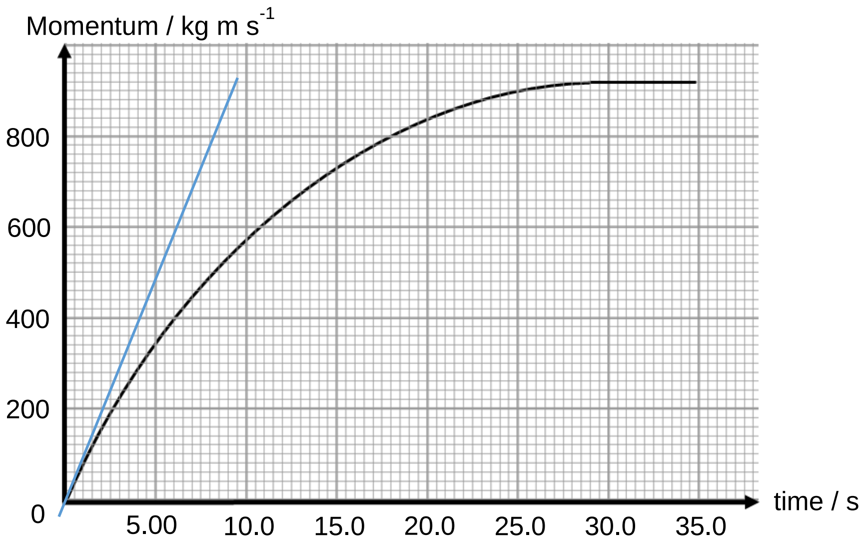
DUNMAN HIGH SCHOOL
2023 H2 PHYSICS (YEAR 6)

Answers to Prelim Exam H2 Physics Paper 2

Qn	Answer	Marks
1(a)	Speed is a physical quantity and can only be defined in terms of other physical quantities. Distance is a physical quantity, but <u>second is a unit for time</u> which cannot be used to define speed.	B1 B1
1(b)	Vertically, from *v* = *u* + *gt* and taking upward as positive, $-u\sin\theta = u\sin\theta - gT$ Time of flight, $T = \dfrac{2u\sin\theta}{g}$ Horizontally, from *s* = *ut* $R = (u\cos\theta)(T)$ $= (u\cos\theta)\left(\dfrac{2u\sin\theta}{g}\right)$ $= \dfrac{2u^2\sin\theta\cos\theta}{g}$	M1 M1 A1 A0
	Marker's comments: It is a "show" type of question and thus important that all steps, including substitution must be explained and shown.	
1(c)	Maximum *R* occurs when $\sin 2\theta = 1$. Hence $\theta = 45^o$	A1
1(d)	$R_0 = \dfrac{u^2}{g}$ $\dfrac{45.36\text{ km}}{1\text{ h}} = \dfrac{45.36(1000)\text{ m}}{(60)(60)\text{ s}} = 12.6\text{ m s}^{-1}$ $g = \dfrac{u^2}{R_0}$ $= \dfrac{(12.6)^2}{16.3}$ $= 9.7399\text{ m s}^{-2}$ $\dfrac{\Delta g}{g} = 2\dfrac{\Delta u}{u} + \dfrac{\Delta R_0}{R_0}$	C1 A1

	$\frac{\Delta g}{9.7399} = 2\left(\frac{3}{100}\right) + \frac{4}{100}$ $\Delta g = 0.97$ $= 1 \text{ m s}^{-2}$ (to 1 s.f.) Therefore, $g = (10 \pm 1)$ m s^{-2}	A1 A1
	Marker's comments: Uncertainty should only be left to 1 sig fig. The final answer and its uncertainty should have the same d.p. It is important to convert the speed to m s^{-1} to obtain g in units of m s^{-2}. Also, there were mistakes in understanding the meaning of percentage uncertainty.	
2(a)	The upthrust is the <u>resultant upward</u> force due to the <u>larger</u> pressure exerted by the fluid at the bottom compared to the top surface of the body.	B1
2(b)	Upthrust $= W_{\text{displaced fluid}}$ $= \rho_{fluid} V_{cannon} g$ $= 1050\left(\frac{800}{8000}\right)(9.81)$ $= 1030$ N (shown)	M1 A0
	Marker's comments: It is a "show" type of question and thus important that all steps, including substitution must be explained and shown.	
2(c)	The rate of change of momentum of a body is directly proportional to the <u>resultant</u> force acting on the body and occurs in the direction of the <u>resultant</u> force.	B1
2(d)	During its upward motion, the cannon experiences viscous <u>drag force</u> which acts in the opposite direction of its motion and <u>increases with the speed of the cannon.</u> Net force on canon = upthrust – (weight + drag force) <u>decreases</u> (since weight and upthrust are constant) Since the net upward force decreases over time, the momentum increases non-linearly (since the net force is directly proportional to the rate of change of momentum)	B1 B1
	Marker's comments: Very often, drag force is not mentioned. There were misconception that the upthrust decreases causing net force to decrease or the velocity decreases while the momentum increases.	

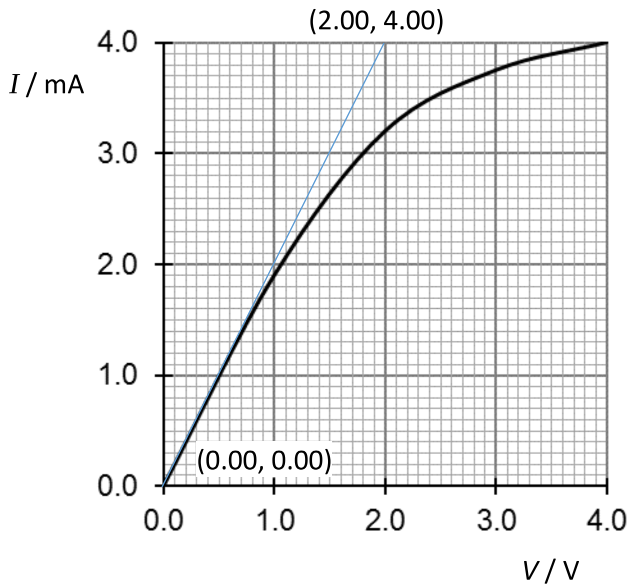
2(e)	 gradient of tangent line $= F_{net}$ $= \dfrac{400-0}{4-0}$ $= 100$ N (M1 for tangent line and computing gradient correctly) Net force on cannon = upthrust of cannon and bag – weight of cannon $F_{net} = \underline{U} - W$ $100 = U - (800)(9.81)$ $U = 7948$ N Hence upthrust on bag = 7948 – 1030 = 6918 N For the bag, $\underline{U} = V\rho g$ $6918 = V(1050)(9.81)$ $V = 0.672$ m	M1 C1 A1
	Marker's comments: Poorly attempted. Gradient not drawn to obtain the initial net force.	
3(a)	friction on the mass provides the centripetal force for the circular motion of the mass	B1
	For mud to remain on the plate, $0.72W \geq md\omega^2$ $0.72mg \geq 0.35m\omega^2$ $\omega \leq 4.49$ rad s^{-1}	M1 C1

	number of revolutions $\leq \frac{4.49}{2\pi} \times 60$ $= 42\ \text{min}^{-1}$	A1
	Marker's comments: The question says to explain your working. As such, a statement that friction provides centripetal force to explain before equating the two forces. There were mistakes made in units of ω or to convert rad s^{-1} to number (an integer) of revolutions per minute.	
3(b)	centripetal force increases as *r* increases/ centripetal force is larger at the edge	M1
	so mud slips off at the edge first.	A1
	Marker's comments: Mud will slip off the plate when friction is not enough to provide the required centripetal force. Students also did not realise that ω is the same for mud near the centre or edge.	
4(a)	acceleration is directly proportional to its displacement from a fixed point	B1
	acceleration is always in opposite direction to its displacement/always towards the fixed point)	B1
	Marker's comments: Majority of candidates got it wrong.	
4(b)	(table below)	
	displacement line correct	B1
	acceleration line opposite to displacement line	B1
	velocity line has B D & F as zero with answers to C and E consistent with their displacement line	B1
	Marker's comments: Candidates demonstrated understanding of vector concepts.	
4(c)(i)	phase difference between displacement and velocity is $\pi/2$ OR $3\pi/2$ radians OR 90°	B1
4(c)(ii)	displacement and acceleration are exactly out of phase OR out of phase by π radians OR 180°	B1
4(d)(i)1	amplitude = 8.0 cm	A1

Table for 4(b):

	B	C	D	E	F
displacement	+	0	–	0	+
velocity	0	–	0	+	0
acceleration	–	0	+	0	–

4(d)(i)2	T = 2.0 s so f = 0.50 Hz	A1
4(d)(ii)1	$F = mA\omega^2$ $= 0.020 \times 0.080 \times (2\pi/2.0)^2 = 0.0158$ N (or 0.016 N)	A1
4(d)(ii)2	negative cosine graph of any amplitude for at least 3.5 s	B1
	Marker's comments: Poorly and wrongly drawn graph. Some negative sine graph were also drawn.	
5(a)	electric field strength is the force acting per unit positive charge	B1
5(b)	equally spaced, parallel straight lines with arrows down over most of space between plates curved lines shown at edges (showing weaker, non-uniform field)	B1 B1
	Marker's comments: Common mistakes of unequal spacing between field lines and wrong direction of electric field were observed.	
5(c)(i)	(W =) VQ	B1
5(c)(ii)	(W =) Fd	B1
5(d)	$VQ = Fd$ so $F / Q = V / d$ i.e., force per unit charge = potential gradient	B1
	(magnitude of) electric field strength between the plates is <u>equal to</u> the potential gradient	B1
	Marker's comments: Candidates could not use the answers in the previous part to deduce the relationship. Some used electric field is force per unit positive charge instead of getting the expression for electric field to deduce the relationship to potential gradient.	
6(a)	As V increases, I increases initially. Further increase of V will cause a less than proportionate increase in I Since resistance is the ratio of potential difference to current, the resistance of the filament lamp increases.	B1 B1
	Marker's comments: Common mistakes stated by candidates that the resistance is the reciprocal of the gradient of the I-V graph.	

6(b)	 The minimum resistance can be determined by drawing the tangent of the graph at the origin. gradient of tangent $= \frac{(4.00-0.00)\times10^{-3}}{2.00-0.00} = 2.00\times10^{-3}$ Hence, resistance $= \frac{1}{2.00\times10^{-3}} = 500\ \Omega$	M1 C1 A1
6(c)	From Fig. 6.1, when V = 4.00 V, I = 4.00 mA resistance of wire $R = \frac{4.00}{4.00\times10^{-3}} = 1000\ \Omega$ resistivity $\rho = \frac{RA}{L}$ $= \frac{(1000)\left(\frac{\pi}{4}\times(0.046\times10^{-3})^2\right)}{2.0}$ $= 8.3\times10^{-7}\ \Omega$ m	M1 C1 A1
6(d)	From Fig. 6.1, when I = 1.0 mA, V = 0.500 V = terminal p.d. across cell $E - Ir = 0.500$ $E - (1/1000)(0.50) = 0.500$ $E = 0.5005$ V	C1 A1

7(a)(i)	electron	B1
7(a)(ii)	any two: • can be deflected by electric and magnetic fields or negatively charged • absorbed by few (1 – 4) mm of aluminum / 0.5 to 2 m or metres for range in air • speed up to 0.99c / range of speeds / energies	B2
7(a)(iii)	decay occurs and cannot be affected by external / environmental factors such as chemical / pressure / temperature / humidity (any two stated factors)	B1
7(b)	3 and 0 for superscript numbers 2 and –1 for subscript numbers	B1
7(c)	energy = $5.7 \times 10^3 \times 1.6 \times 10^{-19}$ (= 9.12×10^{-16} J) $v^2 = \frac{2 \times 9.12 \times 10^{-16}}{9.11 \times 10^{-31}}$ $v = 4.5 \times 10^7$ m s^{-1}	C1 A1
8(a)(i)	It represents the <u>rated</u> power output that the turbine is expected to generate under <u>ideal</u> operating conditions. The actual power output can vary based on factors such as wind speed and availability, air density, turbulence, temperature, altitude, and other environmental conditions.	B1
8(a)(ii)	The energy <u>demand</u> or consumption of homes can <u>vary</u> significantly depending on factors such as the size of the house, the number of occupants, energy-efficient appliances, and individual usage patterns.	B1
8(b)	Minimum height = 56 – 44/2 = 34 m	A1
8(c)(i)1	600 kW	A1
8(c)(i)2	15.0 m s^{-1}	A1
8(c)(ii)1	$E_{max} = \frac{1}{2}\pi r^2 v^3 \rho = \frac{1}{2}\pi\left(\frac{44}{2}\right)^2 (15.0)^3 (1.25)$ $= 3.21 \times 10^6$ W	C1 A1

8(c) (ii)2	Overall efficiency $= \frac{P_{out}}{P_{in}} \times 100\% = \frac{600 \times 10^3}{3.21 \times 10^6} \times 100\%$ $= 18.7\%$	C1 A1
8(c) (iii)	$P_{remaining} = P_{in} - P_{out} - 10\% P_{in}$ $= 2.29 \times 10^6$ W (3 s.f.)	C1 A1
8(c) (iv)1	25 m s^{-1}	A1
8(c) (iv)2	A safety measure: it helps avoid overloading of the electrical system and generator, preventing equipment damage or electrical failures. OR At high wind speeds, the forces acting on the blades can become excessive, potentially causing damage such as blade failure, gearbox stress, or tower vibrations. [If the cut-out mechanism also involves shutting down the turbine and feather the blades – turn them out of the wind) to prevent over-rotation.]	B1 [B1]
8(d) (i)	Alternating current because in Fig. 8.3, it shows a frequency of 50 Hz. (Accept explanation using A.C. generator concept: e.g., as the hub and blades rotate, they drive the generator's rotor, which contains magnets or magnetic fields. This rotor is mounted on a shaft and rotates within proximity to a stationary coil. This relative motion results in a dynamic change in magnetic flux linkage, which, in turn, induces an e.m.f. in the coil. This induced voltage takes the form of AC because the rotor's rotation periodically alters the magnetic field's orientation relative to the coil.)	B1 B1
8(d) (ii)	$P_{\text{nominal}} = I_{\text{nominal}} V$ $I_{\text{nominal}} = \frac{500 \times 10^3}{690}$ $= 725$ A (3 s.f.)	C1 A1
8(e) (i)	The rotor blades of a wind turbine are typically the highest and most exposed part of the entire structure, and most likely to be struck by lightning. Their height and exposure, positioning, blade geometry (e.g., pointed tips) make them more susceptible.	B1 B1
8(e) (ii)	Installing a lightning protection system (lightning rods in blades to attract lightning strikes) and proper grounding (connecting metal parts of the turbine with conductive cables or grounding systems) to create low resistance path to dissipate the lightning current to the ground. Additional information: Wind turbine blades are commonly made using composite materials (e.g., fiberglass-reinforced composites) that are non-	B1 B1

	conductive. Manufacturers must often incorporate lightning protection systems into the blade design to mitigate the risk associated with lightning strikes.	