EUNOIA JUNIOR COLLEGE

General Certificate of Education Advanced Level
Higher 2

PHYSICS

9646

SUGGESTED SOLUTIONS

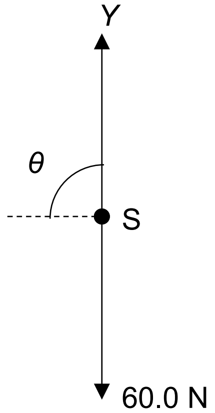
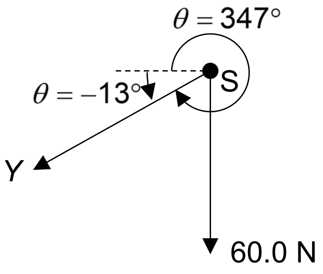
October/November 2014

Paper 1
Multiple Choice

Question	*Key*	*Question*	*Key*
1	**C**	21	**D**
2	**A**	22	**C**
3	**A**	23	**B**
4	**D**	24	**D**
5	**D**	25	**A**
6	**C**	26	**D**
7	**C**	27	**D**
8	**D**	28	**B**
9	**C**	29	**A**
10	**D**	30	**D**
11	**B**	31	**D**
12	**B**	32	**C**
13	**B**	33	**D**
14	**C**	34	**B**
15	**A**	35	**D**
16	**B**	36	**C**
17	**A**	37	**A**
18	**C**	38	**D**
19	**A**	39	**A**
20	**D**	40	**C**

Notes
Q4: need to solve simultaneous equations, one equation with unknown time and 0.25 of distance, d, from start to ground, the other equation with required time and d
Q9: calculate power output of the train first
Q22: distance between 2 nodes, i.e. 2 minimum points on voltage graph is half a wavelength, not one wavelength
Q25: directions of field at all 4 points are the same even though their magnitude is different
Q28: current is given by charge x frequency, $ef = e\omega/2\pi$

Paper 2
Structured Questions

Qns		Marks
1(a)(i)	magnitude = 60.0 N  angle = 90°	**B1** **B1**
1(a)(ii)	vector sum of forces = 0 along horizontal considering magnitudes: $\left.\begin{aligned} &\text{horizontally: } Y\cos\theta = 200\cos(30^\circ) = 100\sqrt{3}\ \text{N} \\ &\text{vertically: } Y\sin\theta + 200\sin(30^\circ) = 60.0 \end{aligned}\right\}$ $Y\sin\theta = -40.0\ \text{N}$ $x = arcsin(-40.0\ /\ (20\sqrt{79}))$ magnitude of $Y = \sqrt{40^2 + (100\sqrt{3})^2}$ $= 20\sqrt{79} = 178\ \text{N}$  $\tan\theta = \dfrac{Y\sin\theta}{Y\cos\theta} = \dfrac{-40}{100\sqrt{3}}$ $\theta = -13^\circ$ or 347° **Notes** Do not miss out the negative signs in your working and answer.	**M1** **A1** **A1**

Qns		**Marks**
1(b)	[magnitude] as long as magnitude of X is above zero [direction] and X remains directed at 30° anticlockwise to the horizontal, there will be a horizontal component of force $X\ \cos\theta$ acting on S to the right since vector sum of forces on S must be zero for S to be in equilibrium, Y must provide a horizontal component force acting on S to the left Y is along same direction as rope B, so must be at an angle to the left and cannot be parallel to weight of S **Notes** Cannot just describe general conditions for equilibrium rather than target it towards the context of this question, i.e. must focus on forces acting on object S.	**B1** **B1** **A0**
2	(out of syllabus)	
3(a)	current decreases as resistance of R and total circuit resistance increases drop in p.d. across internal resistance decreases $(V_{\text{int resistance}} = Ir)$ terminal p.d. increases as it is the difference between electromotive force and p.d. drop across internal resistance $(V_{\text{terminal}} = \text{e.m.f.} - Ir)$ **Notes** Remember that the terminal potential difference is *not* the potential difference across the internal resistance. Also do not simply quote the potential divider formula without explaining in detail.	**M1** **M1** **A1**

Qns		Marks
3(b)(i)	current in circuit $I = \dfrac{\text{e.m.f}}{R_{\text{total}}}$ $= \dfrac{5}{0.25+4+3.5} = \dfrac{5}{7.75}$ $(= 0.645\text{ A})$	**C1**
	$V_{\text{terminal}} = \text{e.m.f.} - Ir$	**C1**
	$= 5 - \dfrac{5}{7.75}(0.25)$ $= 4.84\text{ V}$	**A1**
	or by potential divider rule: $\dfrac{V_{\text{internal}}}{\text{e.m.f.}} = \dfrac{r_{\text{internal}}}{R_{\text{total}}}$	**C1**
	$V_{\text{internal}} = (\text{e.m.f.})\dfrac{r_{\text{internal}}}{R_{\text{total}}}$ $= 5\dfrac{0.25}{0.25+4+3.5} = 0.161\text{ V}$	**C1**
	$V_{\text{terminal}} = (\text{e.m.f.}) - V_{\text{internal}}$ $= 5 - 5\dfrac{0.25}{0.25+4+3.5}$ $= 4.84\text{ V}$	**A1**
3(b)(ii)	same current passing through efficiency $= \dfrac{P_{\text{external}}}{P_{\text{total}}} \times 100\%$ $= \dfrac{IV_{\text{terminal}}}{I(\text{e.m.f.})} \times 100\%$ $= \dfrac{4.84}{5} \times 100\% = 96.8\%$	
3(c)(i)	PJ is balanced length so $V_{\text{PL}} = (\text{e.m.f.})_{\text{C}} = 1.2\text{ V}$	**A1**
3(c)(ii)	$V_{\text{PQ}} = iR_{\text{PQ}}$ $= (0.645)(3.5)$ $= 2.26\text{ V}$ OR by potential divider rule: $\dfrac{V_{\text{PQ}}}{\text{e.m.f.}} = \dfrac{R_{\text{PQ}}}{R_{\text{total}}}$ $V_{\text{PQ}} = 5\left(\dfrac{3.5}{0.25+4+3.5}\right) = 2.26\text{ V}$ by potential divider rule: $\dfrac{l}{L_{\text{PQ}}} = \dfrac{(\text{e.m.f.})_{\text{C}}}{V_{\text{PQ}}}$ $l = (1)\dfrac{1.2}{2.26}$ $= 0.531\text{ m}$	

Qns		Marks
3(c)(iii)	p.d. across PJ increases and is larger than the p.d. across cell C a net p.d. is exerted opposite to the polarity of cell C and results in a current flow **Notes** Do not just mention that p.d. across PJ changes without linking to current flow.	
4(a)(i)	[flux linkage] the magnetic flux linkage is the product of magnetic flux density normal to the cross sectional area and varies sinusoidally when the coil spins around PQ [Faraday's Law] sides of coil that are parallel to PQ cut the magnetic flux lines when rotating , therefore produce sinusoidal induced e.m.f. that is directly proportional to the rate of change of magnetic flux linkage [min e.m.f.] when the cross sectional area is normal to the flux lines, there is minimum rate of change of magnetic flux linkage so magnitude of induced e.m.f. is zero [max e.m.f.] when the cross sectional area is parallel to the flux lines, there is maximum rate of the coils cutting flux lines so magnitude of induced e.m.f. is maximal **Notes** Note that the maximum e.m.f. is where the **rate of change** of flux linkage is greatest, not when the flux linkage is greatest.	
4(a)(ii)1.	peak-to-peak voltage: 6.8 cm maximum induced e.m.f. = $\frac{6.8}{2}(0.050) = 0.17$ V	
4(a)(ii)2.	length of trace representing 2 complete oscillations: 10 cm frequency: $\frac{1}{T} = \frac{1}{\frac{10}{2}(8.0 \times 10^{-3})} = 25$ Hz	
4(b)	$E_0 = (N\Phi)\omega = (NBA)\omega = (NBA)(2\pi f)$ $B = \frac{E_0}{NA(2\pi f)} =$ $= \frac{0.17}{(120)(1.3 \times 10^{-3})(2\pi(25))}$ $= 0.0605$ T	**M1** **M1** **A1**
5(a)	work done per unit mass in bringing small test mass from infinity to that point	**B1**

Qns		Marks
5(b)(i)	using point $\left(2\times10^{8},\ -6.4\times10^{8}\right)$ $\phi=-\frac{GM}{r}$ $M=\frac{-r\phi}{G}$ $=\frac{-\left(2\times10^{8}\right)\left(-6.4\times10^{8}\right)}{6.67\times10^{-11}}$ $=1.92\times10^{27}\text{ kg}$ **Notes** Do not miss out negative sign.	
5(b)(ii)	$\text{GPE }=m_{\text{moon}}\phi=m_{\text{moon}}\left(-\frac{GM}{r_{\text{moon}}}\right)$ $\text{KE }=\frac{1}{2}m_{\text{moon}}v^{2}=\frac{1}{2}m_{\text{moon}}\left(r_{\text{moon}}\omega\right)^{2}=\frac{1}{2}m_{\text{moon}}r^{2}{}_{\text{moon}}\left(\frac{2\pi}{T}\right)^{2}$ $E_{\text{total}}=\text{GPE + KE}$ $=m_{\text{moon}}\left(-\frac{GM}{r_{\text{moon}}}\right)+\frac{1}{2}m_{\text{moon}}r^{2}{}_{\text{moon}}\left(\frac{2\pi}{T}\right)^{2}$ $=m_{\text{moon}}\left[\left(-\frac{GM}{r_{\text{moon}}}\right)+\frac{1}{2}r^{2}{}_{\text{moon}}\left(\frac{2\pi}{T}\right)^{2}\right]$ $=\left(8.93\times10^{22}\right)\left[\left(-\frac{\left(6.67\times10^{-11}\right)\left(1.92\times10^{27}\right)}{4.22\times10^{8}}\right)+\frac{1}{2}\left(4.22\times10^{8}\right)^{2}\left(\frac{2\pi}{1.53\times10^{5}}\right)^{2}\right]$ $=-1.37\times10^{31}\text{ J}$	
5(c)	initial distance from S can be regarded as infinity where potential is zero $\text{KE }=q\Delta V$ $\frac{1}{2}mv^{2}=e\left(V_{\text{final}}-V_{\text{initial}}\right)$ $v=\sqrt{\frac{2e\left(V_{\text{final}}-V_{\text{initial}}\right)}{m_{\text{p}}}}$ $\approx\sqrt{\frac{2\left(1.6\times10^{-19}\right)\left(1.02\times10^{6}-0\right)}{1.67\times10^{-27}}}$ $=1.40\times10^{7}\text{ m s}^{-1}$ **Notes** Cannot use kinematics equations to solve as those are only for constant acceleration (with constant force).	

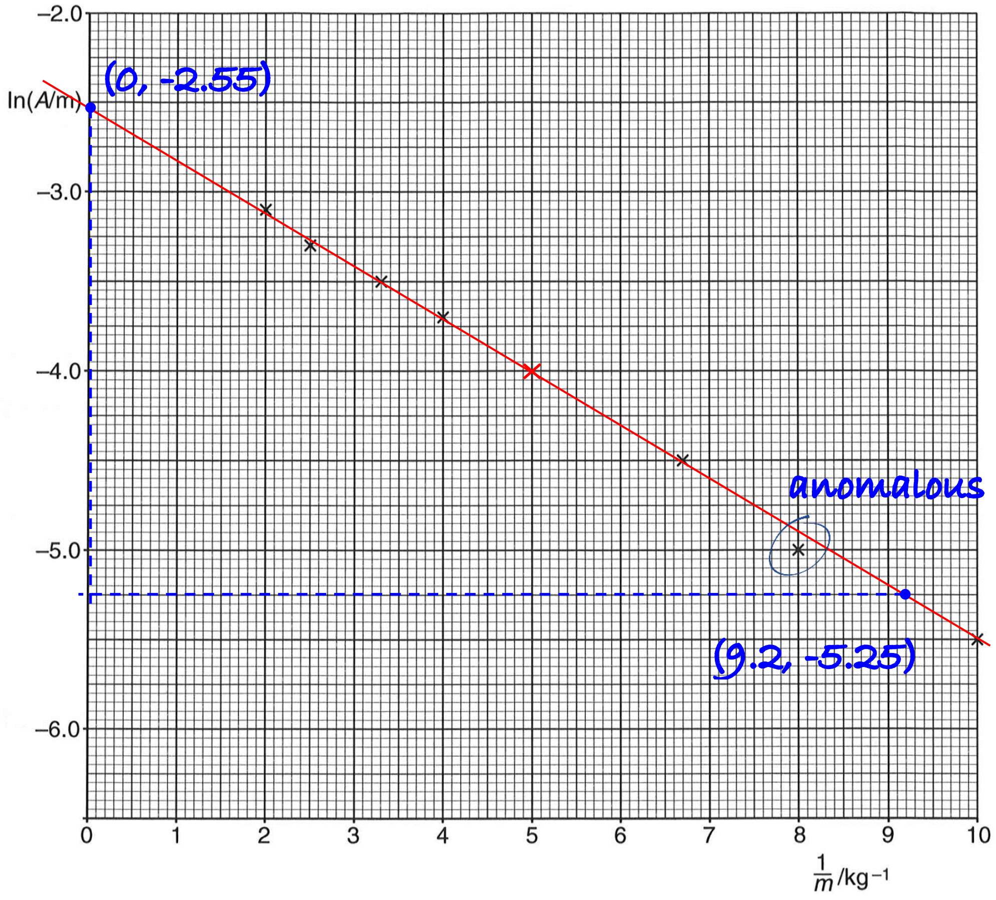
<table>
<tr><th>Qns</th><th></th><th>Marks</th></tr>
<tr><td>5(d)</td><td>[magnitude] similarity: gradient of both graphs approaches zero as distance increases. the magnitude of field strength decreases to near zero with distance.

[direction] difference: the gradient of gravitational potential graph is positive while the gradient of the electric potential graph is negative. the direction of the field strength is towards lower potential, so gravitational potential graph shows an attractive potential while the electric potential graph shows a repulsive potential.

Notes
Remember to state and explain for *both* the similarity and difference.</td><td></td></tr>
<tr><td>6(a)</td><td>the rate of change of A decreases with time (A decreases at a decreasing rate)

the rate at which the oscillating system loses energy as work done against resistive forces decreases with time

Notes
The gradient of graph is used to infer that rate of change of A decreases with time, not to explain it. Need to give physical significance and not use the gradient of the graph to explain this.</td><td></td></tr>
<tr><td>6(b)(i)</td><td>
<table>
<tr><td>m / kg</td><td>$\frac{1}{m}$ / kg^{-1}</td><td>A / 10^{-2} m</td><td>ln (A / m)</td></tr>
<tr><td>0.200</td><td>5.00</td><td>1.8</td><td>-4.0</td></tr>
</table>
</td><td></td></tr>
</table>

Qns		**Marks**
6(b)(ii)		
6(b)(iii)	gradient $= \frac{y_1 - y_2}{x_1 - x_2} = \frac{-2.55-(-5.25)}{0-9.2}$ $= -0.293$	
6(b)(iv)	$A = A_0 e^{\left(\frac{-bt}{2}\frac{1}{m}\right)}$ $\ln A = \ln A_0 - \left(\frac{bt}{2}\right)\left(\frac{1}{m}\right)$ the plot of ln *A* against $\left(\frac{1}{m}\right)$ results in a straight line graph a y-intercept value for $\ln A_0$ and a negative gradient of magnitude $\left(\frac{bt}{2}\right)$	
6(b)(v)1.	gradient $= -0.293 = \left(\frac{-bt}{2}\right)$ $b = \frac{2(0.293)}{5}$ $= 0.117 \text{ kg s}^{-1}$ **Notes** Remember to give units for *b*.	

Qns		Marks
6(b)(v)2.	$\ln A_0 = -0.255$ $A_0 = e^{-0.255}$ $= 0.775$ m	
6(c)	$A = A_0 e^{\left(\frac{-bt}{2}\frac{1}{m}\right)}$ $\frac{A}{A_0} = e^{\left(\frac{-bt}{2}\frac{1}{m}\right)}$ $\ln\left(\frac{A}{A_0}\right) = \ln(0.5)$ $= -\left(\frac{bt}{2}\right)\left(\frac{1}{m}\right)$ $t = \frac{-2m(\ln(0.5))}{b}$ $= \frac{-2(0.500)(\ln(0.5))}{0.117}$ $= 5.92$ s **Notes** Remember to convert 500 g to 0.5 kg.	
6(d)	$T_{1/2}$ increases as m increases a larger mass, so greater initial total* energy of the system for the same initial amplitude, but lower maximum speed during oscillations (*Note: max amplitude A_0 is kept constant, so initial elastic potential energy is kept constant. So in terms of thinking, it is easier to think about same Elastic PE, so for the same KE, higher m means lower v_{max} $\frac{1}{2}kx_{\text{max}}^2 = \frac{1}{2}kA_0^2 = \frac{1}{2}mv_{\text{max}}^2$. However, for the same "height" the GPE is greater so initial *total* energy is bigger.) lower maximum speed so less maximum drag force between the disc and the fluid. the rate of energy loss as work done against resistive force is less so the time taken for the amplitude to decrease by a factor of 2 is longer	

Qns		Marks
7	<u>Measurement of Variables</u> Measure intensity in transmission geometry Measure thickness of material Analysis Suggestion of equation in the form of $I = I_0 e^{-kt}$ $\ln I = \ln I_0 - kt$ Plot of $\ln I$ against t shdould yield a straight line with y-intercept $\ln I_0$ and gradient $-k$ Safety Possible details may include • Clean surfaces of microscope slides • minimise air gap between microscope slides • measure total thickness of slides at multiple positions for average • Keep distance between light source and intensity meter constant • Keep intensity of light source constant • Measure of ambient intensity without light source and without slides • Measure initial intensity without microscope slides • Ensure initial intensity does not overload light meter • Ensure that light meter can still be read when with maximum possible thickness of slides • Dark environment	

Paper 3
Longer Structured Questions

Qns		Marks
1(a)(i)	does not change/remains constant	B1
1(a)(ii)	increases from zero accelerates at a constant rate of $9.81\ \text{m s}^{-2}$	B1 B1
1(b)(i)	decreases **Notes** Air resistance will affect horizontal velocity as it is a force that acts against velocity in horizontal direction also, hence decreasing horizontal velocity.	B1
1(b)(ii)	increases from zero accelerates at a decreasing rate from $9.81\ \text{m s}^{-2}$ until it reaches terminal velocity	B1 B1 B1
1(c)	initial path similar to path without air resistance, i.e. horizontal path parabolic and always below path without air resistance **Notes** Remember that in your sketch, the very initial part of the path should be horizontal as initial velocity is horizontal.	
2(a)(i)	angle subtended at centre of a circle by an arc whose arc length is equal to the radius of circle	B1 B1
2(a)(ii)	related to natural frequency of simple harmonic motion by $\omega = 2\pi f$	B1
2(b)(i)	total energy of sphere = max PE of sphere = mgh = $(0.120)(9.81)(0.40 \times 10^{-2})$ = 4.7×10^{-3} J	 M1 M1 A0
2(b)(ii)	total energy of sphere = max PE of sphere total energy of sphere = $\frac{1}{2} m\omega^2 x_0^2$ $4.7 \times 10^{-3} = \frac{1}{2}(0.120)(2\pi f)^2(8.0 \times 10^{-2})^2$ $f = 0.557$ Hz **Notes** Do not be confused, amplitude is 8.0 cm, not 0.40 cm.	C1 M1 M1 A1

<table>
<tr><th>Qns</th><th></th><th>Marks</th></tr>
<tr><td>3(a)</td><td>the increase in the internal energy of a system is equal to
the sum of the thermal energy supplied to the system and work done on the system</td><td>B1
B1</td></tr>
<tr><td>3(b)(i)</td><td>

$pV = nRT$

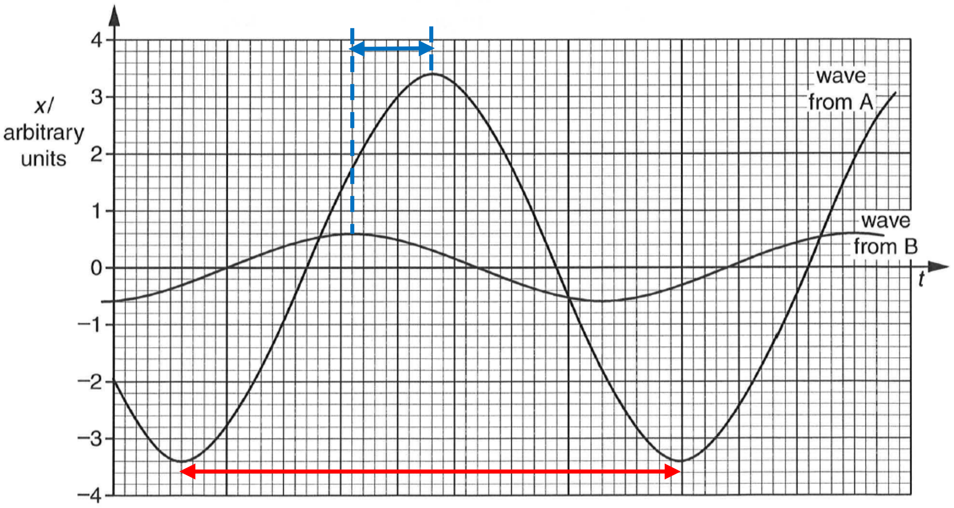
$n = \dfrac{pV}{RT}$

$= \dfrac{(2.4 \times 10^5)(5.0 \times 10^{-4})}{(8.31)(290)}$

$= 0.050$ mol

</td><td>M1
A1</td></tr>
<tr><td>3(b)(ii)1.</td><td>work done from X to Y
= $P\Delta V$
= $(2.4 \times 10^5)[(14.4 - 5.0) \times 10^{-4}]$
= 230 J</td><td>M1
A1</td></tr>
<tr><td>3(b)(ii)2.</td><td>0 J</td><td>B1</td></tr>
<tr><td>3(b)(iii)</td><td>
<table>
<tr><th>change</th><th>work done on gas / J</th><th>heating supplied to gas / J</th><th>increase in internal energy / J</th></tr>
<tr><td>X → Y</td><td>– 230</td><td>+570</td><td>+ 340</td></tr>
<tr><td>Y → Z</td><td>+540</td><td>0</td><td>+ 540</td></tr>
<tr><td>Z → X</td><td>0</td><td>– 880</td><td>– 880</td></tr>
</table>

Notes
Please watch out for the signs.
</td><td>One mark for each row
B1
B1
B1</td></tr>
</table>

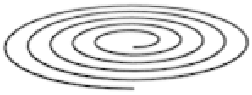
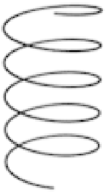
Qns		Marks
4(a)	waves of same kind meet and overlap at a point in time and space resultant displacement is vector sum of individual displacements	B1 B1
4(b)(i)	$\phi = \frac{t}{T} \times 360°$ $= \frac{7}{44} \times 360°$ $= 57°$ **Notes** 44 s is period (between two crests or two troughs of same wave, either A or B). 7 s is time difference between two waves at same phase (e.g. crest of A and crest of B as shown below) 	B1
4(b)(ii)	$\frac{\text{intensity at dark fringe}}{\text{intensity at bright fringe}} = \left(\frac{\text{amplitude at dark fringe}}{\text{amplitude at bright fringe}}\right)^2$ $= \left(\frac{3.4-0.6}{3.4+0.6}\right)^2$ $= \left(\frac{2.8}{4.0}\right)^2$ $= 0.49$	C1 M1 A1

Qns		Marks
5(a)	substitute $\phi = hf_0 = \frac{hc}{\lambda_0}$ $E_{MAX} = hf - \phi$ $= \frac{hc}{\lambda} - \frac{hc}{\lambda_0}$ $= hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right)$ **Notes** To prove something, need to start with stated equation $E_{MAX} = hf - \phi$ and manipulate until you get the resulting equation you want to prove (instead of working backwards).	B1
5(b)(i)	at $E_{MAX} = 0, \ \frac{1}{\lambda} = \frac{1}{\lambda_0}$ from x-intercept of graph, $\frac{1}{\lambda_0} = 2.30 \times 10^6 \text{ m}^{-1}$ $\lambda_0 = 435 \text{ nm}$ **Notes** Need to extend graph to get x-intercept.	M1 A1
5(b)(ii)	gradient of graph $= hc$ $\frac{(3.10 - 1.00) \times 10^{-19}}{(3.85 - 2.80) \times 10^{6}} = h\left(3.0 \times 10^{8}\right)$ $h_0 = 6.7 \times 10^{-34} \text{ J s}$	M1 M1 A1
5(c)	parallel line to the right of existing line	B1

Qns		Marks
6(a)(i)	region of space in which a force acts on a body	B1 B1
6(a)(ii)	may be <u>gravitational force</u> acting on the <u>mass</u> of the charged particle may be <u>magnetic force</u> due to a <u>magnetic flux density</u> acting on a <u>moving</u> charge that is <u>not moving parallel</u> to the magnetic flux **Notes** Remember to consider both the alternative fields (gravitational and magnetic) and not just one of them. Remember to state that the magnetic force acts on <u>moving</u> charge.	B1 B1 B1 B1
6(b)(i)	the two regions are conductors electric charges inside conductors redistributed onto surface electric charges at electrostatic equilibrium do not move so field strength is zero **Notes** Cannot just say no field inside spheres without giving reason.	B1
6(b)(ii)1.	4.0 cm 2.0 cm	B1 B1
6(b)(ii)2.	graph always positive so <u>direction of electric field</u> due to both spheres is <u>same</u> the spheres have charges of <u>opposite signs</u>	M1 A1
6(b)(iii)1.	change in electric potential $\Delta V =$ area under graph $\approx \left(1.2\times10^{5}\right)\left(5.0\times10^{-2}\right)$ $= 6000\text{ V}$ change in electric potential energy $= q\Delta V$ $\approx \left(3\times1.60\times10^{-19}\right)\left(6000\right)$ $= 2.88\times10^{-15}\text{ V}$ **Notes** Li nucleus has 3 protons so the charge is 3*e*. Have to use area under graph, no other method possible.	C1 M1 C1 M1 A1
6(b)(iii)2.	$F_E = ma$ $qE = ma$ $\left(3\times1.60\times10^{-19}\right)\left(3.0\times10^{5}\right) = \left(7\times1.66\times10^{-27}\right)a$ $a = 1.24\times10^{-13}\text{ m s}^{-1}$ **Notes** Li nucleus has 7 nucleons so the mass is 3*u*.	M1 A1

Qns		Marks
6(b)(iii)3.	magnitude of the acceleration decreases from a maximum at x = 4.0 cm to a minimum at x = 18.5 cm magnitude of the acceleration then increases to a maximum at x = 28.0 cm **Notes** Acceleration is minimum **but not 0** at 18.0 cm. Electric field is not 0 so there is a force and hence acceleration at that point.	B1 B1 B1

Qns		**Marks**
7(a)(i)	ratio of the potential difference across the wire to the current flowing through the wire	B1
7(a)(ii)	resistance per unit length of a conductor having unit cross-sectional area	B1 B1
7(b)(i)	$V = IR$ $6.0 = 1.2\left(0.10 + R_{coil}\right)$ $R_{coil} = 4.9\ \Omega$	C1 M1 A0
7(b)(ii)	$R_{coil} = \frac{\rho L}{A}$ $L = \frac{R_{coil} A}{\rho}$ $\frac{(4.9)\left(\pi \times \frac{0.60\times10^{-3}}{2}\right)^2}{1.7\times10^{-8}}$ $= 81.5$ m number of turns $= \frac{81.5}{\text{circumference}}$ $= \frac{81.5}{\pi\left(22.0\times10^{-2}\right)}$ $= 118$	M1 A1 M1 A1
7(c)	$B = 0.72\left(4\pi\times10^{-7}\right)\left(\frac{118\times1.2}{\frac{22.0\times10^{-2}}{2}}\right)$ $= 1.2$ mT	M1 A0
7(d)(i)	gain in E_K = loss in E_P $\frac{1}{2}mv^2 - 0 = e\Delta V$ $mv = \sqrt{2e\Delta V m}$ $= \sqrt{2\left(1.60\times10^{-19}\right)(250)\left(9.11\times10^{-31}\right)}$ $= 8.54\times10^{-24}$ Ns	B1 M1 A1
7(d)(ii)	magnetic force provides centripetal force $Bqv = \frac{mv^2}{r}$ $r = \frac{mv}{Bq}$ $= \frac{8.54\times10^{-24}}{\left(1.2\times10^{-3}\right)\left(1.60\times10^{-19}\right)}$ $= 0.0445$ m	B1 M1 A1

Qns		Marks
7(e)	component of velocity perpendicular to magnetic field causes causes magnetic force to act perpendicular to this component	B1
	hence electron moves in circular motion with axis parallel to magnetic field	B1
	component of velocity parallel to magnetic field does not experience force hence this component is constant	B1
	resultant path is helical	B1
	Notes Do not confuse helical with spiral.  spiral  helical	

Qns		Marks
8(a)(i)	spontaneous and random emission of particles or electromagnetic radiation from unstable nucleus **Notes** Need to say *unstable* nucleus. (Topic not tested for 2020 graduating batch.)	B1 B1
8(a)(ii)	each nucleus have an equal probability of decaying per unit time	B1
8(a)(iii)	rate of decay independent of external conditions such as temperature	B1
8(b)(i)	$\lambda=\frac{0.693}{T_{\frac{1}{2}}}$ $=\frac{0.693}{86.4\times365\times24\times60\times60}$ $=2.54\times10^{-10}\ \text{s}^{-1}$	C1 M1 A1
8(b)(ii)	number of decays per unit time, activity $A=\frac{\text{power}}{\text{energy released in 1 decay}}$ $=\frac{2400}{(5.48\times10^{6})(1.60\times10^{-19})}$ $=2.74\times10^{15}\ \text{s}^{-1}$ number of nuclei $N=\frac{A}{\lambda}$ $=\frac{2.74\times10^{15}}{2.54\times10^{-10}}$ $=1.08\times10^{25}$ $\text{mass}=\frac{N}{N_A}(m_r)$ $=\frac{1.08\times10^{25}}{6.02\times10^{23}}(0.238)$ $=4.27\ \text{kg}$ **Notes** The activity is not the number of nucleus in the sample. Remember to calculate the number of nuclei by dividing activity by decay constant. Do not forget the Avogadro constant when calculating mass.	M1 A1 M1 A1 M1 A1
8(c)(i)	$\text{efficiency}=\frac{160}{2400}\times100\%=6.7\%$	B1

Qns		**Marks**
8(c)(ii)	power released after 3.2 years $= 2400e^{-\frac{0.693}{86.4}(3.2)}$ electrical power generated $=$ efficiency $= \frac{6.7}{100} \times 2400e^{-\frac{0.693}{86.4}(3.2)}$ $= 160$ W	M1 A1
8(d)(i)	<u>half-life</u> of plutonium-238 is <u>higher</u> than that of polonium-210 so fuel <u>lasts longer</u> hence provide <u>higher average power</u> during the flight	B1 B1
8(d)(ii)	plutonium-238 emits α <u>particles</u> while strontium-90 emits β particles hence <u>thinner shielding material</u> can be used	B1 B1