EUNOIA JUNIOR COLLEGE
JC2 MID-YEAR EXAMINATIONS 2022
General Certificate of Education Advanced Level
Higher 1

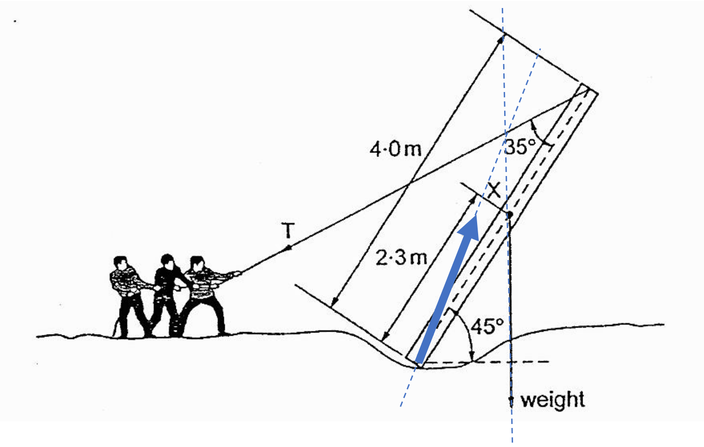
H1 PHYSICS 8867

PAPER 2 MARK SCHEME

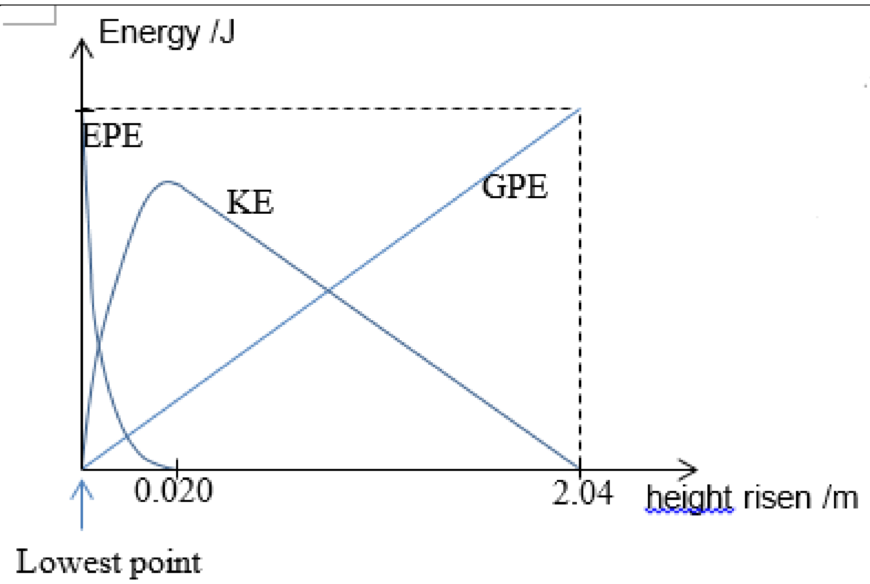
Jul 2022

1 (a)	$\frac{\Delta X}{X}=\frac{\Delta I}{I}+\frac{\Delta V}{V}$ $=\frac{0.1}{4.9}+\frac{0.03}{3.00}$ = 0.030 $\frac{\Delta X}{X}\times 100\%$ **= 3.0%**	M1 A1
(b)	$X=\frac{V}{I}=\frac{3.00}{4.9\times 10^{-3}}$ = 612 Ω △*X* = 0.030 x 612 = 20 Ω (to 1 s.f.) *X* ± △*X* = (610 ± 20) Ω	M1 M1 A1
2 (a)	Rate of change of velocity with respect to time.	B1
(b)(i)	Vertical acceleration = - 2.5 / 0.625 = - 4.0 m s^{-2} (accept from -3.9 to -4.1 m s^{-2})	M1 A1
(ii)	Taking upward as positive, $v^2 = u^2 + 2as$ $v^2 = (5.0 \sin 30^o)^2 + 2(-4.0)(-1.1)$ v = -3.9 ms^{-1}	M1 A1
(iii)	Taking upward as positive, v = u + at -3.9 = 5.0 sin 30° + (- 4.0) t t = 1.6 s OR: Explain their method of determining by reading off from the graph the time for which v = - 3.9 ms^{-1}	M1 A1
(iv)	Area bounded by the line between 1.25 s and 1.60 s. (can accept ±half small square for each timing above)	B1

(v)	'X' marked at velocity of - 4.3 m s^{-1}. When the velocity is 45° with respect to the vertical, both vertical and horizontal velocity are of the same magnitude, i.e. v_x = 5.0 cos 30° = 4.3 m s^{-1}.	B1 B1
3 (a)	Total momentum of the system remains constant, provided no external resultant force acts on the system.	B1 B1
(b)(i) 1.	v = u +at v = 100 + (– 900)(0.030) = 73 m s^{-1}	 A1
2.	v = u +at v = 0 + 300(0.030) = 9.0 m s^{-1}	 A1
(b)(ii)	Impulse = change in momentum = (0.010)(73 – 100) = – 0.27 Ns or kg ms^{-1} (with correct magnitude & units) OR Impulse = F Δt = (ma) Δt = (0.010 x 900)(0.030) = 0.27 Ns (with units)	M1 A1
(iii)	$M_{bullet}u_{bullet} + m_{block}u_{block} = m_{bullet}v_{bullet} + m_{block}v_{block}$ (0.010)(100) + m_{block} (0) = (0.010)(73) + m_{block}(9.0) m_{block} = 0.030 kg	 M1 A1
(iv)	Total Initial Kinetic energy = (1/2)(0.010)$(100)^2$ = 50 J Total Final Kinetic energy of bullet and block = (1/2)(0.010)$(73)^2$ + (1/2)(0.030)$(9.0)^2$ = 28 J Collision was inelastic as total kinetic energy is not conserved. OR: relative speed of approach = 100 – 0 = 100 m s^{-1} relative speed of separation = 9.0 – 73 = – 64 m s^{-1} Collision was inelastic since relative speed of separation is NOT equal to relative speed of approach.	 M1 A1
4(a)(i)	No resultant force acting in any direction. No resultant moment about any point.	B1 B1

(ii) 1.	Clockwise moment about base = 180 x 9.81 x (2.3 cos 45º) = 2.87 x 10^3 N m (shown)	B1
2.	Taking moment about base of column, Anticlockwise moment = Clockwise moment = 2.87 x 10^3 *T* sin 35º x 4.0 = 2.87 x 10^3 *T* = **1.25 x 10^3** N	 M1 A1
3.	To keep the column in equilibrium, the three forces, (ie. Tension, weight and force from the ground) should be concurrent and pass through the same point. (must draw lines of action to show) 	B1
4.	The tension will decrease. As the column rotates anticlockwise, the horizontal distance of the weight from the pivot decreases, the clockwise moment decreases. Hence, the amount of anticlockwise moment required for equilibrium decreases. For the same angle between rope and column, tension decreases for the decreased anticlockwise moment required.	A1 M1
(b)(i)	From conservation of energy, the elastic energy stored in the spring will be transformed into gravitational potential energy. $\frac{1}{2} kx^2 = mgH$ $H = \frac{1}{2} kx^2 / (mg)$ = ½ (500)(0.020^2) / (0.0050 x 9.81) = 2.04 m = 204 cm	 M1 A1
(ii)	When the spring just started to recover from its 2.0 cm compression, the decrease in elastic potential energy will be equal to sum of increase in kinetic energy and gravitational potential energy. When the compression decreases to less than 0.00981 cm, the increase in gravitational potential energy is equal to the sum of the decrease in kinetic energy and elastic potential energy. After the spring reaches its natural length, the decrease in kinetic energy will be equal to the increase in gravitational potential energy.	B1 B0 B1

(iii)



[1 mark] for each of the following:

- EPE graph: correct shape and zero from 0.020 m to 2.04 m — B1
- GPE graph: straight line till 2.04 m (i.e. H value from (b)(i)) — B1
- KE graph: correct shape till 2.04 m (i.e. H value from (b)(i)) — B1

5(a)(i)

When the bob is at the greatest height,

T + mg = centripetal force

$$T + mg = \frac{mv^2}{r}$$ M1

If the string is just taut, then T = 0

$$0 + mg = \frac{mv^2}{r}$$ M1

$$\Rightarrow \frac{v^2}{r} = g$$

$\Rightarrow v = \sqrt{rg} = \sqrt{0.40 \times 9.81} =$ **1.98** m s^{-1}. **(accept 2.0** m s^{-1}**)** A1

(ii)

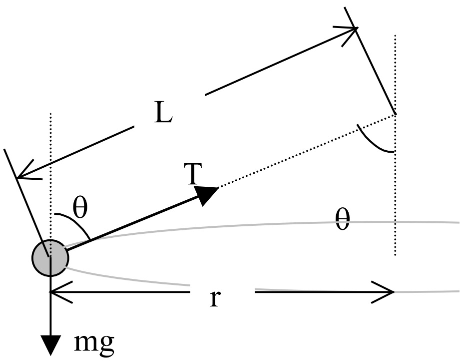
Loss in GPE = Gain in KE,

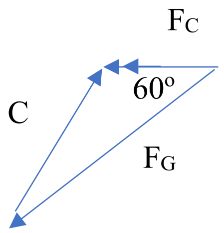
mg(2r) = final KE (at bottom) – initial KE (at top)

$$2mgr = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$2(9.81)(0.40) = \frac{1}{2}v^2 - \frac{1}{2}(1.98)^2$$ M1

∴ speed of bob at lowest point, v = **4.4 m s^{-1}**. A1

(b) (i)	 For circular motion, horizontal component of T provides Centripetal force $T \sin\theta = mr\omega^2$ $T \sin\theta = m(L \sin\theta)\,\omega^2$, since $r = L \sin\theta$ $T = mL\omega^2$ tension, $T = mL\,\omega^2 = mL\left(\frac{2\pi}{\tau}\right)^2$, where τ = period $T = (0.050)(1.00)\left(\frac{2\pi}{1.20}\right)^2$ = **1.37** N	 M1 M1 A1
(ii)	Since there is no acceleration in the vertical direction: $T \cos\theta = mg$ $1.37 \cos\theta = (0.050)(9.81)$ θ = **69°**	M1 A1
(c)(i)	$\omega = \frac{2\pi}{\tau} = \frac{2\pi}{1.35 \times 60 \times 60} = 1.29 \times 10^{-3}$ rad s^{-1}	A1
(ii)	$F_C = mr\omega^2 = (65.0)(8750 \times 10^3 \times \cos 60°)(1.29 \times 10^{-3})^2$ = 473 N	M1 A1
(iii)	<u>The resultant (centripetal) force is always perpendicular to the velocity / direction of motion.</u> So <u>work done is zero</u> hence no change in kinetic energy. OR using Newton's law with correct explanation on no component in tangential direction.	B1 B1
(iv)	$F_G = \frac{GMm}{r^2} = \frac{6.67 \times 10^{-11} \times 2.46 \times 10^{25} \times 65.0}{(8750 \times 10^3)^2}$ = 1390 N	M1 A1

(v)	 $C^2 = F_G{}^2 + F_C^2 - 2F_GF_C\cos 60°$ $C^2 = 1390^2 + 473^2 - 2(1390)(473)\cos 60°$ $C = 1220$ N	M1 A1
(vi)	Direction: **<u>no change</u>**; Magnitude: **<u>increases</u>**	A1
6(a)(i)	There are no horizontal forces acting on each body. Hence each body's <u>horizontal velocity</u> component is <u>constant.</u> There is a vertical downward force acting on each body and hence there is a <u>constant</u> <u>vertical</u> downward <u>acceleration</u> on each body. Hence the ball and the electron follow similar paths.	B1 B1
(ii)	a = 10^{15}g $\Rightarrow \frac{F}{m} = 10^{15}g$ $\therefore \frac{eE}{m} = 10^{15}g$ $\frac{1.60 \times 10^{-19} E}{9.11 \times 10^{-31}} = 10^{15}(9.81)$ $\therefore E = 5.59 \times 10^4$ V m^{-1}	M1 A1
(bi)	Magnetic force provides centripetal force Bqv = mv^2/r $r = \frac{mv}{Bq}$	M1 M1 M1 A0
(bii)	$r = \frac{mv}{Bq}$ = (2.0 × 10^{-25})(1.8 × 10^5) / (0.70 × 1.6 × 10^{-19}) = 0.32 m	A1
(biii)	Deflection will be less/ radius will increase *r* is proportional to *m* when all other variables are held constant (alternative wording accepted) OR {correct use of equation stating all other variables held constant}	A1 M1

7 **(a)** **(i)** $x = 2$ A1

(ii) *either* beta particle *or* electron B1

(b) **(i)** mass of separate nucleons = {(92 × 1.007) + (143 × 1.009)} u C1
= 236.931 u C1
binding energy = 236.931 u – 235.123 u
= 1.808 u A1

(ii) $E = mc^2$ C1
energy = $1.808 \times 1.66 \times 10^{-27} \times (3.0 \times 10^{8})^2$
= 2.7×10^{-10} J C1
binding energy per nucleon = $(2.7 \times 10^{-10}) / (235 \times 1.6 \times 10^{-13})$ M1
= 7.18 MeV A0

(c) energy released = (95 × 8.09) + (139 × 7.92) – (235 × 7.18) C1
= 1869.43 – 1687.3
= 182 MeV A1
(*allow calculation using mass difference between products and reactants*)