PHYSICS

9749

SUGGESTED MARK SCHEME

Maximum Mark: 190

October/November 2020

Paper 1 Multiple Choice

Question	*Key*	*Question*	*Key*	*Question*	*Key*
1	**B**	6	**C**	11	**B**
2	**D**	7	**B**	12	**A**
3	**D**	8	**A**	13	**A**
4	**A**	9	**D**	14	**B**
5	**C**	10	**B**	15	**B**
16	**A**	21	**A**	26	**D**
17	**C**	22	**B**	27	**C**
18	**C**	23	**A**	28	**D**
19	**D**	24	**B**	29	**A**
20	**C**	25	**B**	30	**D**

Notes:

Candidates found Questions 8, 16, 19, 22 and 24 more challenging.

Question 8
distractor **B** – did not account for two ropes
distractor **C** – confused the air densities
distractor **D** – did not account for the weight of air inside the balloon

Question 11
Takes 1 hour (3600 s) for a minute hand to complete one revolution.

Question 14
Note that line MN is NOT an isothermal change. Using PV = nRT, temperature is decreasing.

Question 16
Note that the energy of the oscillations reduced **by** E / 4 rather than **to** E / 4.

Question 19
Single slit equation accounts for only one side of the central maximum. The width of the central maximum is double of this.

Question 24
Note that the question asks for potential difference, not potential.

Paper 2
Structured Questions

Notes:
Candidates need to take care with definitions and make sure that all detail is included, and correct scientific language is used, especially in definitions. Stronger candidates used the word 'per' to indicate the division of two quantities.

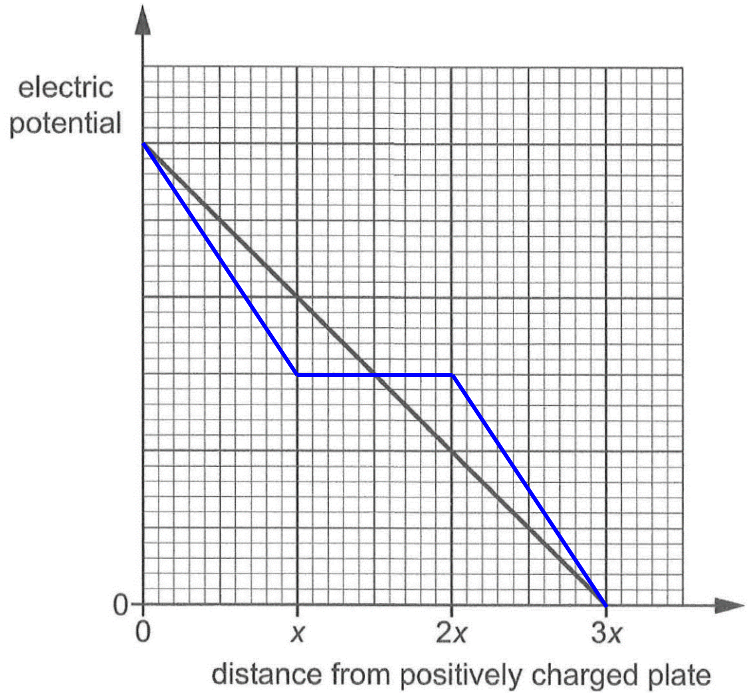
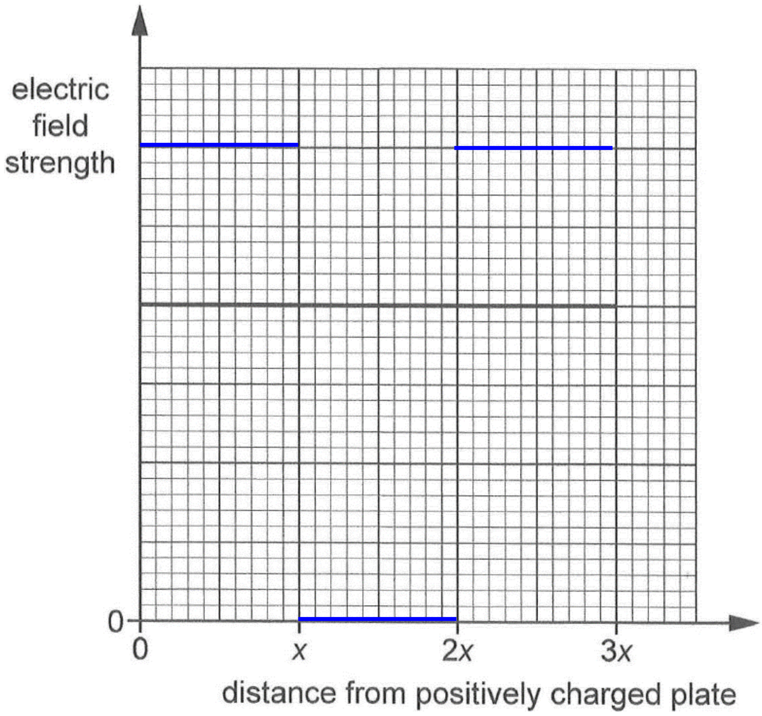
In 'show that' questions, stronger candidates made each step in the logic of the proof or calculation clear in order to show how to achieve the formula or answer.

Stronger responses were often short and pertinent to the question asked.

Qns		Marks
1(a)	the cyclist exerts a forward driving force which equals in magnitude and opposite to the frictional force. (weight of the cyclist is equal in magnitude and opposite in direction to the normal contact force from the horizontal ground)	**B1**
	By Newton's 1st law, the cyclist continues at constant velocity since there is no resultant force	**B1**
1(b)	$F=\frac{1}{2}c_{D}\rho A v^{2}$ $v=\sqrt{\frac{2F}{c_{D}\rho A}}$ $=\sqrt{\frac{2(22)}{(0.88)(1.2)(0.32)}}=11.4109\text{ m s}^{-1}$	**M1**
	Method 1 $\Delta v=\frac{1}{2}(v_{max}-v_{min})$ $=\frac{1}{2}\left(\sqrt{\frac{2(24)}{0.87(1.1)(0.3)}}-\sqrt{\frac{2(20)}{(0.89)(1.3)(0.34)}}\right)$	**M1**
	$=1.4\ (2\text{ s.f.})$	**M1**
	Method 2 $\frac{\Delta v}{v}=\frac{1}{2}\frac{\Delta F}{F}+\frac{1}{2}\frac{\Delta c_{D}}{c_{D}}+\frac{1}{2}\frac{\Delta\rho}{\rho}+\frac{1}{2}\frac{\Delta A}{A}$ $\Delta v=\frac{1}{2}\left(\frac{2}{22}+\frac{0.01}{0.88}+\frac{0.1}{1.2}+\frac{0.02}{0.32}\right)(v)$	**M1**
	$=\frac{1}{2}\left(\frac{2}{22}+\frac{0.01}{0.88}+\frac{0.1}{1.2}+\frac{0.02}{0.32}\right)(11.4109)$ $=1.4\ (2\text{ s.f.})$	**M1**
	$v=11\pm1\text{ m s}^{-1}$	**A1**
	Notes: one s.f. for the final uncertainty in v	

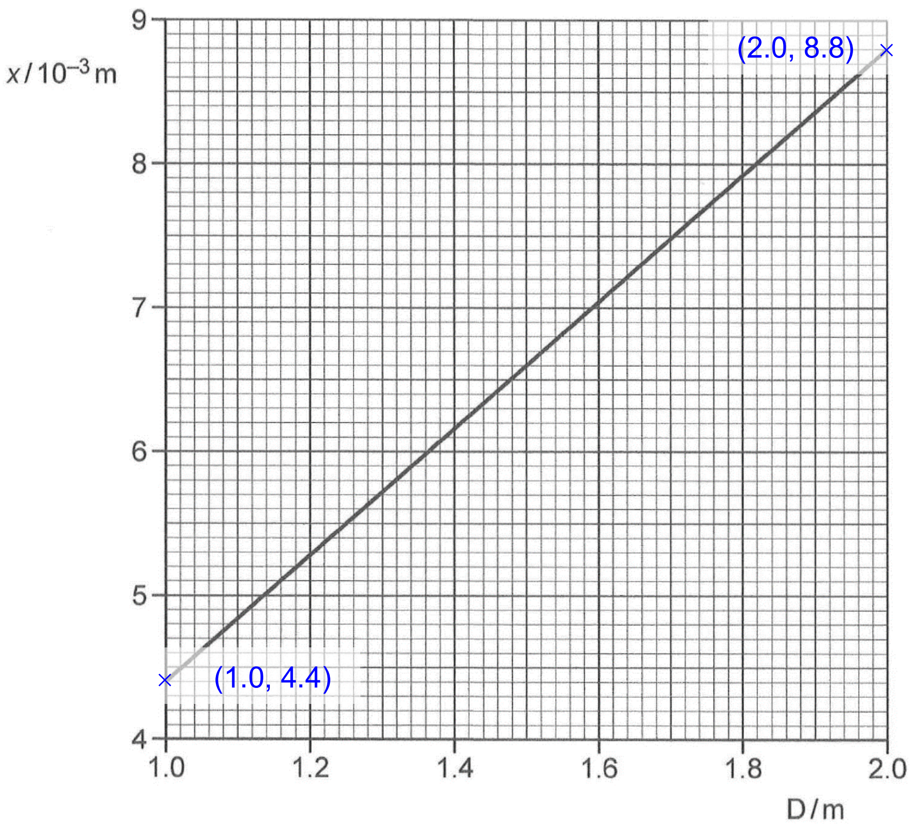
Qns		Marks
1(c)(i)	Work done = force x displacement in the direction of force	**B1**
	Power = work done/time	
	Power = (force ×displacement)/time	
	Power = force × velocity	**B1**
1(c)(ii)	$P = Fv$	
	$= \left(\frac{1}{2}c_D \rho A v^2\right)v$	
	$= \frac{1}{2}c_D \rho A v^3$	
	$= \frac{1}{2}(0.88)(1.2)(0.32)(11.4)^3$	
	$= 250\,\mathrm{W}$	**A1**

Qns		Marks
2(a)	work done per unit mass in bringing a small test mass from infinity to that point in the field	B1
2(b)	$$\Delta E_p = \frac{-GM_{\text{Earth}}m_{\text{satellite}}}{r_{\text{orbit}}} - \frac{-GM_{\text{Earth}}m_{\text{satellite}}}{r_{\text{surface}}}$$ $$= -Gm_{\text{satellite}}\left(\frac{M_{\text{Earth}}}{r_{\text{orbit}}} - \frac{M_{\text{Earth}}}{r_{\text{surface}}}\right)$$ $$= -(1600)(6.67\times10^{-11})(6.0\times10^{24})\left(\frac{1}{2.7\times10^{7}} - \frac{1}{6400\times10^{3}}\right)$$ $$= 7.6\times10^{10}\text{ J}$$	C1 A1
2(c)(i)	gravitational force provides centripetal force $$\frac{GMm}{r^2} = \frac{mv^2}{r}$$ $$\frac{GMm}{r^2}\times\frac{r}{2} = \frac{mv^2}{r}\times\frac{r}{2}$$ $$\frac{GMm}{2r} = \frac{1}{2}mv^2 = E_k$$ **Notes:** Show algebra with all the steps clearly set out. In 'show that' questions, all the steps are required.	B1 B1
2(c)(ii)	$$E_k = \frac{GMm}{2r}$$ $$= \frac{(6.67\times10^{-11})(6.0\times10^{24})(1600)}{2(2.7\times10^{7})}$$ $$= 1.19\times10^{10}\text{ J}$$	A1
2(c)(iii)	equation only applicable for masses in orbit, where the only force on the satellite is gravitational force which provides the centripetal force on the surface, the centripetal force is provided by the difference between weight and normal contact force from surface on satellite. Hence the satellite is not in orbit and hence expression is not applicable not correct	M1 A1

Qns		Marks
3(a)	 **-1 M for each wrong section**	
3(b)	 **B1 for each correct section**	

Qns		Marks
4(a)	spreading of waves (towards geometric shadow) after passing through aperture or around an obstacle **Notes:** Do not use "bending of waves"	A1
4(b)	• waves of same type must meet and overlap • waves from sources must be coherent (OR have constant phase difference) • if waves are transverse, they must be either unpolarised or polarised in the <u>same plane</u> • for good contrast, waves should have approximately same amplitudes	B2

4(c)(i)



$$x = \frac{\lambda D}{a} = \left(\frac{\lambda}{a}\right) D$$

gradient $= \dfrac{y_1 - y_2}{x_1 - x_2} = \dfrac{(8.8 - 4.4)\times 10^{-3}}{2.0 - 1.0} = 4.4 \times 10^{-3}$ **M1**

$$\left(\frac{\lambda}{a}\right) = 4.4 \times 10^{-3}$$

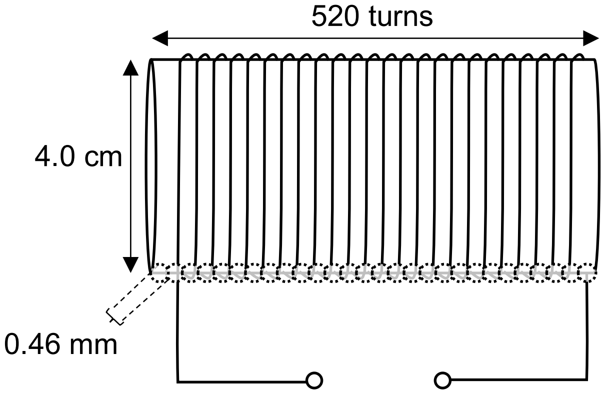
$\lambda = 4.4a = \left(4.4 \times 10^{-3}\right)\left(0.12 \times 10^{-3}\right) = 5.3 \times 10^{-7}$ m **A1**

Qns		Marks
4(c)(ii)	$I \propto A^2$	M1
	$\dfrac{\text{max } I \text{ of CBF}}{I \text{ of first dark fringe}} = \left(\dfrac{A_{\text{source}} + \frac{1}{2} A_{\text{source}}}{A_{\text{source}} - \frac{1}{2} A_{\text{source}}} \right)^2$	M1
	$= 9.0$	A1
5(a)	$I = \dfrac{Q}{t}$	
	$Q = It = (Anvq)t = \left(\pi \left(\dfrac{d}{2} \right)^2 nvq \right) t$	M1
	$= \left(\pi \left(\dfrac{0.38 \times 10^{-3}}{2} \right)^2 (5.9 \times 10^{28})(7.2 \times 10^{-5})(1.6 \times 10^{-19}) \right)(30 \times 60)$	
	$= 140 \text{ C}$	A1
5(b)(i)1.	$f = \dfrac{\omega}{2\pi} = \dfrac{120\pi}{2\pi} = 60 \text{ Hz}$	A1
5(b)(i)2.	$V_{\text{rms}} = \dfrac{V_0}{\sqrt{2}} = \dfrac{9.0}{\sqrt{2}} = 6.4 \text{ V}$	A1
5(b)(ii)1.	$R_{\text{total}} = 12 + \left(\dfrac{12(6)}{12+6} \right) = 16 \ \Omega$	C1
	$I_0 = \dfrac{V_0}{R_{\text{total}}} = \dfrac{9}{(16)}$	M1
	$= 0.56 \text{ A}$	A1
5(b)(ii)2.	$I_{total} = I_1 + I_2$	
	$0.56 = \dfrac{V}{6.0} + \dfrac{V}{12}$	
	$V = 2.24V$	M1
	$\langle P \rangle = \dfrac{P_0}{2} = \dfrac{V_0^2}{2R}$	
	$= \dfrac{(2.24)^2}{2(6.0)}$	
	$= 0.42 \text{ W}$	A1

Qns		Marks
6(a)	Magnetic flux density is the force acting per unit current per unit length on a wire carrying a current that is normal to the magnetic field.	B1

Notes: marks are lost if it is stated as "unit current" instead of "*per* unit current".

6(b)



$$R = \frac{\rho L}{A}$$ **C1**

$$= \frac{\rho\left(N\left(\pi d_{\text{solenoid}}\right)\right)}{\pi\left(\frac{d_{\text{wire}}}{2}\right)^2}$$ **C1**

$$= \frac{\left(1.7\times10^{-8}\right)\left(520\left(4\times10^{-2}\right)\right)}{\left(\frac{0.46\times10^{-3}}{2}\right)^2}$$

$$= 6.7\ \Omega$$ **A1**

6(c)

$$B = \mu_0 nI$$ **C1**

$$= \mu_0\left(\frac{N}{L}\right)\left(\frac{V}{R}\right) = \mu_0\left(\frac{N}{Nd_{\text{wire}}}\right)\left(\frac{V}{R}\right) = \mu_0\left(\frac{1}{d_{\text{wire}}}\right)\left(\frac{V}{R}\right)$$ **C1**

$$= \left(4\pi\times10^{-7}\right)\left(\frac{1}{0.46\times10^{-3}}\right)\left(\frac{24}{6.68}\right)$$

$$= 9.8\times10^{-3}\,\text{T}$$ **A1**

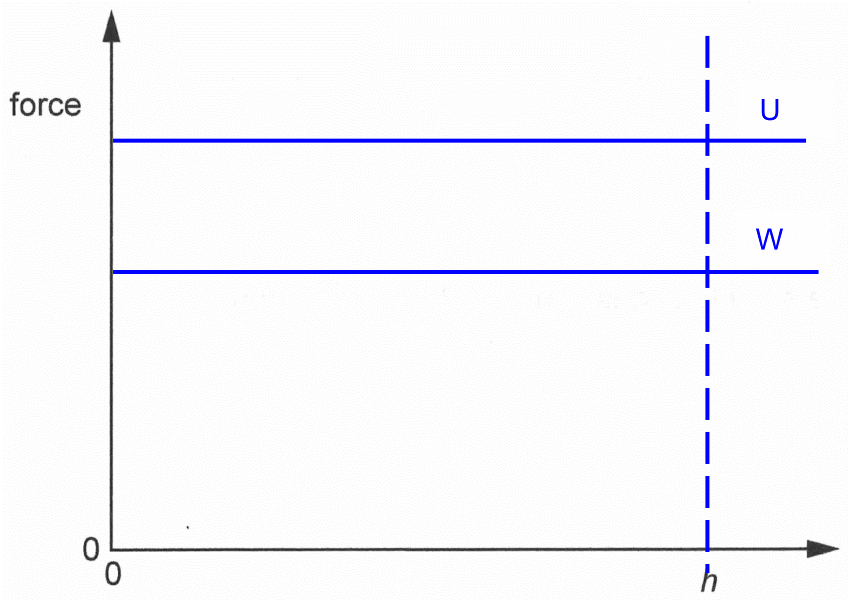
6(d) direction of current <u>parallel to the magnetic field</u> generate by the solenoid **A1**
zero

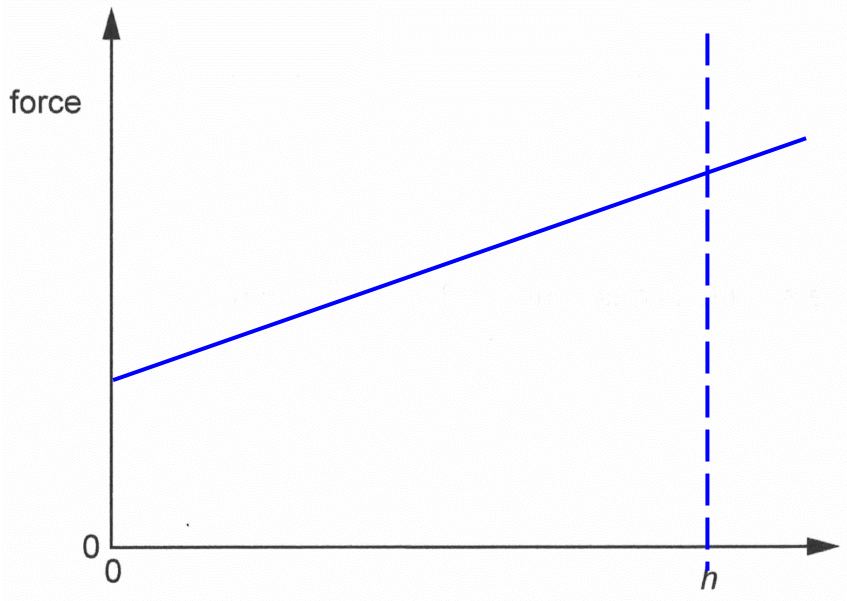
Qns		Marks
	Notes: "not perpendicular" does not mean parallel	
7(a)	a discrete packet of energy of electromagnetic radiation energy of one photon = Planck constant x frequency	B1 B1
7(b)	electrons in gas atoms/molecules interact with photons	B1
	photon energy causes electron to move to higher energy level (or to be excited)	B1
	photon energy = difference in energy of electron energy levels	B1
	when electrons de-excite, photons re-emitted in all directions	B1
7(c)(i)	$E = \frac{-13.6}{n^2} = \frac{-13.6}{2^2} = -3.40$ eV	A1
7(c)(ii)	$\Delta E = \left(\frac{-13.6}{3^2} - \frac{-13.6}{2^2}\right)(1.6 \times 10^{-19}) = 3.022 \times 10^{-19}$ J	M1
	$\Delta E = \frac{hc}{\lambda}$	
	$3.022 \times 10^{-19} = \frac{(6.63 \times 10^{-34})(3.00 \times 10^{8})}{\lambda}$	M1
	$\lambda = 6.58 \times 10^{-7}$ m	A1
7(c)(iii)	electric potential is zero at infinity	A1
	electric force of attraction between positively charged nucleus and negatively charged electron decrease in potential energy as charges approach	

Qns		Marks
8(a)	assuming uniform deceleration, $v^2 = u^2 + 2as$ $a = \frac{v^2 - u^2}{2s} = \frac{0 - \left(\frac{185 \times 10^3}{60^2}\right)^2}{2(80)}$ $= -17 \text{ m s}^{-2}$	M1
	deceleration = 17 m s^{-2}	A1
8(b)(i)	$a = \frac{v^2}{r}$	M1
	$v_{max} = \sqrt{ar} = \sqrt{4gr}$	M1
	$= \sqrt{4(9.81)(30)}$ $= 34 \text{ m s}^{-1}$	A1
	Notes: acceleration is not constant in circular motion. Kinematics equations of motion cannot be applied.	
8(b)(ii)	From Fig. 8.1, tyres provide greatest friction, with coefficient 1.6, when temperature is about 80 °C	B1
	higher than ambient temperature of about 30 °C so need to heat	B1
	From Fig. 8.2, heated tyres are softer and so will meld its shape to the irregular road surface to increase contact area and provide more friction (more friction allows more acceleration and higher speeds when turning)	B1
8(c)	air experiences a rate of change of momentum upwards and hence by Newton's 2nd Law, it experiences an upward force	B1
	By Newton's 3rd Law, the wing experiences a force equal in magnitude and opposite in direction of that experienced by air. the force presses down on the car and increases the apparent weight	B1
8(d)(i)	Taking moments about centre of gravity, sum of clockwise moments = sum of anti-clockwise moments	
	$N_R x_R = N_F x_F + Dh$ ---(1)	B1
	car is in vertical translational equilbirum, vector sum of forces along vertical is 0	
	$N_R + N_F = W$ ---(2)	B1
	Solving (1) and (2) , $N_R x_R = N_F x_F + Dh$ $N_R x_R = (W - N_R) x_F + Dh$	
	$N_R (x_R + x_F) = W x_F + Dh$	B1
	$N_R = \frac{W x_F + Dh}{x_R + x_F}$	

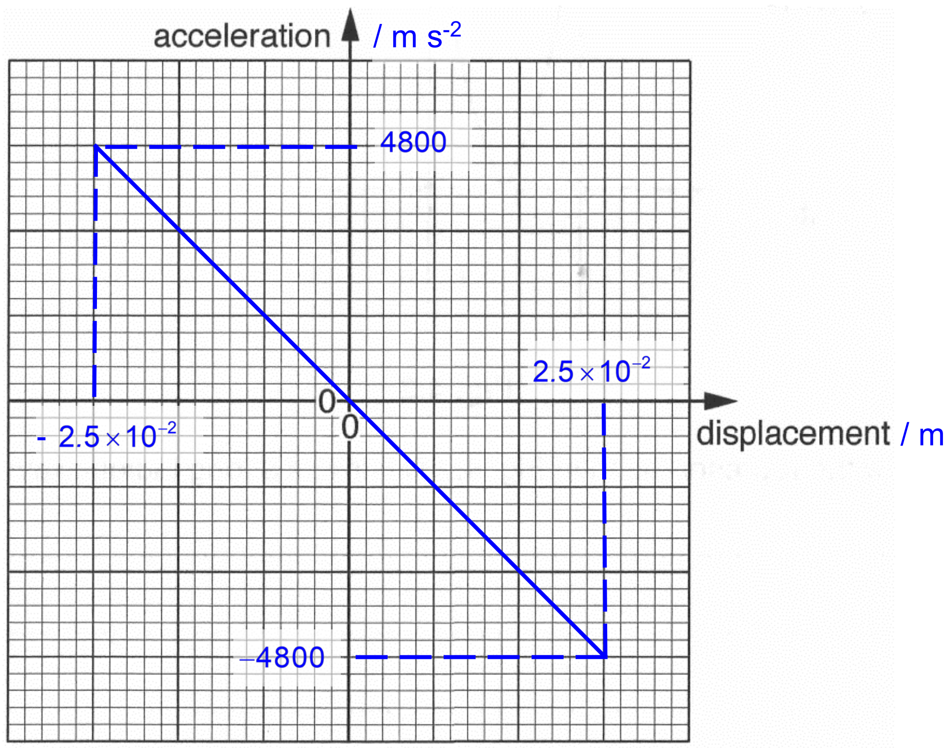
Qns		Marks
8(d)(ii)	$$N_R = \frac{Wx_F + Dh}{x_R + x_F}$$ $$W - N_F = \frac{Wx_F + Dh}{x_R + x_F}$$ $$N_F = W - \frac{Wx_F + Dh}{x_R + x_F}$$ $$= \frac{Wx_R + Wx_F - Wx_F - Dh}{x_R + x_F}$$ $$= \frac{Wx_R - Dh}{x_R + x_F}$$	A1
8(d)(iii)	*D* increases as the car accelerates	B1
	magnitude of N_R increases and magnitude of N_F decreases	B1
8(e)(i)	Loss in KE of car = Heat gain by brakes	B1
	$$\frac{1}{2}m_{car}v^2 = m_{brakes}c\Delta\theta$$	
	$$4(1.2)(1130)\Delta\theta = \frac{1}{2}(750)\left(\frac{185\times10^3}{60^2}\right)^2$$	M1
	$$\Delta\theta = 180\ °C$$	A1
8(e)(ii)	no heat loss from brakes to surrounding	B1
8(e)(iii)	to reduce weight without too much loss of structural integrity to ventilate the brake discs by increasing available surface area to allow water to be pushed out between brake discs and brake pads under slippery conditions	B2

Paper 3
Longer Structured Questions

Qns		Marks
1(a)(i)	pressure exerted by liquid increases with depth of submersion, given by $p = \rho gh$	**B1**
	there is greater pressure exerted at lower surface of submerged sphere than the pressure exerted at upper surface	**B1**
	net upward force due to pressure difference results in upthrust	**B1**
1(a)(ii)	magnitude of upthrust is equal to the weight of liquid displaced by the sphere	**M1**
	upthrust U = weight of liquid displaced = (mass of liquid displaced) g $= \rho_L Vg$	**A1**
1(b)	 **A1 for each correct graph**	

Qns		Marks
1(c)	 **A1 for upward sloping straight line** **A1 for starting from non-zero value**	

Qns		Marks
2(a)	Gas atoms are in continuous random direction. There is an equal probability of moving in any direction. Mean velocity in any direction is equal in magnitude to the mean velocity in the opposite direction.	B1
	Velocity if a vector quantity with both magnitude and direction. Hence the vector sum of the mean is zero	B1
2(b)	$pV = NkT$	M1
	$N = \frac{pV}{kT} = \frac{(3.6\times10^{5})(4.2\times10^{-3})}{(1.38\times10^{-23})(273.15+70)}$	M1
	$= 3.2\times10^{23}$	A1
2(c)	assume spherical volumes $V_{\text{total}} = NV_{\text{sphere}} = N\left(\frac{4}{3}\pi\left(\frac{d}{2}\right)^{3}\right)$ $= (3.2\times10^{23})\left(\frac{4}{3}\pi\left(\frac{2\times10^{-10}}{2}\right)^{3}\right)$	
	$= 1\times10^{-6}\ \text{m}^3$	A1
2(d)	volume of gas atoms is $1\times10^{-6}\ \text{m}^3$, which is 3 orders of magnitude smaller than the volume of the container occupied by gas	M1
	supports one of the assumptions that the total volume of the gas atoms is negligible compared to volume of container	A1

Qns		Marks
3(a)(i)	t_3 and time t_7	**A1**
3(a)(ii)	t_4 and time t_8	**A1**
3(b)(i)	$f = \dfrac{1}{\text{period } T} = \dfrac{1}{\frac{60}{4200}} = 70 \text{ Hz}$	**A1**
3(b)(ii)	$a = -\omega^2 x$	**M1**
	$a_{max} = -(2\pi f)^2 (\text{max displacement from equilibrium})$	
	$= -(2\pi(70))^2 (2.5\times10^{-2})$	**M1**
	$= 4800 \text{ m s}^{-2}$	**A1**
3(c)		

A1 for correct shape
A1 for correct values and units for acceleration
A1 for correct values and units for displacement

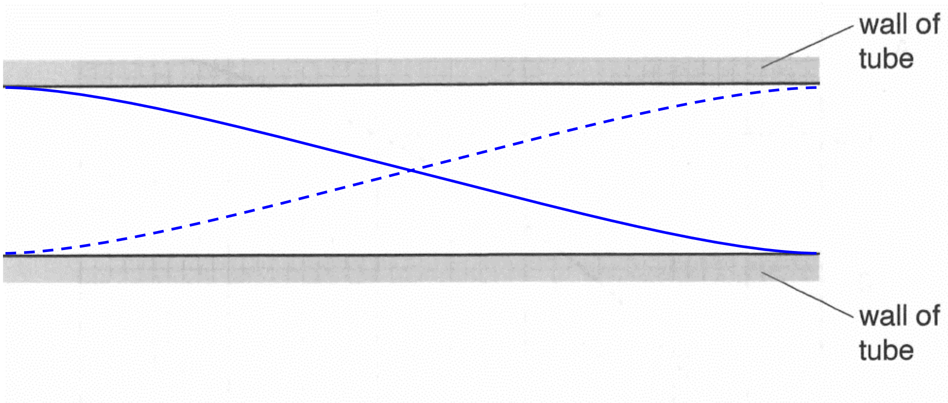
Qns		Marks
4(a)	two waves travelling in opposite directions superpose	B1
	waves are same type and have same speed, frequency and wavelength	B1

Notes:
1. Do not use "reflected waves" as it is too specific.
2. "Superpose" instead of "meet" or "overlap" should be used as these do not imply interference taking place.

4(b) Represents the amplitudes of individual particles on displacement-position axes where the central vertical axis of the pipe represents the positions of individual particles and horizontal axis as the displacement. **B1**

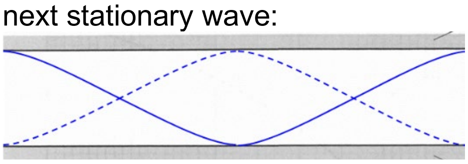
At the water surface, the particles have no amplitude, hence a node.
At the opening, the particles oscillate between maximum amplitudes, hence an antinode. **B1**

4(c)



Notes: Draughtsmanship is important

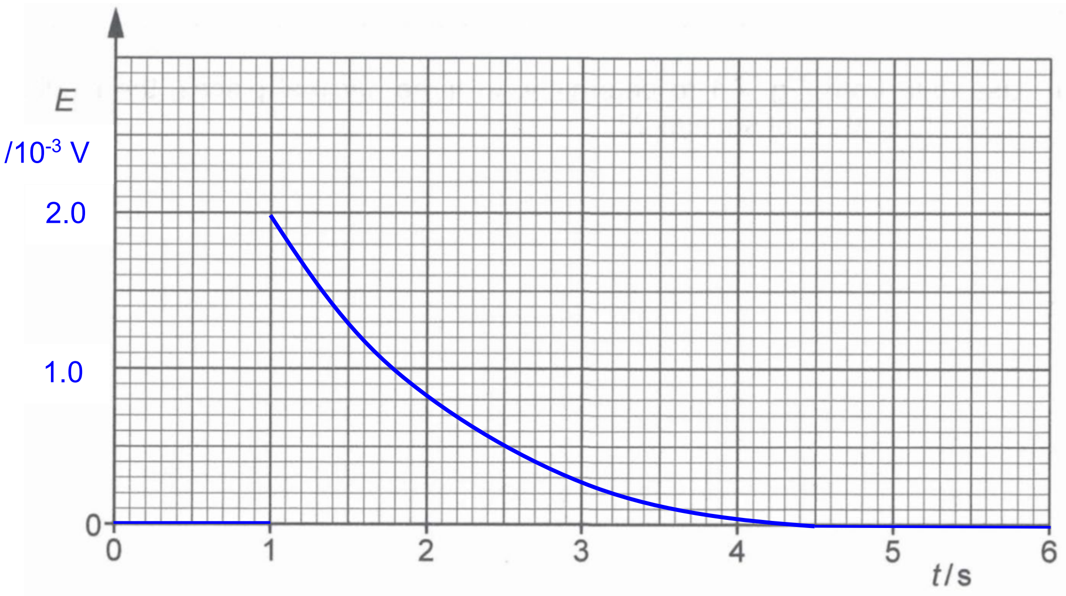
4(d) next stationary wave:



let length of tube be L
speed of sound waves in air be v
and frequency of wave be f

$$v = f\lambda$$
$$(540)(2L) = fL$$ **M1**
$$f = 1100 \text{ Hz}$$ **A1**

Qns		Marks
5(a)	$R_{3.0} - R_{1.5} = \frac{3.0}{0.3} - \frac{1.5}{0.2}$	M1
	$= 2.5\ \Omega$	A1
	Notes: Gradient is not the resistance	
5(b)(i)	from graph at 0.36 A, $V_{lamp} = 4.5\text{ V}$	
	$V_{5.0\ \Omega} = 0.36 \times 5.0 = 1.8\text{ V}$	
	$V_{14\ \Omega} = V_{5.0\ \Omega} + V_{lamp}$	
	$= 4.5 + 1.8$	
	$= 6.3\text{ V}$	M1
	$I_{14\ \Omega} = \frac{6.3}{14}$	
	$= 0.45\text{ A}$	A1
5(c)(ii)	$V_r = E - V_{terminal}$	
	$= E - V_{14\ \Omega}$	
	$= 7.5 - 6.3$	
	$= 1.2\text{ V}$	
	$I_r = I_{total}$	
	$= 0.36 + 0.45$	
	$= 0.81\text{ A}$	
	$r = \frac{V_r}{I_r}$	
	$= \frac{1.2}{0.81}$	M1
	$= 1.5\ \Omega$	A1

Qns		Marks
6(a)	induced e.m.f. directly proportional to rate of change of magnetic flux linkage	B1 B1
6(b)(i)	Rate of change of magnetic flux density $\frac{dB}{dt} =$ gradient of B - T graph at 1.0 s $= \frac{30 \times 10^{-3} - 0}{1.5 - 1}$ $= 6.0 \times 10^{-2}$ T s^{-1}	M1 M1 A0
	Notes: tangent should use points on it as far apart as possible.	
6(b)(ii)	$E = \left\lvert \frac{d(N\Phi)}{dt} \right\rvert$ $= \left\lvert NA\frac{dB}{dt} \right\rvert$ $= 140 \times (2.4 \times 10^{-4}) \times (6.0 \times 10^{-2})$ $= 2.0 \times 10^{-3}$ V	 M1 A1
6(b)(iii)	 B1 – label units and values for vertical axis B1 – 0 V for 0 – 1 s and 4.5 s onwards B1 – curve fro 1 s to 4.5 s	

Qns		Marks
7(a)(i)	minimum energy required to <u>completely separate</u> the nucleons in a nucleus to infinity	B1
	binding energy = (mass defect) × (speed of light)^2	B1
7(a)(ii)	mass defect = [(11 × 1.00814) + (12 × 1.00898) – 22.99706]u = 0.20024u	M1
	binding energy per nucleon $= \dfrac{0.20024}{23} \times 931.4$ MeV	M1
	$= 8.109$ MeV	A1
7(b)(i)	mass change $= (22.99706 + 1.00898 - 23.99857)u$	M1
	$= 7.47 \times 10^{-3} u$	A0
7(b)(ii)	energy released in γ photon, $E = 7.47 \times 10^{-3} \times 931.4$ MeV $= 7.47 \times 10^{-3} \times 931.4 \times 10^6 \times 1.60 \times 10^{-19}$ $= 1.11 \times 10^{-12}$ J	M1
	$E = \dfrac{hc}{\lambda}$ $\lambda = \dfrac{hc}{E}$ $= \dfrac{(6.63 \times 10^{-34})(3.0 \times 10^8)}{1.11 \times 10^{-12}}$	M1
	$= 1.78 \times 10^{-13}$ m	A1
7(c)	$A = A_o e^{-\lambda t}$ $\dfrac{A}{A_o} = e^{-\lambda t}$ $\dfrac{1}{20} = e^{-\lambda (65)}$	C1
	$\lambda = 0.0461$ hour^{-1}	A1

Qns		Marks
8(a)(i)	relative speed of approach of objects is not the same as relative speed of separation of the objects	B1 B1
8(a)(ii)	kinetic energy is not conserved but total energy is conserved some of the initial kinetic energy is transferred from the system into other forms of energy	B1
8(b)	change in height, $h = 1.5 \times (1 - \cos 21°)$ $= 9.96 \times 10^{-2}$ m	M1
	loss in GPE = gain in E_k $mgh = \frac{1}{2}mv^2 - 0$ $v = \sqrt{2gh}$	B1
	$= \sqrt{2(9.81)(9.96 \times 10^{-2})}$	M1
	$= 1.4 \text{ m s}^{-1}$	A0
8(c)(i)	by conservation of linear momentum, $p_{A,i} + p_{B,i} = p_{A,f} + p$ $m_A u_A + 0 = m_A v_A + p$ $0.096(1.4) + 0 = 0.096(-0.79) + p$	M1
	$p = 0.21 \text{ kg m s}^{-1}$	A1
8(c)(ii)	$(100 - 14)\% \times KE_{A,i} = KE_{A,f} + KE_{B,f}$	
	$86\% \times \frac{1}{2}(0.096)(1.4)^2 = \frac{1}{2}(0.096)(0.79)^2 + KE_{B,f}$	M1
	$KE_{B,f} = 0.051 \text{ J}$	A1

Qns		Marks
8(d)(i)	$KE = \frac{1}{2}mv^2 ---(1)$ $p = mv ---(2)$ $\frac{(1)}{(2)}: \frac{KE}{p} = \frac{v}{2}$	C1
	$v = 2\left(\frac{KE}{p}\right) = 2\left(\frac{0.051}{0.21}\right)$ $= 0.49 \text{ m s}^{-1}$	A1
8(d)(i)	$p = mv$ $0.21 = m(0.49)$ $m = 0.43 \text{ kg}$	A1
8(e)	initial total momentum of system is momentum of A which is not zero	M1
	no net external force acting on isolated system during collision, so by principle of conservation of momentum, momentum must be conserved throughout the event and cannot be zero at any time	M1
	so both spheres cannot be stationary at the same time	A1
	Notes: momentum is conserved throughout the process, even during collision.	
8(f)	$\text{impulse} = p_f - p_f$ $= (0.096)(-0.79 - 1.4)$ $= -0.21 \text{ kg m s}^{-1}$	M1
	$\text{magnitude} = 0.21 \text{ kg m s}^{-1}$	A1
8(g)	impulse on A is horizontal to the left, hence impulse on B is horizontal to the right	M1
	if centres of spheres are not on same horizontal level, there will be a component of impulse in the vertical direction and B's initial speed will not be horizontal.	A1

Qns		Marks
9(a)(i)	region of space where a <u>force acts</u> <u>on a body</u>	B1 B1
9(a)(ii)	1. gravitational field	B1
	2. electric field and gravitational field	B1
9(b)(i)	$t = \frac{s_x}{u_x}$ $= \frac{12 \times 10^{-2}}{6.7 \times 10^{7}}$ $= 1.8 \times 10^{-19}$ s	B1
9(b)(ii)	$a_y = \frac{F_E}{m_e}$ $= \frac{eE}{m_e}$ $= \frac{e\frac{\Delta V}{d}}{m_e}$	M1
	$= \frac{1.6 \times 10^{-19} \frac{960}{2.4 \times 10^{-2}}}{9.11 \times 10^{-31}}$	M1
	$= 7.0 \times 10^{15}$ m s^{-2}	A1
9(c)	$s_y = \frac{1}{2}\left(7.0 \times 10^{15}\right)\left(1.8 \times 10^{-9}\right)^2$	M1
	$= 0.011$ m = 1.1 cm	M1
	since 1.1 cm < 1.2 cm (vertical displacement of electron to upper plate), will not collide	A1
9(d)(i)	magnetic force normal to velocity/direction of motion throughout magnitude of magnetic force constant	B1
	so magnetic force provides the centripetal force speed is constant while changing direction of velocity	B1
	Note: Should use 'the direction of motion of the particle' or velocity instead of 'the motion of the particle'	

Qns		Marks
9(d)(ii)	magnetic force provides for centripetal force $Bqv = \frac{mv^2}{r}$ $m = \frac{Bqr}{v}$ $= \frac{0.090\left(1.6\times10^{-19}\right)\left(\frac{14.8\times10^{-2}}{2}\right)}{4.6\times10^{4}}$ $= 2.32\times10^{-26}$ kg $= 14u$	M1 M1 M1 A1
9(e)(i)	radius of circular path decreases	B1
9(e)(ii)	radius of the path (hence diameter) is halved diameter of new path = 7.4 cm	B1 B1