Anderson Serangoon Junior College 2023 H2 Physics Prelim P2 Exam Mark Scheme

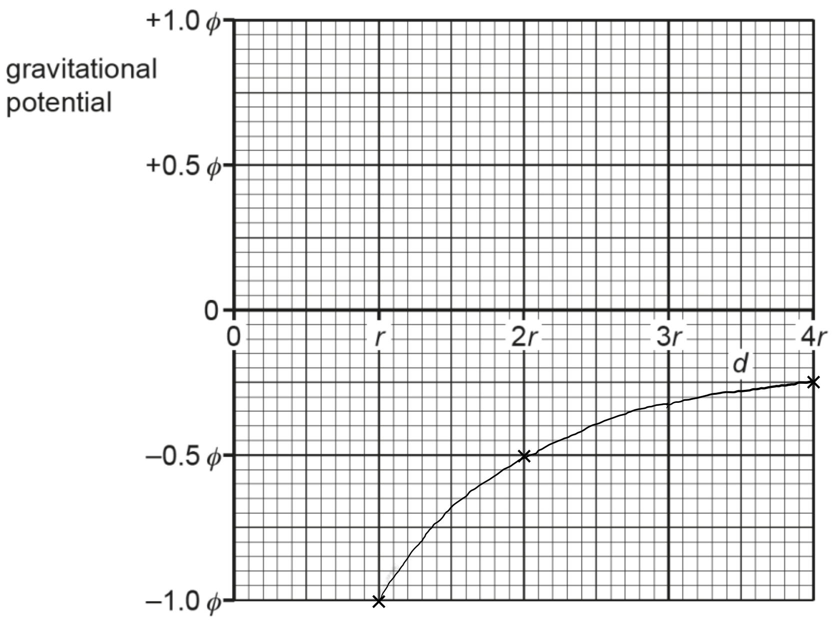
Paper 2 (80 marks) **E – Easy, A – Average, D – Difficult**

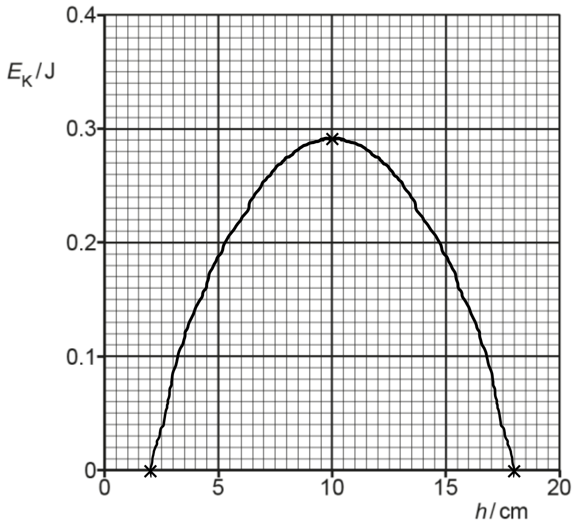
ECF	Error carried forward	**SF**	Significant figures error	**M0**	No A marks awarded
AE	Arithmetic error	**BOD**	Benefit of doubt	**^**	More is needed in answer
POT	Power of ten error	**CON**	Contradictory response	**XP**	Wrong physics
TE	Transcription error	**IR**	Irrelevant (part) response		

1a	$k = \frac{F}{e}$ $= \frac{0.180 \times 9.81}{0.036}$ $= 49\ \text{N m}^{-1}$	**A**	 C1 A1
1b	$k = \frac{F}{e}$ $\frac{\Delta k}{k} = \frac{\Delta F}{F} + \frac{\Delta e}{e} = \frac{2}{36} + 0.02$ $\Delta k = (\frac{2}{36} + 0.02) \times 49$ $= 3.7$ $= 4\ \text{N m}^{-1}$ *Accept* $\Delta k = \frac{k_{\max} - k_{\min}}{2}$	**A**	C1 A1
1ci	F is weight of the column of liquid above the area A $p = \frac{F}{A} = \frac{m_{fluid} g}{A}$ $= \frac{(V_{fluid} \rho_{fluid}) g}{A}$ $= \frac{(hA\rho_{fluid}) g}{A}$ $= h\rho g$	**A**	B1 B1 A0
1cii	*U* + *ke* = *mg* *U* = *mg* – *ke* = (0.180)(9.81) – 49(0.030) = 0.2958 N $\Delta p A = \Delta h A \rho g$ $U = V \rho g$ $0.2958 = (2.0 \times 10^{-5})(9.81)\rho$ $\rho = 1500\ \text{kg m}^{-3}$	**A**	C1 C1 A1

2a	The total momentum before collision is non-zero. By COM, (total) momentum is never zero, so not possible for both blocks to be at rest simultaneously.	**A**	M1 A1

bi	By COLM, taking rightwards as positive (3M x 0.40) – (M x 0.25) = (3M x 0.20) + Mv v =0.35 m s^{-1}	**E**	 A1
bii	To right / away from block A, as direction to the right is taken as positive in **(b)(i)**	**E**	B1
c	relative speeds of approach is non-zero, and relative speeds of separation is zero Relative speed of approach is <u>not equal</u> the relative speed of separation, Hence <u>inelastic</u> collision.	**A**	M1 A1

3ai	work done per unit mass bringing (small test) mass from infinity (to the point)	**E**	B1
3aii	(near Earth's surface change in) height ≪ radius **or** height much less than radius potential inversely proportional to radius **and** radius approximately constant (so potential approximately constant)	**A**	B1 B1
3b	curve from *r* to 4*r*, with gradient of decreasing magnitude and starting at (*r*, ±ϕ) <u>and</u> line passing through (2*r*, ±0.5ϕ) and (4*r*, ±0.25ϕ) line showing potential is negative throughout  	**A**	B1 B1
3ci	Gain in KE = loss in GPE ½*m* v^2 = 0–(– *GMm* / *R*) At distance R = 3r, $v=\sqrt{\frac{2GM}{3r}}=\sqrt{\frac{2\times 6.67\times 10^{-11}\times 6.0\times 10^{24}}{3\times 6.4\times 10^{6}}}$ = 6.46 × 10^3 m s^{-1} At distance R = 4r, $v=\sqrt{\frac{2GM}{4r}}=\sqrt{\frac{2\times 6.67\times 10^{-11}\times 6.0\times 10^{24}}{4\times 6.4\times 10^{6}}}$ = 5.59 × 10^3 m s^{-1} Change in speed = 6.46 × 10^3 –5.59 × 10^3 = 8.7 × 10^2 m s^{-1}	**D**	 C1 C1 A1

4a	$a = -\omega^2 x$ a = acceleration, x = displacement <u>from equilibrium position</u> and ω = angular frequency	**E**	B1
4bi	$\omega = 2\pi$ / T $= 2\pi$ / 4.0 = 1.57 = 1.6 rad s^{-1}	**A**	B1 A0
4bii	$E = ½m\omega^2 x_0^2$ *Or* $E = max\ E_k = ½mv^2_{max} = ½m\omega^2 x_0^2$ $= ½ \times 36 \times 1.6^2 \times 0.080^2$ = 0.29 J	**A**	B1 C1 A1
4c	<u>dome-shaped curve</u>, starting and ending at E_K = 0 maximum E_K shown as 0.29 J, position of peak shown at h = 10.0 cm line intercepts h-axis at h = 2.0 cm and at h = 18.0 cm 	**D**	B1 B1 B1

5a	The field strength at a point equals the <u>negative</u> of the potential gradient there. i.e. the electric potential gradient is the electric field strength the <u>direction</u> of the field is the same as the direction of <u>decreasing</u> potential.	**A**	(B2) B1 B1
5bi	Straight line vertically upward	**E**	B1
5bii	E = V/d = 75/(1.2 $\times 10^{-2}$) = 6250 V m^{-1}	**E**	 A1
5biii	gain in kinetic energy (= loss in potential energy) = charge × p.d. **or** $qV = ½mv^2$ because separation not in expressions so v is independent of separation	**D**	B1 A0
5biv	(at x = 0.40 cm), potential = (–) 75 × 0.40 / 1.2 (= (–) 25 V) $½mv^2 = qV$ $½ \times 4 \times 1.66 \times 10^{-27} \times v^2 = 2 \times 1.60 \times 10^{-19} \times 25$ Or $a = Vq / dm$ **and** $v^2 = 2as$	**D**	C1 C1

	$v^2 = (2 \times 75 \times 2 \times 1.60 \times 10^{-19} \times 0.40 \times 10^{-2}) / (1.2 \times 10^{-2} \times 4 \times 1.66 \times 10^{-27})$ $v = 4.9 \times 10^4$ m s^{-1}		(C1) A1

6a	A progressive wave is a wave in which energy is carried from one point to another by means of vibrations or oscillations within the wave. A transverse wave is a wave in which the oscillations of the particles in the wave are at right angles to the direction of transfer of energy of the wave.	**E**	B1 B1
6b	Speed, v is defined as distance travelled divided by the time taken. From the definition of wavelength, λ, in one cycle of the source, the wave energy moves a distance λ. The time taken for one cycle is the time period T. Since $f = 1 / T$, wave speed, v = (total distance / time taken) $v = \frac{\lambda}{T} = f\lambda$	**E**	B1 B1 A0
6ci	Angle θ / amplitude / intensity: 180° / A / I 90° / 0 / 0 60° / $0.50A$ / $0.25I$ intensity $\propto \cos^2\theta$	**A**	B1 B1 B1
6cii	intensity / angle θ: zero / 90° maximum / $0^\circ, 180^\circ$ $\frac{I}{2}$ / $32.8^\circ, 147^\circ$ Intensity after passing through polaroid Q, $I_Q = I\cos^2\theta$ Intensity after passing through polaroid R $I_R = I_Q\cos^2\theta$ $= I\cos^4\theta$	**D**	B1 B1
7a	When atoms are excited, the electrons move from a lower energy level to a higher energy level. When the <u>electrons de-excite from a higher level to a lower level, they emit photons with energies corresponding to the differences in energy levels of the atoms,</u> giving rise to line emission spectrum. <u>Since the frequencies of the photons are fixed, the photons emitted have discrete amounts of energies. Hence, energy levels are discrete.</u> *<u>Examiner's comments:</u>* Many students did not explain how the energy of the photon is linked to the energy levels in atoms. A few students described the observations for absorption line spectrum.	**A**	M1 A1

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<td>7b</td>
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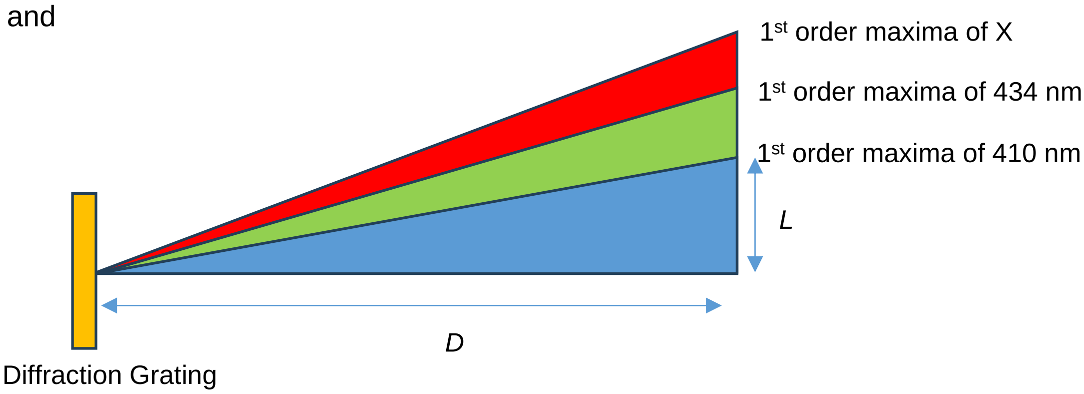
Since d sin θ = λ for 1st order maxima,
and



Hence,

$d(\frac{L}{D}) = 410 \times 10^{-9}$ (1)

$d(\frac{L+0.008}{D}) = 434 \times 10^{-9}$ (2)

From Equation 1 and 2,

L=0.1367 m

Using,

$d(\frac{L+0.075}{D}) = X$ (3)

From Equation 1 and 3,

$X = 635 \times 10^{-9}$ m

Or
Using idea of d sin $\theta = \lambda$ and small angle approximation,
$\theta \propto \lambda$
Since $\theta \propto \lambda$, $\Delta\theta \propto \Delta\lambda$, $\Delta L \propto \Delta\lambda$

$\frac{434-410}{0.8} = \frac{X-410}{8.2}$

$X = 656$ nm
</td>
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A1

(M1)

(A1)</td>
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Energy of photon with wavelength 410 nm

$= \frac{hc}{\lambda}$

$= \frac{(6.63 \times 10^{-34})(3.0 \times 10^{8})}{410 \times 10^{-9}}$

$= 4.85 \times 10^{-19}$ J

$Energy\ level = 4.85 \times 10^{-19} + (-4.08 \times 10^{-19})$

$= 0.77 \times 10^{-19}$ J
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M1</td>
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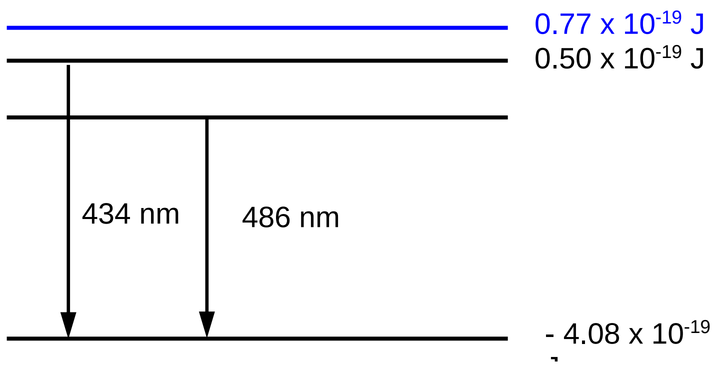
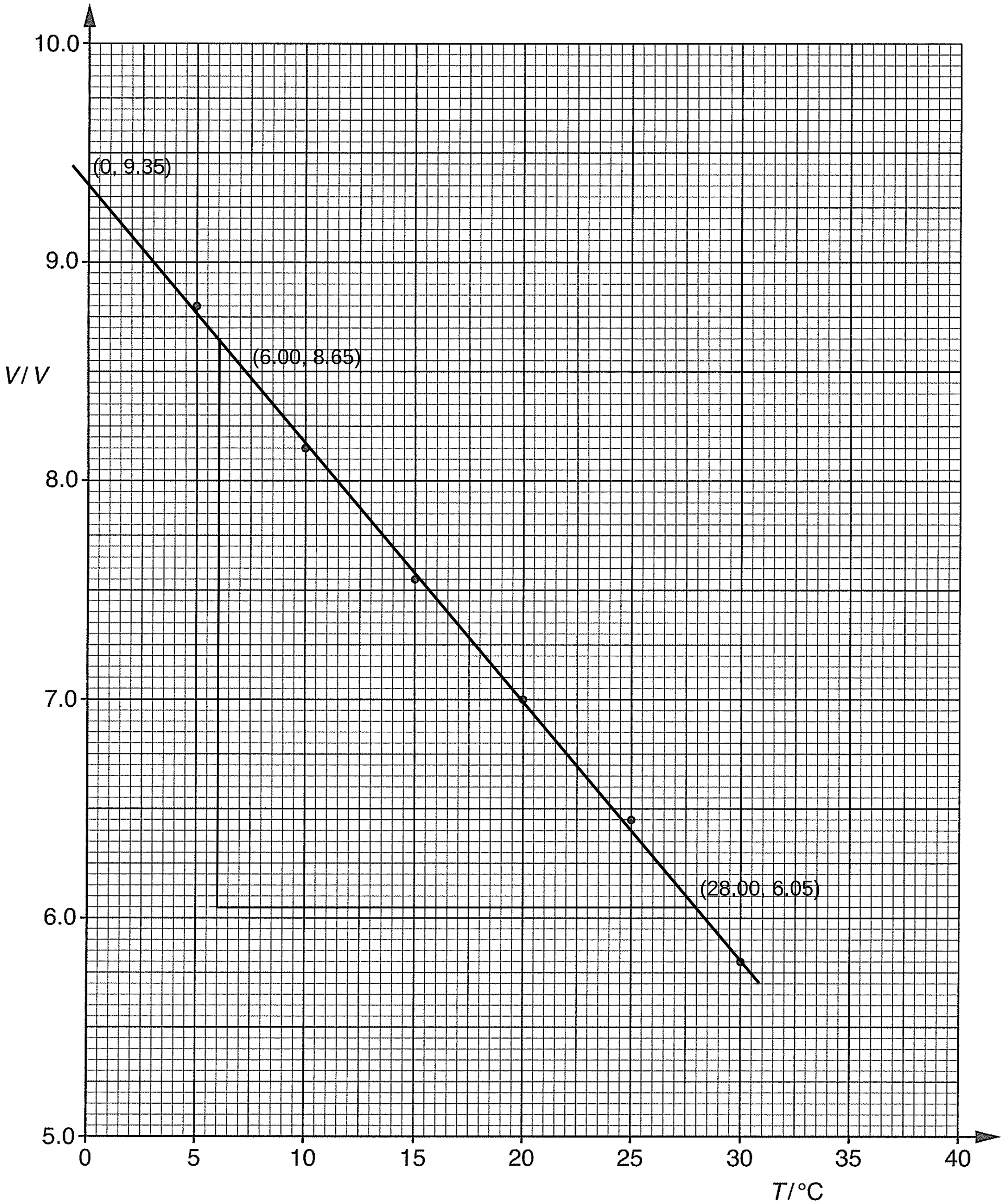
			A1
7d	The lowest energy level shown in Fig 7.3 may not be the energy level at ground state.	**D**	A1
7e	When the electrons are directed to pass through a <u>thin carbon film</u>, <u>concentric rings</u> are observed It shows a <u>diffraction pattern</u> that is unique to wave behaviour after passing through the carbon film.	**A**	M1 A1
7f	E_k of electron = $\dfrac{p^2}{2m}$ $p = \sqrt{2mE_k}$ By de Broglie's equation, $\lambda = \dfrac{h}{p}$ $= \dfrac{h}{\sqrt{2mE_k}}$ $= \dfrac{6.63 \times 10^{-34}}{\sqrt{2(9.11 \times 10^{-31})(4.08 \times 10^{-19})}}$ $= 7.69 \times 10^{-10}$ m	**A**	C1 A1

8a	greater lattice vibrations more frequent collision of electrons with lattice ions /lower drift velocity of the electrons	**A**	B1 B1
8bi	connect cells in series	**E**	B1
8bii	connect cells in parallel	**E**	B1
8c	Active cooling could fail/active cooling needs energy input, increasing costs or decreasing system output/ difficult to eliminate passive cooling	**A**	B1
8d	site panel so that there is <u>an air gap</u> around it e.g. mounts panels a small distance above the roof/in open space/clear from obstructions/ spaced out in field.	**A**	B1
8ei	6.40 V, 7.60 V (2 dp)	**D**	A1

8eii	little / no change to current at low voltages at lower temperature, greater current at higher voltage	**A**	B1 B1
8eiii	Best-fit straight line drawn *(See graph below)*	**E**	B1
8eiv	$V = \mu(T_R - T) + V_R$ Plotting a graph of V against T gives gradient= $-\mu$ and y- intercept= $V_R + \mu T_R$ Use of gradient to determine μ (see graph below) Gradient = $\frac{8.65 - 6.05}{6.0 - 28.0}$ =– 0.118 (note the dp of the coordinates) μ = 0.12 (0.118) V °C^{-1} From graph, y-intercept = 9.35, i.e. $V_R + \mu T_R = 9.35$ $6.40 + 0.12T_R = 9.35$ T_R = 25 (24.6) °C	**A**	 C1 A1 C1 A1
8ev	(7.60 = 0.12 (25-T) + 6.40), T = 15 °C	**A**	 A1
8evi	Rectangle drawn below line Correct area indicated (6.0 V and 0.048 A)	**A**	 A1
8evii	Use of area of rectangle or $P = IV$ P_{max} = 4.8 × 0.10 = 0.48 = 0.5 W	**D**	B1 A1
8fi	Better chance of capturing photons/ photons of a greater range of frequencies (contained within sunlight) can be captured	**A**	B1
8fii	Output power increases as angle of incidence on panel decreases / The closer the angle between PV panel and incident sunlight is to 90°, the larger the output power.	**A**	B1



10.0
9.0
8.0
7.0
6.0
5.0
V / V
(0, 9.35)
(6.00, 8.65)
(28.00, 6.05)
0
5
10
15
20
25
30
35
40
T / °C