Physical Quantities & Units

Mark Scheme 1

Level	International A Level
Subject	Physics
Exam Board	CIE
Topic	Physical Quantities & Units
Sub Topic	
Paper Type	Theory
Booklet	Mark Scheme 1

Time Allowed: **90 minutes**

Score: **/75**

Percentage: **/100**

A*	A	B	C	D	E	U
>85%	'77.5%	70%	62.5%	57.5%	45%	<45%

1	**(a**	power = work / time or energy / time or (force × distance) / time	B1	
		$= \text{kg m s}^{-2} \times \text{m s}^{-1} = \text{kg m}^2\text{ s}^{-3}$	A1	[2]
	(b)	power = VI [or V^2/R **and** $V = IR$ or I^2R **and** $V = IR$]	B1	
		(units of V:) $\text{kg m}^2\text{ s}^{-3}\text{ A}^{-1}$	B1	[2]
2	**(a**	(work =) force × distance or force × displacement or (W =) $F \times d$	M1	
		units of work: $\text{kg m s}^{-2} \times \text{m} = \text{kg m}^2\text{ s}^{-2}$	A1	[2]
	(b)	(p.d. =) $\dfrac{\text{work (done) or energy (transformed) (from electrical to other forms)}}{\text{charge}}$	B1	[1]
	(c)	$R = V/I$	B1	
		units of V: $\text{kg m}^2\text{ s}^{-2}/\text{A s}$ **and** units of I: A	C1	
		or		
		$R = P/I^2$ [or $P = VI$ **and** $V = IR$]	(B1)	
		units of P: $\text{kg m}^2\text{ s}^{-3}$ **and** units of I: A	(C1)	
		or		
		$R = V^2/P$	(B1)	
		units of V: $\text{kg m}^2\text{ s}^{-2}/\text{A s}$ **and** units of P: $\text{kg m}^2\text{ s}^{-3}$	(C1)	
		units of R: ($\text{kg m}^2\text{ s}^{-2}/\text{A}^2\text{s}$ =) $\text{kg m}^2\text{ s}^{-3}\text{ A}^{-2}$	A1	[3]

3	**(a**	150 or 1.5×10^2 Gm	A1	[1]
	(b)	distance = $2 \times (42.3 - 6.38) \times 10^6$ (= 7.184×10^7 m)	C1	
		(time =) $7.184 \times 10^7 / (3.0 \times 10^8) = 0.24$ (0.239) s	A	[2]
	(c)	units of pressure P: $kg\,m\,s^{-2} / m^2 = kg\,m^{-1}\,s^{-2}$	M1	
		units of density ρ: $kg\,m^{-3}$ and speed v: $m\,s^{-1}$	M1	
		simplification for units of C: $C = v^2\,\rho / P$ units: $(m^2\,s^{-2}\,kg\,m^{-3}) / kg\,m^{-1}\,s^{-2}$ and cancelling to give no units for C	A1	[3]
	(d)	energy and power *(both underlined and no others)*	A1	[1]
	(e) (i)	vector triangle of correct orientation	M1	
		three arrows for the velocities in the correct directions	A1	[2]
	(ii)	length measured from scale diagram 5.2 ± 0.2 cm or components of boat speed determined parallel and perpendicular to river flow	C1	
		velocity = 2.6 $m\,s^{-1}$ (allow ± 0.1 $m\,s^{-1}$)	A1	[2]
4	**(a**	temperature current (allow amount of substance and luminous intensity)	B1	[2]
	(b)	base units of force constant: $kg\,m\,s^{-2}\,m^{-1}$ or $kg\,s^{-2}$	B1	
		base units of time and mass: s and kg	C1	
		base units of C: $s\,(kg\,s^{-2} / kg)^{1/2}$ cancelling to show no units	B1	[3]

5	**(a**	ampere	B1	
		kelvin	B1	[2]
		(allow mole and candela)		
	(b) **(i)**	stress: N m^{-2}	C1	
		kg m s^{-2} / m^2 = kg m^{-1} s^{-2}	A1	[2]
	(ii)	Young modulus = stress / strain and <u>strain has no units</u> hence units: kg m^{-1} s^{-2}	B1	[1]
6	**(a**	displacement / velocity / acceleration / momentum / etc. three correct (none wrong) 2, two correct (none or one wrong) 1	A2	[2]
	(b) **(i)**	Y = 70 N [allow 71 N as +½ small square on graph]	A1	[1]
	(ii)	θ = 90°	M1	
		(for equilibrium) the direction of Y must be <u>opposite</u> to Z		
		or using $Y \sin\theta = Z$, hence $\sin\theta = 70 / 70 = 1$, $\theta = 90°$	A1	[2]
	(iii) **1.**	$Y \cos\theta = 160$ and $Y \sin\theta = 70$	C1	
		$\tan\theta = 70/160$ hence $\theta = 23.6°$ (24°)	A1	[2]
	2.	Y = 160 / cos 23.6° or 70 / sin 23.6°	C1	
		= 174.6 or 175 or 170 N	A	[2]
		or:		
		$160^2 + 70^2 = Y^2$	(C1)	
		Y = 174.6 or 175 or 170 N	(A1)	
	(c)	(equilibrium not possible as) there is no vertical component from Y to balance Z	B1	[1]

7	**(a**	power = energy / time *or* work done / time force: $kg\,m\,s^{-2}$ (including from *mg* in *mgh* or *Fv*) *or* kinetic energy ($\frac{1}{2}mv^2$): kg $(m\,s^{-1})^2$	B1	
		(distance: m and (time)$^{-1}$: s^{-1}) and hence power: $kg\,m\,s^{-2}\,m\,s^{-1} = kg\,m^2\,s^{-3}$	B1	[3]
	(b)	Q/t : $kg\,m^2\,s^{-3}$	C1	
		A: m^2 and x: m and T: K	C1	
		correct substitution into $C = (Qx)/tAT$ or equivalent, or with cancellation	C1	
		units of C : $kg\,m\,s^{-3}\,K^{-1}$	A1	[4]
8	**(a**	current, mass and temperature two correct 2/2, one omission or error 1/2	A2	[2]
	(b)	σ : no units, V: m^3	C1	
		E_P: $kg\,m^2\,s^{-2}$	C1	
		C: $kg\,m^2\,s^{-2} \times m^{-3} = kg\,m^{-1}\,s^{-2}$	A1	[3]
9	**(a**	kelvin / K	B1	
		ampere / amp / A [allow mole / mol and candela / Cd]	B1	[2]
	(b) (i)	energy OR work = force × distance [allow any energy expression]	C1	
		units: kg m s^{-2} × m OR kg $(m\,s^{-1})^2$ for ½ mv^2 or mc^2 (ignore any numerical factor)	M1	
		= kg m^2 s^{-2}	A0	[2]
	(ii)	units: ρ: $kg\,m^{-3}$ g: $m\,s^{-2}$ A: m^2 l_0: m	C1	
		C: $kg\,m^2\,s^{-2}$ / $kg^2\,m^{-6}\,m^2\,s^{-4}\,m^2\,m^3$ [any subject]	C1	
		= $kg^{-1}\,m\,s^2$ (allow $m\,s^2/kg$)	A1	[3]

10	volume = π $(14 \times 10^{-3})^2 \times 12 \times 10^{-3}$ (=7.389×10^{-6} m^3)	C1	
	density = mass / volume [any subject]	C1	
	mass = $6.8 \times 10^3 \times 7.389 \times 10^{-6}$ = 0.0502		
	weight = *mg*	C1	
	= 0.0502×9.81 = 0.49 N (mark not awarded if not to **two** s.f.)	A1	[4]

11	**(a** power = energy / time	C1	
	= (force × distance / time) = kg m^2 s^{-2} / s	C1	
	= kg m^2 s^{-3}	A1	[3]
	(b) (i) units of L^2: m^2 and units of ρ: kg m^{-3} and units of v^3: m^3 s^{-3}	C1	
	($C = P / L^2 \rho v^3$) hence units of *C*: kg m^2 s^{-3} m^{-2} kg^{-1} m^3 m^{-3} s^3		
	or any correct statement of component units	M1	
	argument /discussion / cancelling leading to *C* having no units	A1	[3]
	(ii) power available from wind = $3.5 \times 10^5 \times 100 / 55$ (= 6.36×10^5)	C	
	$v^3 = 3.5 \times 10^5 \times 100 / (55 \times 0.931 \times (25)^2 \times 1.3)$	C1	
	v = 9.4 m s^{-1}	A1	[3]
	(iii) not all kinetic energy of wind converted to kinetic energy of blades	B1	
	generator / conversion to electrical energy not 100% efficient / heat produced in generator / bearings etc	B1	[2]
	(there must be cause of loss and where located)		