EUNOIA JUNIOR COLLEGE
JC2 MID YEAR EXAMINATION 2021
General Certificate of Education Advanced Level
Higher 1

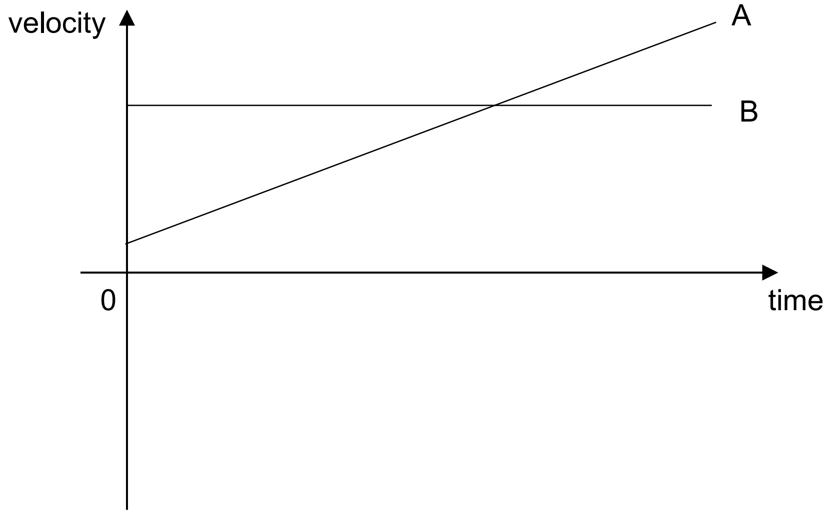
PHYSICS 8867/02

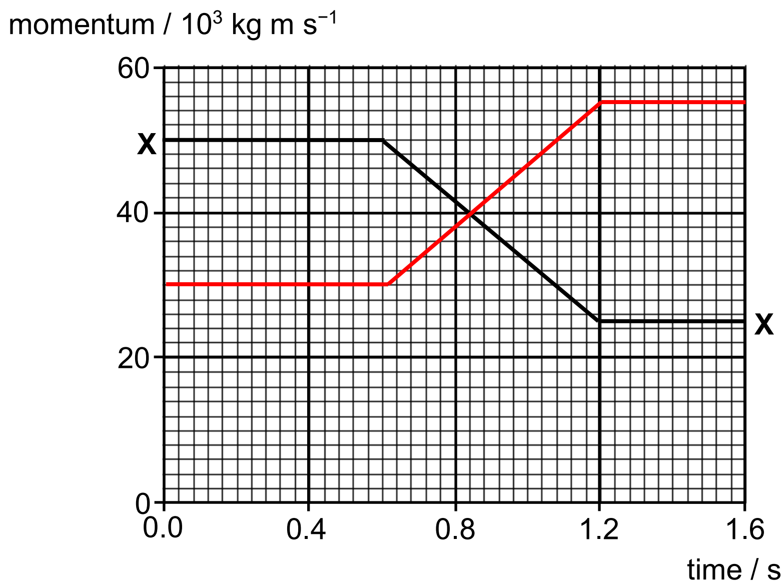
MARK SCHEME

July 2021

Section A

Question			Solution	Marks
1	(a)		Rate of change of velocity (with time)	B1
	(b)		Constant acceleration OR Motion in a straight line	B1
	(c)	(i)	$s_x = u_x t$ $25 = (50\cos 20^o)t$ $t = 0.53\ s$	C1 A1
		(ii)	$v_y = u_y + a_y t$ $v_y = 50\sin 20^o + (9.81)(0.53)$ $v_y = 22.3\ \text{m s}^{-1}$ $\tan\theta = \frac{v_y}{v_x} = \frac{22.3}{50\cos 20^o}$ $\theta = 25\ ^o$	C1 C1 A1
		(iii)	$s_y = u_y t + \frac{1}{2} a_y t^2$ $s_y = (50\sin 20^o)(0.53) + \frac{1}{2}(9.81)(0.53)^2$ $s_y = 10.4\ \text{m}$ $s = \sqrt{s_x{}^2 + s_y{}^2}$ $s = \sqrt{25^2 + 10.4^2}$ $s = 27\ \text{m}$	C1 C1 A1

		(iv)	 Accept positive or negative velocities.	**B1** **B1**

Question			Solution	Marks
2	(a)		Total momentum of a system remains constant provided no external resultant force acts on the system.	B1
	(b)	(i)	$\Delta P = P_f - P_i$ $= 25 \times 10^3 - 50 \times 10^3$ $= -25 \times 10^3 \text{ kg m s}^{-1}$	A1
		(ii)	 Initial momentum of Y is 30×10^3 kg m s^{-1} Momentum of Y *increases* by 25×10^3 kg m s^{-1}	B1 B1
		(iii)	$u_X = 25 \text{ m s}^{-1}$, $u_Y = 10 \text{ m s}^{-1}$, $v_X = 12.5 \text{ m s}^{-1}$, $v_Y = 18.3 \text{ m s}^{-1}$ total kinetic energy before collision = 775 kJ total kinetic energy after collision = 660 kJ Since the total kinetic energy before collision (775 kJ) is not equal to the total kinetic energy after collision (660 kJ), the collision in not elastic. OR relative speed of approach = 15 m s^{-1} relative speed of separation = 5.83 m s^{-1} Since relative speed of approach (15 m s^{-1}) is not equal to relative speed of separation (5.83 m s^{-1}), the collision is not elastic.	M1 A1 (M1) (A1)
		(iv)	$E_K = \frac{1}{2} m v^2 = \frac{1}{2}(1240)(22.2)^2 = 3.055608 \times 10^5 \text{ J}$	C1

			$\frac{\Delta E_K}{E_K} = \frac{\Delta m}{m} + 2\frac{\Delta v}{v}$ $\frac{\Delta E_K}{3.055608 \times 10^5} = \frac{20}{1240} + 2\frac{0.8}{22.2}$ $\Delta E_K = 0.3 \times 10^5$ J $E_K = (310 \pm 30)$ kJ	**C1** **A1**
	Examiner's Comments			

Question			Solution	Marks
3	(a)		$F = ma$ *Driving force* – mgsin9.0° = ma *Driving force* – (2500)(9.81)sin9.0° = (2500)(2.0) *Driving force* = 8837 N *Power* = Fv *Power* = (8837)(8.5) *Power* = 7.5×10^4 W	 **C1** **C1** **A1**
	(b)		loss in KE = gain in GPE + work done against friction $\left(\frac{1}{2}mu^2 - \frac{1}{2}mv^2\right) = mgh + (friction)(s)$ $\left(\frac{1}{2}(2500)(12)^2 - \frac{1}{2}(2500)(8.0)^2\right) = (2500)(9.81)\left(s\sin 9.0\right) + (500)(s)$ s = 23 m	**C1** **A1**
	Examiner's Comments			

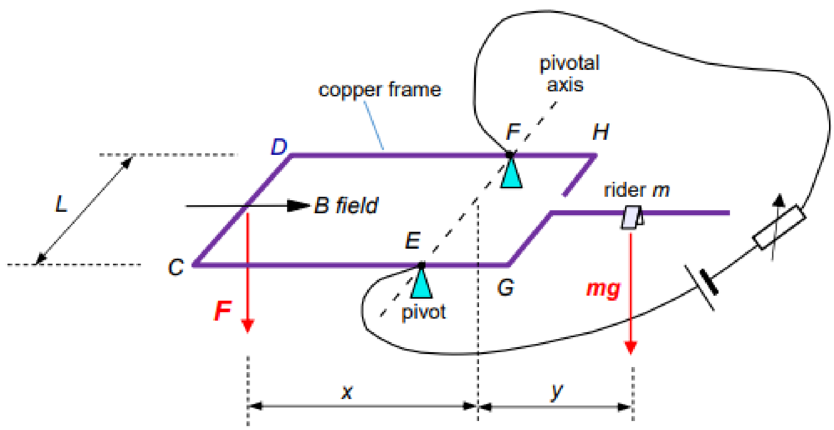
Question			Solution	Marks
4	(a)		gravitational force provides centripetal force $GMm / r^2 = mr\omega^2$ $\omega = 2\pi/T$ *Showing algebra clearly to reach answer*	**B1** **B1**
	(b)		Any two of the followings: appears to remain above the same point on the Earth has a period of 24 hours. equatorial orbit/orbits (directly) above the equator from west to east	 **B1** **B1**
	(c)		$(24 \times 3600)^2 = 4\ \pi\ r^3 \div (6.67 \times 10^{-11} \times 6.0 \times 10^{24})$ $r = 4.2 \times 10^7$ m $\omega = 2\pi \div (24 \times 60 \times 60) = 7.27 \times 10^{-5}$ rad s^{-1} $v = r\ \omega = (4.2 \times 10^7)(7.27 \times 10^{-5}) = 3.1 \times 10^3$ m s^{-1}	**M1** **M1** **A1**
	(d)		gravitational force is just sufficient to provide the centripetal force 'weight'/sensation of weight/contact force/reaction force is difference between F_G and F_C which is zero	**B1** **B1**
	Examiner's Comments			

Question				Solution	Marks
5	(a)	(i)		$t = s_x/v$ $= (40 \times 10^{-3}) \div (1.5 \times 10^7)$ $= 2.7 \times 10^{-9}$ s	A1
		(ii)	1.	change in velocity, Δv = change in y-component $= v_f \sin 20° - 0$ $= 1.6 \times 10^7 (\sin 20°)$ $= 5.5 \times 10^6$ ms^{-1}	C1 A1
			2.	By Newton's 2nd Law, the rate of change of momentum of the body must be in the same direction as the resultant force acting on the body. Hence the direction of the change in velocity must be in the same direction as the electric force which is vertically upwards.	B1 B1
		(iii)		**F = qE = ma** where $a = (V_y - u)/t$ and $E = V/d$ $(1.6 \times 10^{-19})V/(20 \times 10^{-3}) = 9.11 \times 10^{-31} \times (5.5 \times 10^6)/(2.7 \times 10^{-9})$ $V = 230$ V	M1 A1
		(iv)		For no deflection: Net force on the electron is zero Electric force = magnetic force $qE = Bqv$ $230 / (20 \times 10^{-3}) = B (15.0 \times 10^6)$ $B = 7.7 \times 10^{-4}$ T	M1 A1
	(b)			To find the radius of the semi-circle: Magnetic force provides the centripetal force for the electron to complete the circular path. $Bqv = mv^2/r$ $r = mv/Bq$ $= 9.11 \times 10^{-31} \times 1.5 \times 10^7 / [(7.7 \times 10^{-4})(1.6 \times 10^{-19})]$ $= 0.11$ m Circumference of circle $= 2\pi r = 2 \times \pi \times 0.11 = 0.691$ m Total distance travelled in 1 cycle $= 2 \times (40 \times 10^{-3}) + (0.691)$ $= 0.771$ m Time $= 0.771 / (1.5 \times 10^7) = 5.14 \times 10^{-8}$ s	M1 C1 A1
	Examiner's Comments				

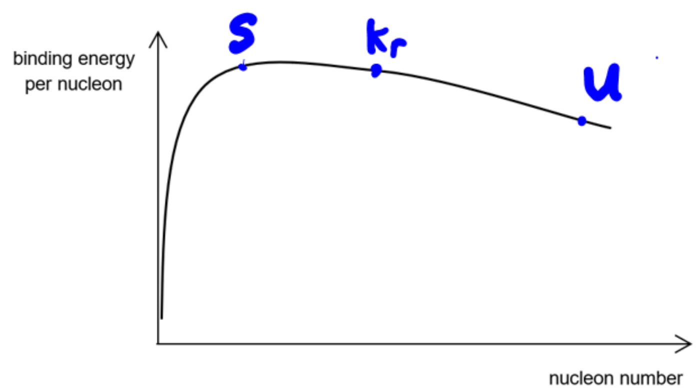
Question			Solution	Marks
6	(a)	assuming uniform deceleration, $v^2 = u^2 + 2as$ $a = \frac{v^2 - u^2}{2s} = \frac{0 - \left(\frac{185 \times 10^3}{60^2}\right)^2}{2(80)}$ $= -17 \text{ m s}^{-2}$ deceleration = 17 m s-1		C1 A1
	(b)	(i)	$a = \frac{v^2}{r}$ $v_{max} = \sqrt{ar} = \sqrt{4gr}$ $= \sqrt{4(9.81)(30)}$ $= 34 \text{ m s}^{-1}$	M1 A1
		(ii)	From Fig. 6.1 to increase the value of contact force by increasing the value of μ at high temperature. From Fig. 6.2, when tyres are heated, it becomes softer and can increase the contact area with the surface by covering up the air gap	B1 B1
	(c)	the wing is shaped to deflect air upwards. By N2L, air experiences a rate of change of momentum upwards and hence experiences an upward force By N3L, 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 (no marks awarded if only mention about force acting down on the car)		M1 M1 A0
	(d)	(i)	car is in rotational equilibirum. by principle of moments, about centre of gravity, sum of clockwise moments = sum of anti-clockwise moments $N_R x_R = N_F x_F + Dh$ car is in vertical translational equilbirum, vector sum of forces along vertical is 0 $N_R + N_F = W$ Sub N_F : $N_R x_R = N_F x_F + Dh$ $N_R x_R = (W - N_R) x_F + Dh$ $N_R (x_R + x_F) = W x_F + Dh$ $N_R = \frac{W x_F + Dh}{x_R + x_F}$	B1 B1 A0

		(ii)	$N_R = \dfrac{Wx_F + Dh}{x_R + x_F}$ $W - N_F = \dfrac{Wx_F + Dh}{x_R + x_F}$ $N_F = W - \dfrac{Wx_F + Dh}{x_R + x_F}$ $= \dfrac{Wx_R + Wx_F - Wx_F - Dh}{x_R + x_F}$ $= \dfrac{Wx_R - Dh}{x_R + x_F}$	**A1**
		(iii)	~~as~~ magnitude of D increases as the car accelerates magnitude of N_R increases and magnitude of N_F decreases since by vertical translational equilibirum $N_R + N_F = W$ a greater share of the weight is supported by the rear wheel as driving force increases	**B1** **B1**
	Examiner's Comments			

Section B

Question			Solution	Marks
7	(a)	(i)	Magnetic flux density is defined as the force per unit length per unit current acting on a conductor carrying a current, placed perpendicularly to the magnetic field.	B1 B1
		(ii)	kg s^{-2} A^{-1}	A1
		(iii)	Clearly labelled diagram:  Diagram – Presence of Pivots, Coil and Current Magnetic Force must be acting downwards Rider/Mass acting downwards Application of principle of moment: Showing the full equation. By measuring the current *I*, the mass m of the rider, the distances L, x and y, the magnetic flux density B can be determined.	B1 B1 B1 B1 B1
	(b)		When switch is opened: PD across the 4.0 Ω resistor = 12 / (0.5 + 4) x 4 = 10.667 V Power across the 4.0 Ω resistor = V^2/R = 28.45 W When switch is closed: 4//3 = 1.714 Ω PD across the 4.0 Ω resistor = 12/ (0.5 + 1.714) x 1.714 = 9.2899 V (Since 4 Ω and 3 Ω resistors are parallel, they have the same PD) Power across the 4.0 Ω resistor = V^2/R = 21.58 W Decrease in power = 28.45 – 21.58 = 6.87 W = 6.9 W (2 SF)	C1 C1 C1 M1 A1

	(c)	**(i)**	a spontaneous and random process in which an unstable nucleus emits particles or radiation to acquire a more stable state.	**B1** **B1**
		(ii)	A spontaneous process is one which is not triggered or affected by external factors such as temperature and pressure.	**B1**
		(iii)	A random process is one with a constant probability of decay (of a nucleus) per unit time and hence unable to predict which nucleus will decay.	**B1**
	(d)	**(i)**	0 = - (A – 4)v + 4V or equivilent	**A1**
		(ii)	$\frac{\text{initial kinetic energy of } \alpha\text{-particle}}{\text{initial kinetic energy of daughter-particle}} = \frac{\frac{1}{4}(4u)V^2}{\frac{1}{2}(A-4)uv^2}$ = … shows substitution of **(i)** … = $(\frac{1}{4}A - 1)$	**M1** **M1** **A0**
	Examiner's Comments			

Question			Solution	Marks
8	(a)	(i)	$R = \rho l / A$ $1200 = 15.0 \times 10^{-5} (0.25) / (1 \times 10^{-3} \times t)$ $t = 3.13 \times 10^{-5}$ m	M1 A1
		(ii)	1. Light dependent resistor	A1
			2. Correctly drawn LDR Output Potential should be on the graphite resistor	B1 B1
		(iii)	1. Current in the graphite resistor does not change because the PD across the graphite resistor is constant.	A1
			2. Connect the rheostat in series with other resistors	A1
	(b)		External load resistance = 20//60 = 15 Ω PD across the 20 Ω resistor = 12 / (15 + 5) x 15 = 9 V PD across the 50 Ω resistor = 9 / (50 + 10) x 50 = 7.5 V	C1 C1 C1 A1
	(c)	(i)		B1 B1 B1
		(ii)	the minimum work done to separate the individual constituent nucleons of a nucleus to infinity	B1 B1
		(iii)	the fission products have higher binding energy per nucleons binding energy = binding energy per nucleon × number of nucleons leading to higher total binding energy than the original nucleus product is more stable than original Hence heat is released	B1 B1 B1 B1
	Examiner's Comments			