EUNOIA JUNIOR COLLEGE
JC2 PRELIMINARY EXAMINATIONS 2022
General Certificate of Education Advanced Level
Higher 2

PHYSICS

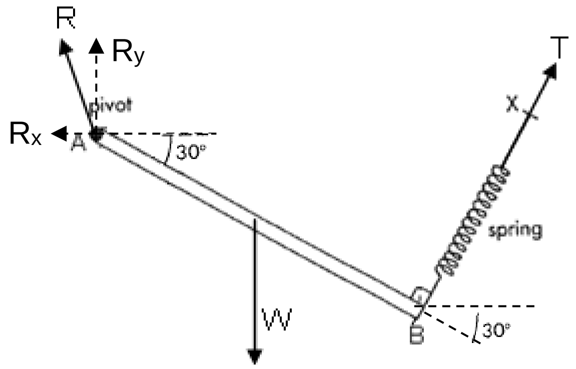
9749

MARK SCHEME

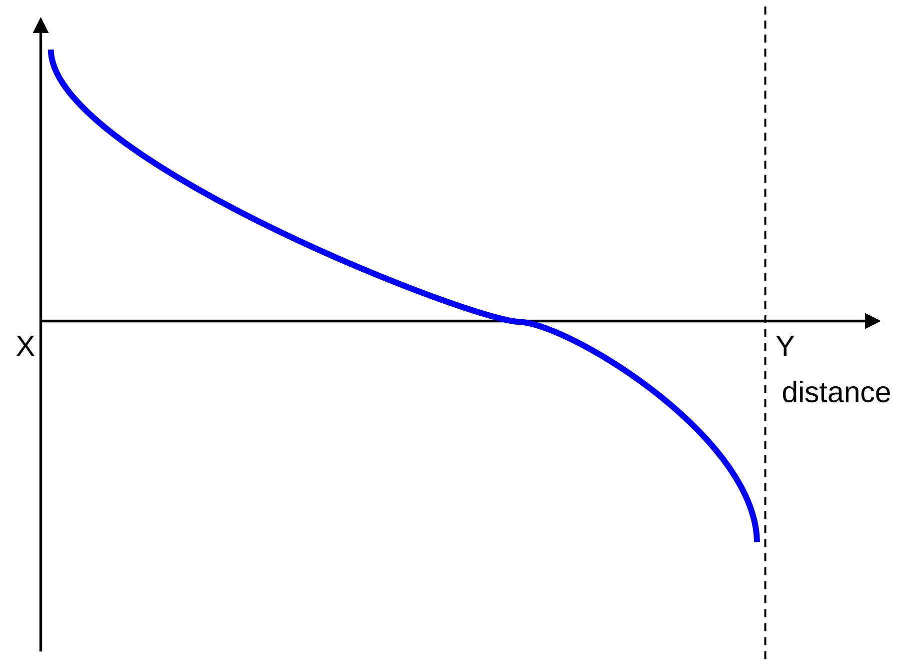
August/September 2022

Paper 2
Structured Questions

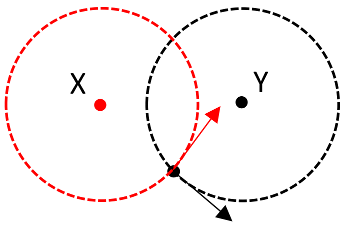
Qns	Answer	Marks
1(a)	Forces must be labelled forces clearly in full – Weight, Reaction Force, Tension Lines of action forces (including intersection of the 3 lines) must be clearly shown.	**1**
(b)	Let *T* be the tension in the spring. Taking moments about A, Sum of clockwise moment = Sum of anticlockwise moment mg (0.20 cos30°) = T (0.40) 1.2(9.81) (0.20 cos30°) = T (0.40) T = 5.10 N	**1** **1**

Qns	Answer	Marks
(c)	 Let R_x and R_y be the horizontal and vertical components of the reaction force *R.* Resolving forces horizontally, $R_x = T \cos 60°$ $= 5.10 \cos 60°$ $= 2.55$ N	1
	Resolving forces vertically, $R_y + T\sin 60° = W$ $R_y + 5.10 \sin 60° = (1.2)(9.81)$ $R_y = 7.36$ N	1
	magnitude of reaction force $R = \sqrt{R_X^2 + R_Y^2}$ $= \sqrt{2.55^2 + 7.36^2}$ $= 7.79$ N	1
(c)	increase (stiffer spring so a smaller extension needed for the same elastic force, resulting in larger angle)	1

Qns	Answer	Marks
2(a)(i)	Total momentum of an isolated system of interacting bodies before and after collision remains constant if no net external force acts on the system.	**1**
(a)(ii)	Presence of external force like weight / force from the ground	**1**
(b)	By Conservation of Energy, loss of gravitational potential energy = gain in kinetic energy $\cancel{m}gh = \frac{1}{2}\cancel{m}v^2$ $v = \sqrt{2gh}$ $= \sqrt{2(9.81)(2.0)}$ $= 6.26 \text{ m s}^{-1}$	**1**
(c)	collision is elastic, total KE before and after bounce conserved ½ $(0.8)(6.26)^2$ = ½ $(0.3)(v^2)$ + ½ $(0.5)(3.2)^2$ v = 9.35 m s^{-1}	 **1** **1**

Qns	Answer	Marks
3(a)(i)	Since the direction of field strength is directed upwards at point O, the horizontal component of the electric field strength due to the 2 charges at O are equal in magnitude and opposite in direction. $$\frac{q_1}{4\pi\varepsilon_o r^2}\sin 30^{o} = \frac{q_2}{4\pi\varepsilon_o r^2}\sin 60^{o}$$ $$\frac{q_1}{q_2} = \frac{\sin 60^{o}}{\sin 30^{o}} = 1.73$$ $$= 1.7$$	**1**
3(a)(ii)	 correct shape, graph does not touch the y-axis or dotted line (else max 1) E = 0 at position nearer to Y Relative field strength at X larger in magnitude than at Y	**1** **1**
3(b)(i)	electric field strength is a vector quantity Since the resultant field strength at point O is directed upwards, the resultant electric field strength is the <u>vector sum</u> of the <u>vertical component of the electric field strength</u> due to the 2 charges. $$E_{\text{resultant}} = E_1 + E_2$$ $$= \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r^2}\right)\cos 30° + \frac{1}{4\pi\varepsilon_0}\left(\frac{q_2}{r^2}\right)\cos 60°$$ $$= \frac{q_2}{4\pi\varepsilon_0 r^2}\left[(1.7)\cos 30° + \cos 60°\right]$$ $$= \frac{200\times10^{-9}}{4\pi\left(8.85\times10^{-12}\right)(0.50)^2}\left[(1.7)\cos 30° + \cos 60°\right]$$ $$= 1.42\times10^{4}\ \text{V m}^{-1}$$	**1** **1**

Qns	Answer	Marks
(b)(ii)	electric potential is a scalar quantity total electric potential at point O is sum of electric potential at that point due to the 2 charges. $V_{\text{resultant}} = V_1 + V_2$ $= \frac{1}{4\pi\varepsilon_0}\left(\frac{q_1}{r}\right) + \frac{1}{4\pi\varepsilon_0}\left(\frac{q_2}{r}\right)$ $= \frac{q_2}{4\pi\varepsilon_0 r}\left[(1.7)+1\right] = \frac{200\times10^{-9}}{4\pi\left(8.85\times10^{-12}\right)(0.50)}(2.7)$ $= 9710\text{ V}$	**1**
(b)(iii)	work done $W = q\Delta V$ $= (-2q_2)(V_{\text{final}} - V_{\text{initial}})$ $= (-2)\left(200\times10^{-9}\right)(9710-0)$ $= -0.00388\text{ J}$ $= -2.43\times10^{16}\text{ eV}$	**1** **1**

Qns	Answer	Marks
4(a)	Force per unit current unit length of wire Carrying a wire that is normal to the magnetic field.	**1**
(b)(i)1.	direction (dots above current, crosses below current) field strength stronger when nearer wire (higher density of dots/crosses nearer the current)	**1** **1**
(b)(i)2.	positive	**1**
(b)(ii)	Force is always perpendicular to the velocity of the particle No displacement in the direction of force, so work done by the force is zero, no change in kinetic energy so no change in speed.	**1** **1**
(b)(iii)	Done in vacuum, so no loss of kinetic energy due to no collision with air particles, so no change in speed. OR Weight of the particle is negligible compared to the magnetic force.	**1**
(c)	Observe that 3 cm, 4 cm and 5 cm form a right-angle triangle. So the magnetic flux density at point Z due to currents in X and Y are perpendicular to one another.  The magnetic flux density at Z is the vector sum of magnetic flux densities due to X and Y. $B = \frac{\mu_0 I}{2\pi d}$ $B_{resultant} = \sqrt{B_X^2 + B_Y^2}$ $= \sqrt{\left[\frac{(4\pi \times 10^{-7})(7.0)}{2\pi(3.0\times10^{-2})}\right]^2 + \left[\frac{(4\pi \times 10^{-7})(8.0)}{2\pi(4.0\times10^{-2})}\right]^2}$ $= 6.15 \times 10^{-5}$ T	 **1** **1**

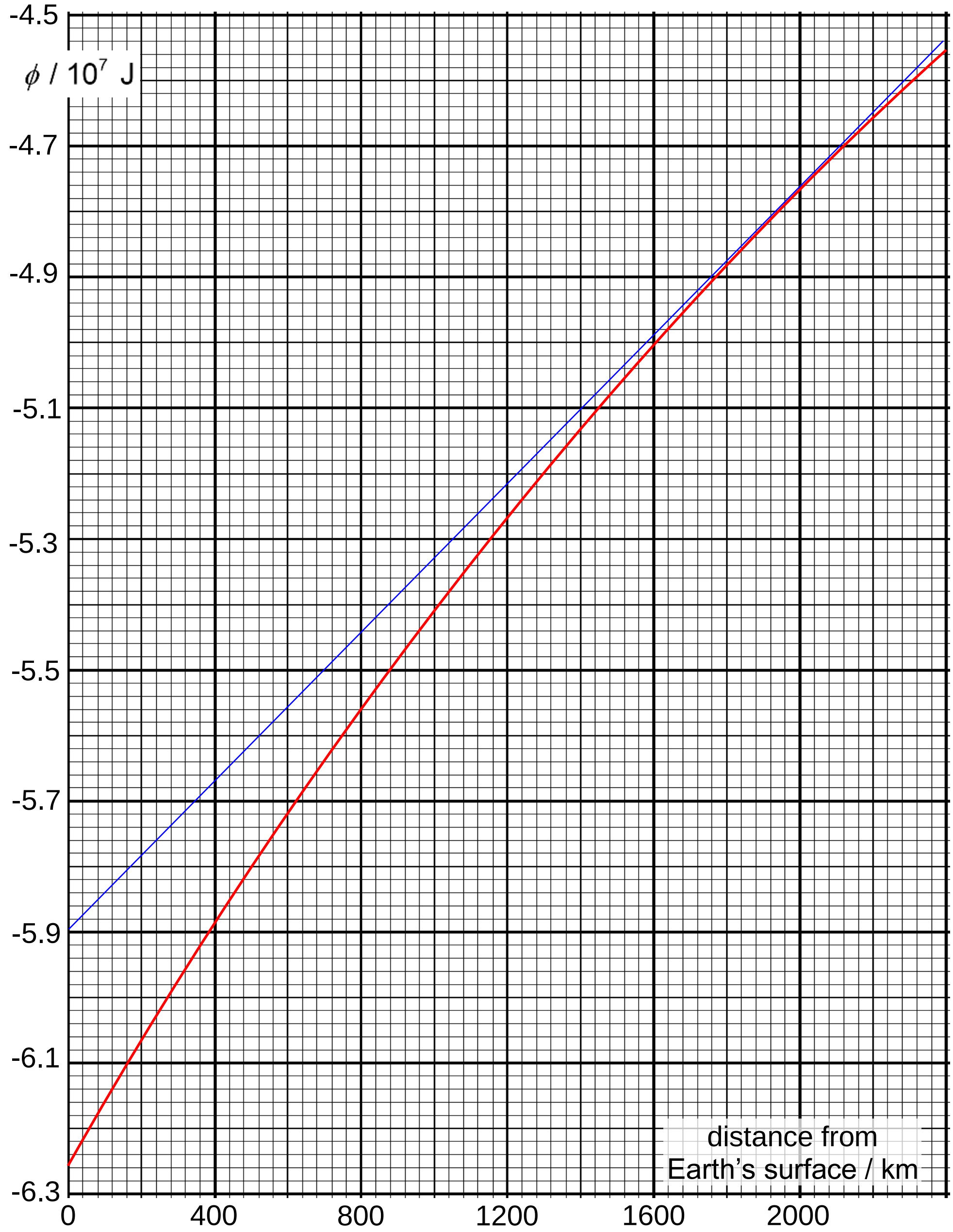
Qns	Answer	Marks
5(a)(i)	At 22.5 °C, R_T = 1.6 kΩ (read from graph) Total resistance $= \left(\frac{1}{1600}+\frac{1}{1600}\right)^{-1}$ = 800 Ω	**1** **1**
(a)(ii)	Using potential divider principle, $\frac{V}{9.0}=\frac{800}{800+1200}$ $V=3.6$ V	**1** **1**
(b)(i)	Using potential divider principle, $\frac{1200}{R_{AB}}=\frac{5}{4}$ $R_{AB}=960\ \Omega$	**1** **1**
(b)(ii)	$\frac{1}{960}=\frac{1}{1600}+\frac{1}{R_T}$ $R_T=2400\ \Omega$ From graph, temperature = 10.5 °C **OR** 10.75 °C (read to half the smallest division) **OR** 11 °C	**1** **1**
(c)	From graph, no calibration data available between 24°C to 25°C (accept "at 25 °C"O). Since graph is non-linear, hence cannot extrapolate to get values of temperature. Based on temperature range of 0 – 25 °C, V_{AB} has a range of 0.48 V to 3.5 V. Since only a small part of the voltage scale is used, the measurement of temperature will be less sensitive.	**1** **1**

Qns	Answer	Marks
6(a)(i)	Progressive wave is one where energy is transferred in the direction of propagation of the wave. Transverse wave is one where the direction of oscillations is normal to the direction of energy propagation.	1 1
6(a)(i)	Polarisation is where oscillations of a wave to one direction only, in the plane normal to the direction of energy propagation. Since the oscillations in a longitudinal wave is parallel to the direction of energy propagation, longitudinal wave cannot be polarised.	1 1
6(b)(i)	Based on the amplitudes of the electricity field strength graphs, $A = A_o \cos\theta$ $16 = 9\cos\theta$ $\theta = 56^o$	1 1
6(b)(ii)	$I \propto A^2$ $I = \cos^2(\theta)$ $\frac{I}{I_0} = \cos^2(\theta) = \left(\frac{9}{16}\right)^2 = 0.316$	1 1

Qns	Answer	Marks
7(a)(i)	Loss in electric potential energy = gain in kinetic energy $\frac{1}{2}m_e v^2 = eV$ $\frac{1}{2}(9.11\times10^{-31})v^2 = (1.60\times10^{-19})(45)$ $v = 3.98\times10^{6}$ $\approx 4.0\times10^{6}$ m s^{-1}	1
(ii)	$p = m_e v$ $= (9.11\times10^{-31})(4.0\times10^{6})$ $= 3.644\times10^{-24}$ kg m s^{-1} $\lambda = \frac{h}{p}$ $= \frac{6.63\times10^{-34}}{3.644\times10^{-24}}$ $= 1.82\times10^{-10}$ m •	1 1
(b)(i)	Spacing between the crystals is of the <u>same order of magnitude</u> as the de Broglie wavelength of electron (so diffraction effect is significant). The crystal acts as a <u>diffraction grating</u> for the beam of electrons. <u>Bright spots</u> observed when <u>constructive interference</u> takes place.	1 1 1
(ii)	As the accelerating potential increase, the **de Broglie wavelength of the electron <u>decreases</u>.** Hence, the **angle of diffraction <u>decreases</u>** so **spacing between bright spots <u>decrease</u>** •	1 1

Qns	Answer	Marks
8(a)(i)	$v_y = v\cos\theta$ $= (536)\cos(90° - 86.7°)$ $= 535 \text{ m s}^{-1}$	 1 A0
(a)(ii)	$s = ut + \frac{1}{2}at^2$ $-50.4 = (535)t + \frac{1}{2}(-9.81)t^2$ $t = 109 \text{ s}$	 1 1
(a)(iii)	$v^2 = u^2 + 2as$ $0 = 535^2 + 2(-9.81)s_{max}$ $s_{max} = 14588 \text{ m}$ height $= 14588 + 50.4$ $\approx 14600 \text{ m}$	 1 1
(b)(i)	$\frac{\cancel{mg}h_{actual}}{\cancel{mg}h_{ideal}} = \frac{9300}{14600} = 0.637$	1
(b)(ii)	Larger Drag force increases with larger <u>relative velocity</u>. Traditional rockets start off stationary and hence experience less drag across the ascend process	1 1
(c)(i)	$\omega = \frac{2\pi}{T} = \frac{2\pi}{24 \times 60 \times 60} = 7.27 \times 10^{-5} \text{ rad s}^{-1}$	1
(c)(ii)	Towards east. Launching projectile in the same direction as Earth's rotation reduces the amount of kinetic energy that the accelerator has to transfer to the projectile for the projective to achieve the desired speed.	1 1
(d)(i)	$v = r\omega = r\left(\frac{\theta}{t}\right)$ $= (50.0)\left(\frac{2\pi(450)}{60}\right)$ $= 2356$ $= 2360 \text{ m s}^{-1}$	 1

Qns	Answer	Marks
(d)(ii)	$v_{\text{at launch}} = \dfrac{8000\times10^3}{60\times60} = 2220\text{ m s}^{-1}$ $\text{ratio} = \dfrac{\cancel{\frac{1}{2}}\cancel{m}v^2_{\text{at launch}}}{\cancel{\frac{1}{2}}\cancel{m}v^2_{\text{before}}} = \left(\dfrac{2220}{2360}\right)^2 = 0.880\ \ (\text{accept } 0.890)$	1
(d)(iii)	**Minimise loss of** (kinetic) **energy** as heat due to work done against **air resistance**	1
(e)(i)	$\text{KE just before launch} = \dfrac{1}{2}mv^2$ $= \dfrac{1}{2}(200)(2360)^2$ $= 5.57\times10^8\text{ J}$ $\text{time needed} = \dfrac{5.57\times10^8}{100\times10^3} = 5570\text{ s} = 92.8\text{ min}$	
(e)(ii)	$\dfrac{a_c}{g} = \dfrac{r\omega^2}{g}$ $= (50.0)\left(\dfrac{450(2\pi)}{60}\right)^2 \dfrac{1}{9.81}$ $= 11300$ No. They were subject to more than 10 000 *g* for more than an hour.	1 1
(f)(i)	**Work by per unit mass** in bringing **a small test mass** from **infinity to that point**	1

Qns	Answer	Marks
(f)(ii)	 $g=-\dfrac{d\phi}{dr}\approx\dfrac{\left[(-4.54)-(-5.9)\right]\times10^{7}}{(2400-0)\times10^{3}}=5.67\text{ N kg}^{-1}$	1 1
(f)(iii)	The astronauts experience the **same acceleration towards centre of the Earth** as the space craft. Hence there is **no contact force by space craft on the astronaut.**	1 1
(f)(iv)	$\Delta U=m_{\text{projectile}}(\Delta\phi)=m_{\text{projectile}}(\phi_{\text{final}}-\phi_{\text{initial}})$ $=(200)\left((-5.89-(-6.25))\times10^{7}\right)$ $=7.20\times10^{8}\text{ J}$	1 1