u>consistent larger period</u> than Line W [B1]

4	**(a)**	Interference is the <u>superposing of two or more waves</u> to produce <u>regions of maxima and minima in space</u>, according to the principle of superposition.	B1
	(b)(i)	Using dsinθ = nλ, let θ = 90° and choose the largest λ in order for a full spectrum will be observed, $\frac{1}{3 \times 10^5} \sin 90 = n(700 \times 10^{-9})$ $n = 4.8$ Hence, the maximum order for a full spectrum to be observed is 4.	M1 A1
	(b)(ii)	Considering the first order diffraction angle for 700 nm wavelength, $\frac{1}{3 \times 10^5} \sin \theta = 1(700 \times 10^{-9})$ $\theta = 12.1^{o}$ Considering the second order diffraction angle for 400 nm wavelength, $\frac{1}{3 \times 10^5} \sin \theta = 2(400 \times 10^{-9})$ $\theta = 13.9^{o}$ Since the second order diffraction angle for 400 nm wavelength is larger than the first order diffraction angle for 700 nm wavelength, the spectra do not overlap.	C1 C1 A1

	(c)	White light consists of visible light of different wavelengths. There is no diffraction of light at the central region so this region remains white. In diffraction of waves, waves with larger wavelength will have larger diffracted angles. Light sources with lower wavelength do not diffract as much and do not achieve overlapping of light sources at the edge to produce white light.	B1 B1

Qn		Answer	Mark
5	**(a)(i)**	Resistance of copper, R_{copper} $= \dfrac{(1.60 \times 10^{-8})(3.0)}{\pi\,(0.60 \times 10^{-3} + 1.78 \times 10^{-5})^2 - \pi\,(0.60 \times 10^{-3})^2}$ $= 0.705\ \Omega$ Effective resistance $= \left(\dfrac{1}{0.236} + \dfrac{1}{0.705}\right)^{-1}$ $= 0.176\ \Omega$ (show intermediate value of higher sf) $= 0.18\ \Omega$	M1 A1
	(a)(ii)	As current increases, power dissipated increases. Heat is generated and hence equilibrium temperature increases. Hence, the lattice ions vibrate more vigorously, hindering the flow of 'charge carriers', therefore increasing the resistance.	B1 B1

	(b)(i)	Using Vs/Vp = Ns/Np, (max Vs)/240$\sqrt{2}$ = 1/10 max Vs = 33.9 V	M1 A1
	(b)(ii)	period = 0.02 s maximum power $P_0 = \frac{V_0^{\ 2}}{R} = \frac{(33.9)^2}{0.18} = 6380$ W  1 mark for correct shape 1 mark for correct labelling peak power and period	B2

	(b)(iii)	$\langle V^2 \rangle = \frac{1}{2}\frac{V_0^2(T/2)}{T} = \frac{1}{4}V_0^2 \Rightarrow V_{rms} = \sqrt{\langle V^2 \rangle} = \frac{1}{2}V_0$ $\langle P \rangle = V_{rms}^2/R = V_0^2/4R$ $\langle P \rangle = (33.9)^2/4(0.18) = 1600$ W <u>OR</u> $P_0 = \frac{V_0^2}{R} = \frac{(33.9)^2}{0.18} = 6380$ W Mean power for sinusodial graph = $\frac{1}{2}P_0$ Since it is half-wave rectified, mean power for half-wave rectified graph = $\frac{1}{4}P_0 = \frac{1}{4}(6380) = 1600$ W If students use graphical method, deduct 1 mark if students <u>did not provide clear steps</u> on how Vrms and mean P are detemined. There should be clear steps leading to the final answer.	C1 M1 A1 C1 M1 A1
	(c)	A voltage of 24 V steady direct current voltage has the same value as the rms secondary voltage of 24 V of the alternating current. <u>The rms voltage of the half-way rectified voltage is lower (16.9 V)</u>. Hence, the power increases when 24 V direct current voltage is used.	B1

Questions			Answers	Marks
6	(a)		Electric field strength at a point is defined by the <u>force per unit charge</u>. Not acceptable Force on a unit charge. [Unit is N] whereas for force per unit charge, the unit is N C^{-1}]	B1
			acting on a <u>small</u> <u>positive</u> <u>stationary</u> test charge at that point.	B1
	(b)	(i)	electric field strength inside parallel plate $= \frac{\Delta V}{\Delta x} = \frac{1500-0}{0.015} = 1.0 \times 10^5 \text{ V m}^{-1}$	M1
			Since charge is stationary electric force balances the weight so $qE = mg$ or $N \times 1.6 \times 10^{-19} \times 1.0 \times 10^5 = 4.90 \times 10^{-15} \times 9.81$	M1
			$N = 3$ (given as <u>integer</u>)	A1
		(ii)	<u>initial electric force have the same magnitude as weight.</u>	M1

			Now the direction is same as the weight. So net force on charge is twice the weight.	
			2*g*	A1
			downwards	B1

7	**(a)**		Faraday's law of electromagnetic induction states that the e.m.f. induced in a conductor is directly proportional to the rate of change of magnetic flux linkage. Lenz's law states that the direction of the induced e.m.f. is such that it may produce an effect that opposes the change causing it.
	(b)	**(i)**	Flux linkage = NBA [M1] = 85 x (πx 10^{-3}x 2.8)x (π x (1.6 x 10^{-2})^2) = 6.0 x 10^{-4} Wb [A1]
		(ii)	Flux change = ΔΦ = 2 x 6.00 x 10^{-4} [M1] Induced e.m.f. = ΔΦ/Δt = 0.00401 V ~ 4.0 mV [A1]
		(iii)	0 v for t = 0 to 0.3, t = 0.6 to 1.0 and t > 1.6 t [B1] 0.004 V for t = 0.3 to 0.6 s [B1] - 0.002 V for t = 1.0 to 1.6 s [B1]

Questions			**Answers**	**Marks**
8	**(a)**		Electrons have zero potential energy at infinity, and so less than this near the positively charged nucleus. Also accepted: • Electrons are attracted to the positively charged nucleus. So work has to be done / energy has to be given to remove the electrons from the nucleus (where potential energy is zero) .	B1
	(b)	**(i)**	$E = \frac{hc}{\lambda} = \frac{6.63 \times 10^{-34} \times 3.0 \times 10^{8}}{590 \times 10^{-9}}$	M1
			$E = 3.37 \times 10^{-19} = 3.4 \times 10^{-19}$ J	A1
		(ii)	electron transit from -5.8×10^{-19} J to -2.4×10^{-19} J	B1
			absorbing all the energy of the incident photon	B1
	(c)		Incident light is directional; light is re-emitted in all directions.	B1

<table>
<tr><td>9</td><td>(a)</td><td colspan="2">Fig. 9.2 shows an exponential curve and hence count rate tends towards zero but never becoming zero. So theoretically, complete shielding is not possible.</td></tr>
<tr><td></td><td>(b)</td><td>(i)</td><td>Fig. 9.3 shows a straight line of negative gradient passing through the origin so general form of equation for the line is Y= – mX B1

ln (C_X/C_0) = – m x B1 where – m is the gradient of the straight line

(C_X/C_0) = $e^{-m x}$

$C_X = C_0\, e^{-m x}$

where gradient – m = constant – μ</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>gradient = – μ M1

= – 3.9 / 8.8

μ = 0.443 A1</td></tr>
<tr><td></td><td>(c)

(i),
(ii)</td><td colspan="2">

material	μ / cm^{-1}	ρ / g cm^{-3}	μ_m / cm^2 g^{-1} **B1**
aluminium	0.095	2.70	0.035
tin	0.267	7.28	0.037
lead	……**A0**………..	11.3	0.039 **B1**.

Fig. 9.4</td></tr>
<tr><td></td><td>(d)</td><td>(i)</td><td>average μ_m = 1/3 (0.035 + 0.037 + 0.039) = 0.037 B1

2.4×10^3 kg m^{-3} = 2.4 g cm^{-3}

$\mu = \mu_m \times \rho$ = 0.037 × 2.4 M1

0.0888 ≈ 0.09 cm^{-1}</td></tr>
<tr><td></td><td></td><td>(ii)</td><td>Read off from Fig. 9.2, C_X/C_0 = 0.16 B1

Given the relationship, $C_X/C_0 = e^{-\mu x}$

$0.16 = e^{-0.0888 x}$ M1

ln (0.16) = – 0.0888 x

x ≈ 20 cm (approximate) (1 s.f.) A1</td></tr>
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